1976

# Maine Comprehensive Energy Plan

Maine. Office of Energy Resources

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B. Peters
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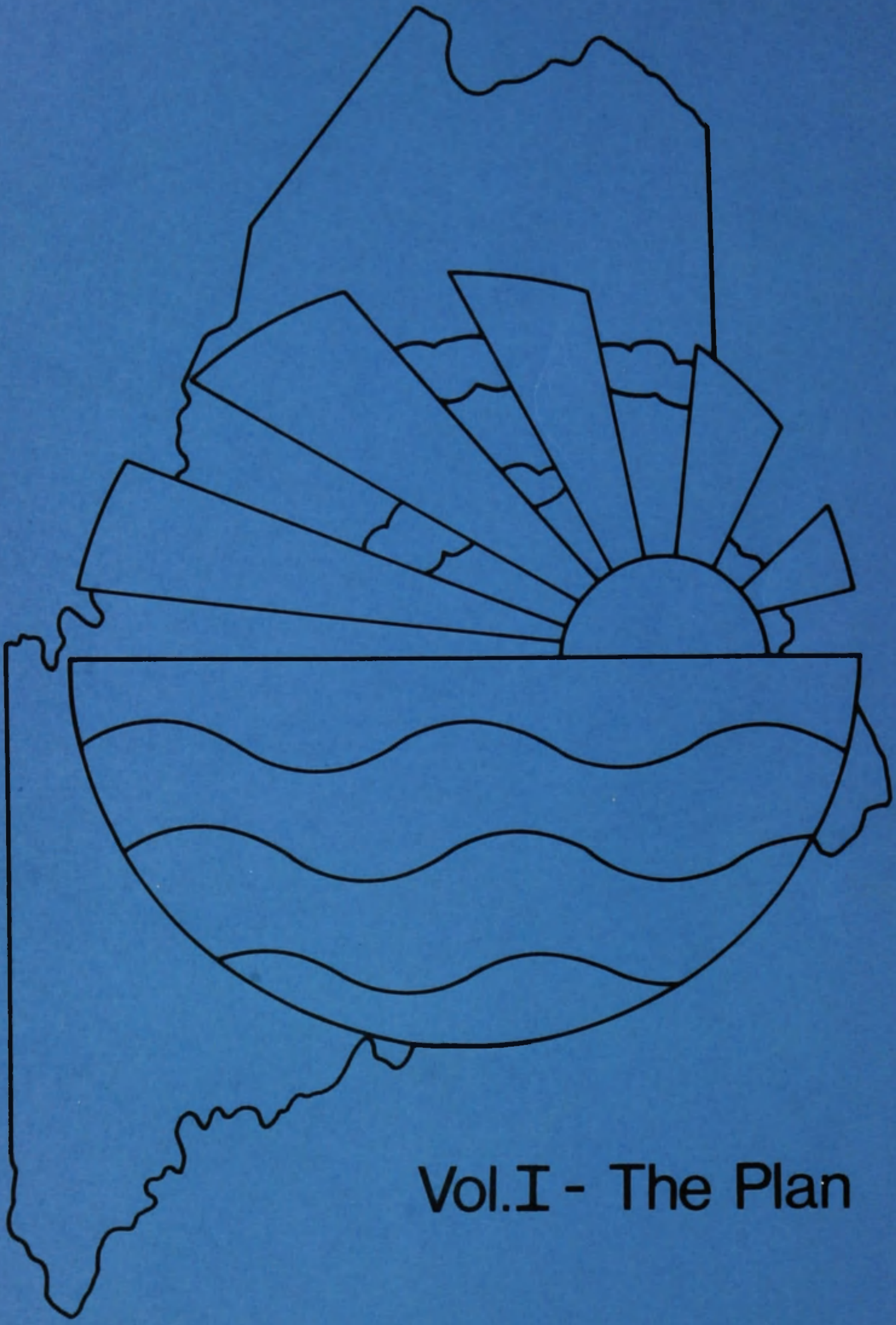
# MAINE COMPREHENSIVE ENERGY PLAN
## 1976 EDITION



Vol.I - The Plan

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To: Governor James B. Longley
Members of the 108th Legislature

There is no quick or easy way to find economically and politically acceptable solutions to the energy problems of the State of Maine. This task will require a sustained effort through the next decade at least, regardless of administrative or political changes.

We have tried, through this document, to provide you with information which you can use in making some of the necessary decisions about Maine's energy future. This document will be out-of-date almost immediately. The recommendations contained herein must, therefore, be considered preliminary recommendations. More complete analysis should be accomplished before many of the aspects of a State Energy Policy are finalized. If you decide that it is in the best interests of the State of Maine that this further analysis be performed, the staff of the Office of Energy Resources is prepared to undertake the necessary work.

Energy is fundamental to the State's economy and the health and welfare of her people. Changes in our existing energy system should be made only when, after careful balancing of <u>all</u> factors, a change is deemed desirable for the long-term good of the people of Maine. To that end, we feel this report and all subsequent reports of this Office should receive widespread public discussion and debate.

No small State Agency can possibly have all the answers, however hard we seek them. We have tried and will continue to try to present an objective discussion of Maine's energy picture and to make recommendations based on such objectivity. We must leave to you the ultimate task of deciding Maine's energy future. We sincerely hope that this document will be of some assistance in the decision-making process.

Sincerely yours,

Abbie C. Page

Abbie C. Page
Director

ACP/rw
Enclosure

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# CREDITS

The Office of Energy Resources is indebted to many people for their efforts and contributions in the preparation of this first volume of the Comprehensive Energy Plan for Maine. In particular, we would like to thank Dr. Carl E. Veazie of the Public Affairs Research Center (PARC) at Bowdoin College for his tireless efforts in assembling the historical data used in preparing Chapter I and II of this report, and from which future scenarios were projected. We are also indebted to Professor Richard Hill of the Department of Industrial Cooperation at the University of Maine at Orono for his insights and contributions in the area of Alternate Energy Sources for Maine. The Office of Energy Resources is also indebted to the Maine Society of Professional Engineers from whom we borrowed the idea of the resource inventory tables in Chapter 4.

Others who have contributed so generously of their time and efforts are the members of the Comprehensive Energy Plan Task Force (Peter Bradford, Professor Richard Hill, P. Andrew Nixon, Professor William Shipman, Elwin W. Thurlow, George Bourassa, John Joseph, Guy Twombley, Steve Weems, and Russell Spinnev) and the members of the Energy Resources Advisory Board (Harold G. Loring, Frederick E. Hutchinson, Audbur J. Drake, Richard R.J. Morin, Jack L. Cook, Senator Howard M. Trotzky, Representative James B. Wagner, and Leslie H. Stanley). We sincerely appreciate the patience and understanding of all of these disinguished gentlemen as they assisted and guided us in the preparation of this document.

Special thanks go to the clerical staff at the Office of Energy Resources as they typed the several rough drafts that have led to this draft manuscript for review. It is through their diligent efforts that this plan has been assembled and prepared for your inspection.

Several reports preceded this one, dealing with the energy situation in Maine to varying degrees. The most complete and thorough of these reports was "Energy Policy for the State of Maine" by William D. Shipman and Carl E. Veazie of the Public Affairs Research Center (PARC) of Bowdoin College, published in June 1973 and commonly referred to as "The PARC Report." The report which you are now reading draws heavily upon the methodologies of that study, and Mr. Veazie has been primarily responsible for the preparation of the historical data and the 1974 base year scenario found in Chapter I and II of this report.

Other studies dealing wholly or in part with energy in Maine have been "Interim Energy Policy and Comprehensive Energy Plan for the State of Maine", Report to the 107th Legislature by the State of Maine Office of Energy Resources, January 1975; "Energy, Heavy Industry, and the Maine Coast", Report of the Governor's Task Force, 1972; "Historical Data on New England's Energy Requirements", prepared for the New England Regional Commission by Arthur D. Little, Inc., September 1974; "Preliminary Projections of New England's Energy Requirements" prepared for the New England Regional Commission by Arthur D. Little, Inc., September 1975; "Report to James B. Longley, Governor, State of Maine" from the Governor's Economic Advisory Committee, November 1975; "Report to James B. Longley, Governor, State of Maine" from the Governor's Special Advisory

Committee concerning the Structure and Operations of Maine's Electric Utility Industry, December 1975; "Electric Power Demand and Supply in New England: A Review of Trends and Forecasts", prepared for the New England Regional Commission by Booz, Allen, and Hamilton, Inc., January 15, 1975; and a series of issue papers by Brookhaven National Laboratories under ERDA's Regional Energy Studies Program dealing with "A Perspective on the Energy Future of the Northeast United States." (See the bibliography in Volume II of this report for a complete listing of the Brookhaven issue papers and other references used in the preparation of this report). All of the above listed documents were used extensively in the development of this report. Credit is due to them for much of the material contained herein, even where specific references and direct quotations are not cited.

# ORGANIZATION OF THE PLAN

One of the most difficult tasks which we faced in the initial stages of drafting the state energy plan was the organization, in logical sequence, of the necessary and desirable information needed to create a plan. This task appears simple on the surface but is actually quite difficult due to the complexity of our energy supply and demand systems and the paucity of available data to describe energy flows throughout our economy. After much deliberation the Office of Energy Resources decided upon the organizational format below:

(1) Presentation of available historical information on energy demands, supplies, and prices. Chapter 1 of this document.

(2) Presentation of the complete energy flows for the latest year for which complete data is available. Chapter 2 analyzes the flows of energy in Maine for the reference year 1974.

(3) Projections of possible future energy demands and prices. Realizing that accurate prediction was an unattainable goal, we chose to present a "bandwidth" of possible demands; that is, we present three alternative "scenarios" labeled "low", "medium" (Business as Usual), and "high" (full recovery) demand. Chapter 3 of this document covers these demand and price scenarios.

(4) Inventory of energy resources available to meet future energy demands. Two types of energy resources are classified: native (indigenous) resources (those within Maine) and "exogenous" resources (those from beyond the State's boundaries). Some speculations are made on the national supply and price of energy resources available to supply Maine's demand for energy. Much more work needs to be done on this topic, but the information which we have assembled thus far is covered in Chapter 4 of this document.

(5) Policy implications of alternative ways of meeting Maine's future energy needs. Originally, it was hard to determine the ultimate value of a plan created by a public agency having neither authority to manage resources, nor regulatory authority at its disposal to implement the plan! We finally decided that our role was that of policy analysts, and that we were limited to weighing pro's and con's of each type of energy development as an essential prelude to making decisions on the wise allocation of energy resources. Energy development, in reality, cannot take place apart from the development of our entire social structure in Maine, and we must analyze the risks and benefits of energy options open to us.

In Chapter 5, we organize and analyze what we consider to be the major energy policy topics facing Maine, and some preliminary recommendations are made.

# INTRODUCTION

## LEGISLATIVE MANDATE

In June, 1975, the 107th Maine Legislature enacted, and Governor James B. Longley signed into law, LD #1913, re-establishing the Office of Energy Resources. This law assigned to the Office of Energy Resources the responsibility to:

> "Prepare a comprehensive energy resources plan to be revised and updated at least annually and more often as the Director of the Office of Energy Resources or the State Legislature deem necessary.
>
> The Comprehensive Plan shall include but is not limited to, a description and quantification of the present supply, rates of use and energy needs of the State; a description and quantification of the projected needs, rate of use and availability of various energy resources to meet future State needs; 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."

The action by the 107th Legislature gives recognition to the appropriate role of State Government in planning to meet Maine's energy needs. Each energy supply industry has historically provided its own forecasts and planned to meet its own anticipated future demands. In the past corporate goals may have precluded objectivity of analysis at least insofar as the public interest is concerned. An impartial public agency is in a position to assess alternative energy systems on their merits, consider each with respect to energy conservation, economics, and environmental and social impacts, and make recommendations regarding future directions based on such assessments.

Where factors blocking the development of the most desirable energy resources are political and/or institutional, rather than technological or economic, a public agency may be most effective at overcoming the obstacles impeding such resource development.

We begin this work with no preconceived notions and with very little by way of satisfactory examples developed in other states. We do not consider this document to be a completed comprehensive energy plan for Maine. It provides the groundwork for such a plan, and a reasonable approach to further plan development. The Office of Energy Resources will continue development and refinement of this energy plan for Maine's future as more complete and more detailed information becomes available.

# CHAPTER - I

## HISTORICAL ENERGY DEMANDS
## 1950-1974

### INTRODUCTION

There is a basic equation of energy use in Maine or any other geographical entity:

$$\begin{array}{l}\text{native}\\\text{energy}\\\text{production}\end{array} + \begin{array}{l}\text{imported}\\\text{energy}\\\phantom{x}\end{array} = \begin{array}{l}\text{energy}\\\text{consumption}\\\text{in Maine}\end{array} + \begin{array}{l}\text{exported}\\\text{energy}\\\phantom{x}\end{array}$$

There is much sentiment on the part of Maine people for eliminating, as much as possible, the "import" and "export" terms of the above equation, for increasing native energy production and for reducing energy consumption.

However, it is doubtful that Maine will ever be an isolated system, where the amount of energy produced from Maine's own resources will exactly equal the amount of energy consumed in the State. It is important to remember this fact. Maine is quite permanently tied to the rest of the nation, and even the very best plans and policies for self-sufficiency will eventually be significantly modified by market and political forces external to the control of Maine and her people.

The first place to start in constructing an energy plan is to examine, in detail, the historical evaluation of the factors in the above equation. There are many ways of doing this, and of them, we have chosen what we think is the simplest: namely to describe first the historical demands for energy by demand sector, then the historical demands for each fuel type. We conclude this chapter with a brief description of historical energy prices.

# CHAPTER I - PART I

## HISTORICAL ENERGY CONSUMPTION BY DEMAND SECTOR

In this report, we define Maine's Demand Sectors as those segments of the Maine economy that can be separated and studied fairly easily, because the data on energy consumption is obtainable. We have analyzed five demand sectors, as shown below:

| Residential | Commercial | Transportation | Industrial | Miscellaneous |
|---|---|---|---|---|
| Single family | Hospitals | Cars | "Primary" | Government |
| Multiple family | Schools | Trains | Fishing | Military |
| etc. | Stores | Busses | Agriculture | etc. |
| | Churches | Boats | Pulp & Paper | |
| | Government | Trucks | Mining | |
| | etc. | Planes | etc. | |
| | | Snowmobiles | "Secondary" | |
| | | etc. | Textiles | |
| | | | Other Manufacturing | |

In the following pages we will discuss the use of energy in each of the above sectors. The consumption trends over the past 25 years are delineated for all fuel types used in each sector. By examining these trends, along with trends in the prices of each fuel, we can learn a great deal about the interrelationships between energy use and the price of energy. These relationships will then form a basis for projections of future demand and price scenarios.

The two illustrations on the following page graphically show the historical uses of energy in each consuming sector. Figure 1 depicts the total energy used in the state in terms of BTU's. Figure 2 shows the percentage of total demand required by each sector. Together the figures show the overall trends in total BTU use in each sector and the fraction of total energy use demanded by each sector. Data is found in Table 1 of the Appendix to this chapter.

FIGURE 1

ULTIMATE USES OF ENERGY IN MAINE, 1950 - 1974

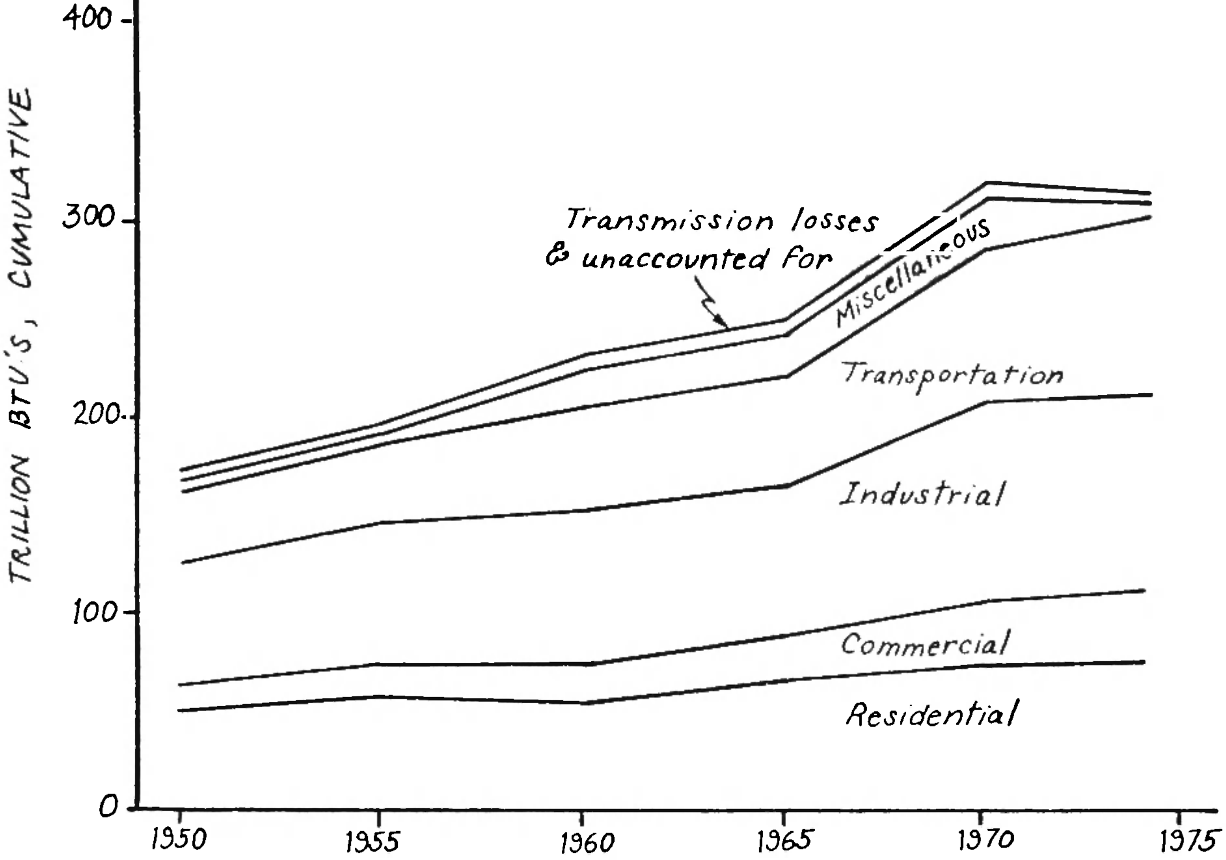
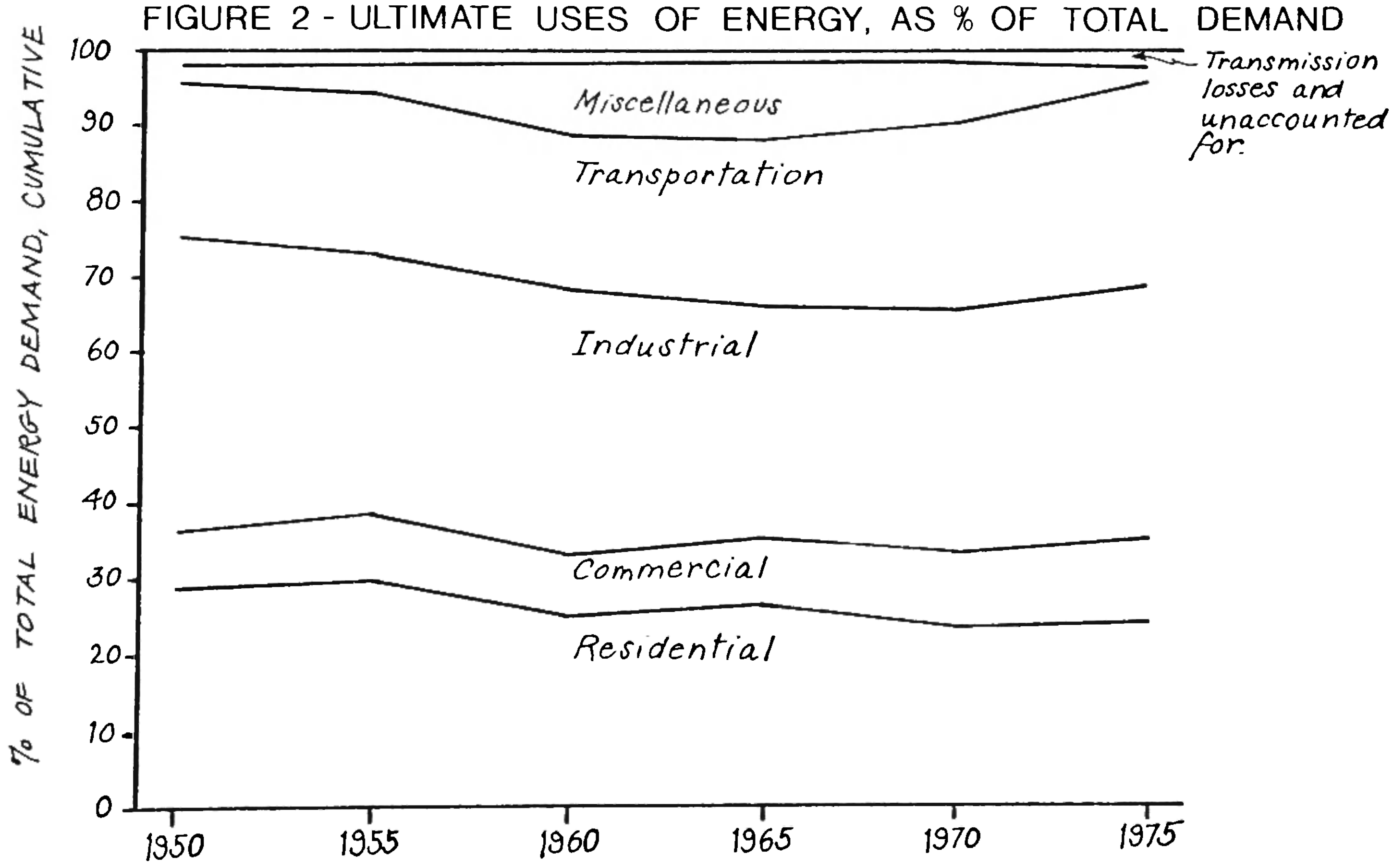


FIGURE 2 - ULTIMATE USES OF ENERGY, AS % OF TOTAL DEMAND



## Historical Energy Consumption in the Residential Sector

Residential consumption of energy in Maine for all end uses increased 58% (equivalent to 1.93% annually) between 1950 and 1974. Petroleum and electricity supplied all of that increase while the use of coal, fuelwood and utility gas fell. Among the specific petroleum products, use of distillate fuel oils more than tripled, LPG use increased 137% and kerosene use declined by 65%.

FIGURE 3

RESIDENTIAL USE OF ENERGY IN MAINE, 1950-1974

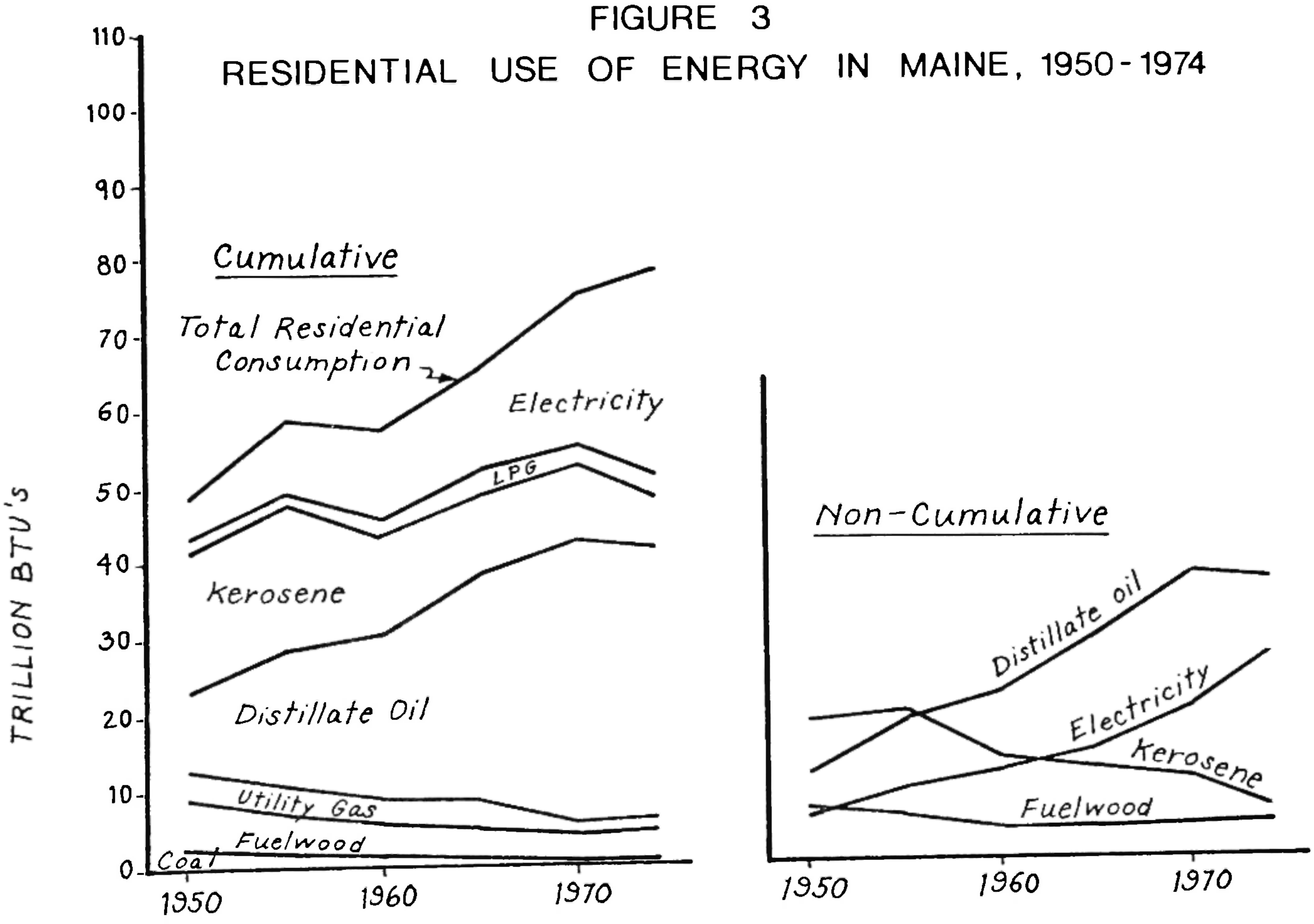


Figure 3 portrays the consumption trends in the Residential Sector. Table 2 in the Appendix to this chapter contains the data from which Figure 3 was drawn.

### Coal Declines -

Residential demand for coal, assumed to be used entirely for space heating, declined dramatically from 1950 through 1970, both in absolute terms and relative to the other fuel types. This decline was caused by the increased use of oil, which was cleaner, cheaper, and more convenient to use. Coal use in the residential sector increased again in 1974 (from 49 billion BTU to 92 billion or from about 2,000 tons to about 4,000 tons). It is thought that this increase came about by a moderate shift to coal during the 1973 oil embargo. (The BTU increase from 1970 to 1974 was about 88%).

### Fuelwood Stabilizes -

Residential consumption of fuelwood, also assumed to be used entirely for space heating, declined in both absolute and relative terms through the 1950's. As was the case with coal, above, this decline in fuelwood use was due primarily to the availability of cheap, clean, convenient oil. The absolute level of consumption stabilized at about 4.5 trillion BTU (about 350,000 cords from 1960 through 1974.) However, the relative contribution continued to decline through the 1960's before stabilizing at 5.8% of the demand from 1970 through 1974.

### Gas on the Decrease -

Manufactured gas* had maintained a constant sectoral input of about 3.4 trillion BTU from 1950 through 1965, declined to 210 billion BTU in 1970, and disappeared by 1974. Natural gas use does not appear in the residential data until 1970, when it began to replace manufactured gas. After its introduction into the state, residential natural gas demand decreased from 800 billion BTU's in 1970 to 645 billion in 1974. It has not become a significant energy resource in Maine due to its high price relative to other available fuels.

### Petroleum Consumption Stabilized -

Petroleum demand increased from 62% of residential demand in 1950 to 66% in 1955, and leveled off at 65% to 66% from 1955 through 1970, before decreasing to 59% in 1974. Most of the petroleum consumption in the residential sector is for space heating. The most significant petroleum fuel used in the residential sector since 1960 has been #2 distillate oil. Kerosene demand has declined steadily since 1950, while LPG demand has increased somewhat although at a slower rate than distillate demand has risen.

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*Prior to the introduction of natural gas into Maine, manufactured gas was produced at several locations. Residual oil and coal were used as the feed stocks, and the conversion efficiency was only about 20%.

The growth in petroleum consumption in general was due to an abundant supply at relatively low prices that were declining relative to the other fuels. In addition, petroleum was much cleaner and more convenient to use than either coal or wood.

### Electrical Growth -

Electricity showed the most significant and dramatic gain among the residential energy sources, in both absolute and relative terms. Residential electricity consumption increased steadily from 6.2 trillion BTU (12.6% of the total residential demand) in 1950 to 26.6 trillion BTU (34.0% of the total) in 1974*. The largest gains in electrical demand were from 1965 through 1974. The accelerated growth through that period was apparently due to an increasingly favorable price situation as electrical rates continued their historical downward trend. This trend was a result of economies of scale (achieved in part through regional integration), relatively low cost oil for generating stations, and the growth of regional nuclear power. Toward the end of this period, electrical consumption was spurred by the energy crisis following the Arab Oil Embargo of the Mid-1970's. The embargo resulted in more rapid rises in oil prices than in electricity prices and helped to improve the competitive position of electric heat. In addition, the supply constraints on petroleum products were more severe and more visible than were those on electricity, and consumers leaned more toward electric heat for reliability of supply.

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*Nationally the average is 22%, expected to rise to 50% by 2010.

## Historical Energy Consumption in the Commercial Sector

Consumption of energy for the state's offices, stores, health facilities, motels, restaurants, etc. has almost tripled from 12.1 trillion BTU to 33.5 trillion BTU. This growth is equivalent to a 4.35% annual increase over the 24 year period. Petroleum has been the primary source of energy for this sector, followed closely by electricity. This report assumes that all of the coal, natural gas, and petroleum are used for space heating and most of the commercial electricity consumption is used for lighting, air-conditioning, and miscellaneous purposes (e.g., display appliances and hospital equipment), with a negligible amount used for space heating.

FIGURE 4

COMMERCIAL USE OF ENERGY IN MAINE, 1950-1974

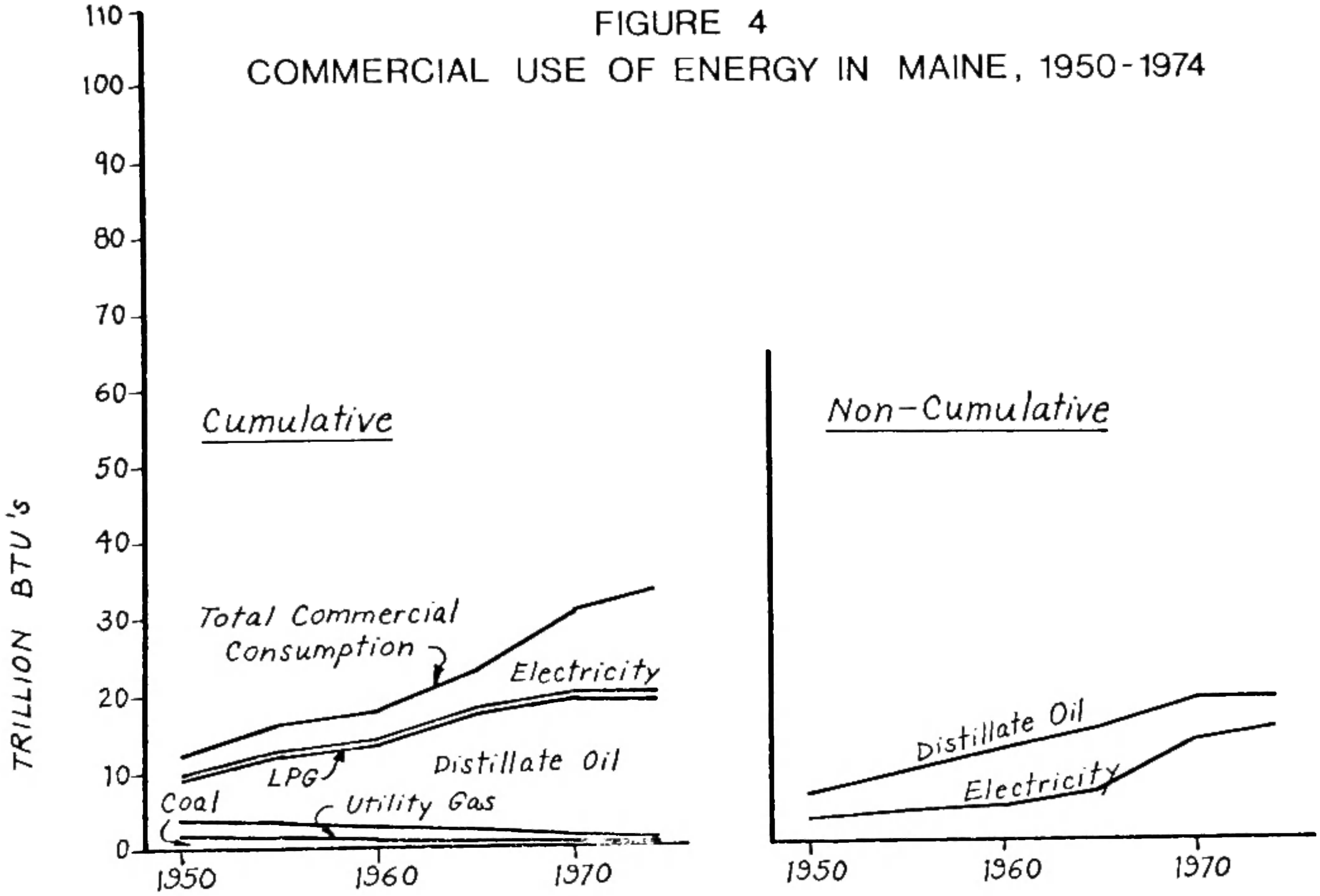

Figure 4 shows the consumption trends for the commercial sector. The data from which Figure 4 was drawn are contained in Table 3 in the Appendix to this chapter.

Coal Declines -

Commercial coal consumption declined from 10.9% of total commercial demand in 1950 to less than 0.1% in 1970. 1974 saw a slight rise in coal use, up from 25 billion BTU in 1970 to 46 billion BTU. It is assumed that virtually all of this coal was used for space heating.

Gas Decreases -

Manufactured gas had declined from 13.5% of total commercial demand in 1950 to 0.5% in 1970 and disappeared in 1974. Only part of the manufactured gas was replaced by natural gas. Natural gas consumption in the commercial sector increased from 1.3% of total commercial demand in 1970 to 1.7% in 1974.

Petroleum Peaks -

Petroleum consumption in the commercial sector increased from 5.7 trillion BTU (47.2%) in 1950 to 11.5 trillion BTU (65.5%) in 1960. By 1970, petroleum consumption increased further to 18.8 trillion BTU, but the relative position of petroleum as a commercial fuel declined to 61.4% of the total commercial demand. In 1974, petroleum consumption declined to 18.6 trillion BTU (55.6%). This relative decline between 1960 and 1970 was due to increased electrification of shopping centers with higher lighting levels and increased air conditioning loads. The absolute decline between 1970 and 1974 was due to conservation following the 1973 embargo, and the general business decline of that period.

Electricity Growing -

Commercial sector consumption of electricity declined relatively between 1950 and 1960, from 28.5% to 22.3% of total commercial demand, although absolute consumption increased from 3.4 trillion BTU to 3.9 trillion. From 1960 through 1974, electrical consumption increased from 3.9 trillion BTU (22.3%) to 14.3 trillion (42.3%), an increase of 262% over the 15 year period.

The relatively slow growth of electricity compared to petroleum through the 1950's can probably be attributed to the relative prices through that period, and to the relatively low energy demand for lighting and air-conditioning furnished by electricity, compared to the space heating, water heating and miscellaneous demand satisfied by oil. The relatively faster growth of electricity through the 1960's and into the 1970's is indicative of the lighting levels, operational appliance exhibits, air-conditioning, and some inroads made by electric space heating in modern shopping centers and commercial establishments.

## Historical Energy Demands in The Transportation Sector

Consumption of energy for transportation increased 153%, (equivalent to 3.94% annually) from 34.4 trillion BTU to 87.0 trillion BTU.

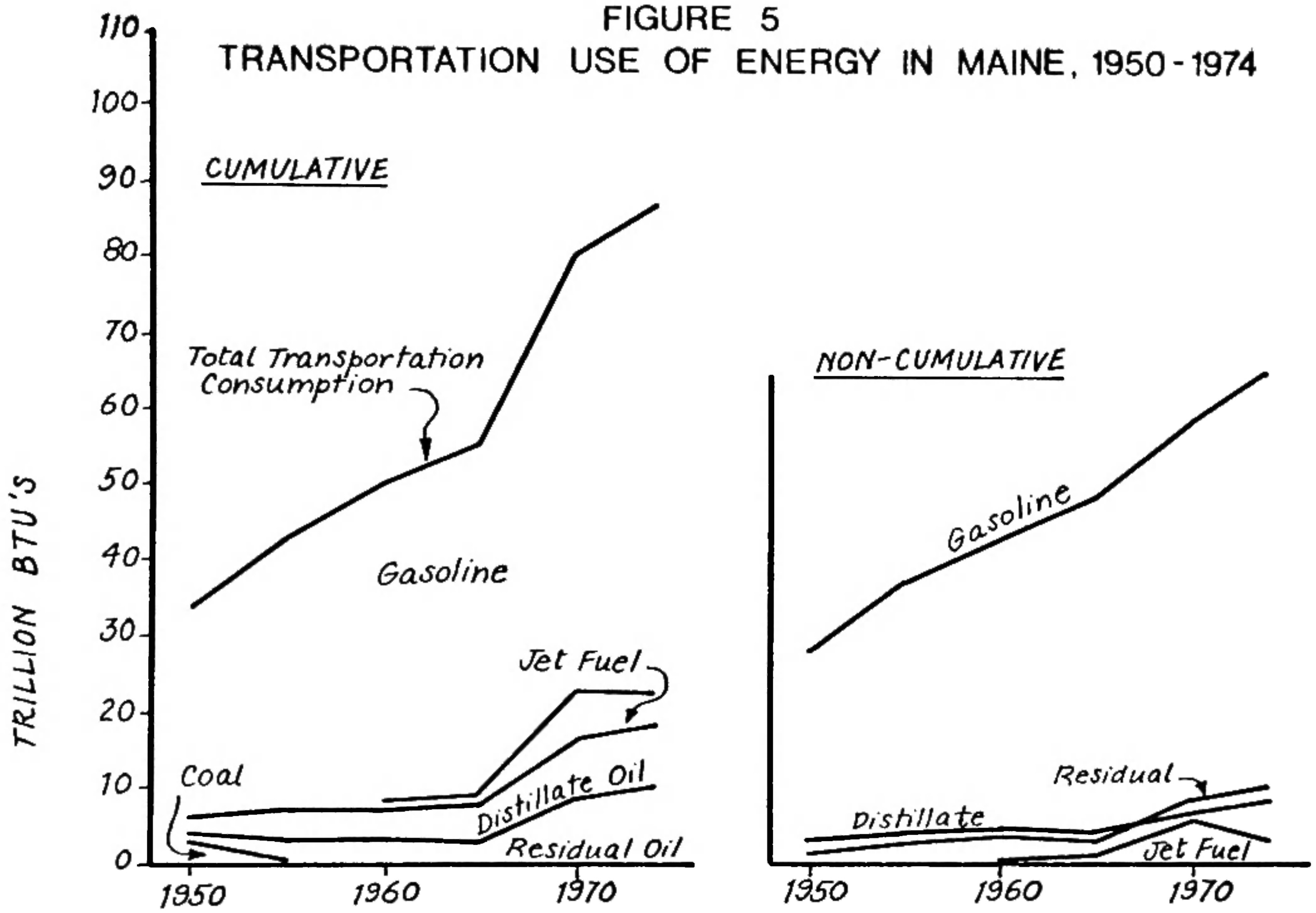

FIGURE 5
TRANSPORTATION USE OF ENERGY IN MAINE, 1950-1974

Figure 5 shows the consumption trends for the transportation sector. Table 4 in the Appendix details the data from which Figure 5 was derived.

## Coal Disappears -

Consumption of coal as a transportation fuel disappeared after 1950 with the replacement of steam locomotives by diesel-powered locomotives, and coal-burning steam ships by diesel-powered and oil-burning steam ships.

Petroleum products have provided essentially all the energy for the transportation sector since 1955. Any non-petroleum fuels that may have been in use since that time have been in insignificant quantities and are, therefore, not considered in this report.

## Residual Fuel Oil Increasing -

Consumption of residual fuel oil in the transportation sector increased from 912 billion BTU (2.6% of total transportation energy use) in 1950 to 10 trillion BTU (11.5%) in 1974, a more than tenfold increase in the intervening 24 years. Virtually all of the current residual consumption is assumed to be for bunkering of steam propelled vessels engaged in international and coastwise trade through Maine ports.

## Distillate Fuel Rising -

Distillate fuel consumption (primarily diesel fuel) increased from 2.3 trillion BTU (6.8%) in 1950 to 8.2 trillion BTU (9.5%) in 1974, a 254% increase. This fuel is used for diesel locomotives, ships, and coastal ferry services, as well as for highway use by diesel-powered trucks and buses, and a limited amount by a few diesel-powered automobiles. The increase in the use of diesel fuel in the transportation sector is due to the replacement of coal in ships and trains by diesel power, and the increased use of diesel-powered trucks for freight hauling over the highways.

## Jet Fuel -

This fuel came into use with the introduction of turboprop aircraft into Maine by the commercial air carriers during the 1950's, and grew with the conversion to all-jet and prop-jet fleets in the 1960's. Jet fuel consumption grew from 120 billion BTU (0.2% of the sector total) in 1960 to 5.9 trillion BTU (7.2%) in 1970, decreasing to 3.8 trillion BTU (4.4%) in 1974. Military jet fuels are not included in this data, but are listed under "Miscellaneous" below.

## Gasoline Growing Steadily -

Gasoline has been and still is, by far the largest contributing fuel to the total transportation demand, although it has declined somewhat in relative importance since 1965. Gasoline contributed 28.4 trillion BTU (82.4%) in 1950 and increased to 48.5 trillion BTU (86.9%) in 1965. In 1970, gasoline constituted 72.8% of the transportation energy at 58.9 trillion BTU, and by 1974 it had increased again to 65.0 trillion BTU (74.6%).

## Historical Energy Demands in the Industrial Sector

Consumption of fuel for industrial uses increased 63% (equivalent to 2.05% annually), from 65 trillion BTU's to 105.8 trillion.

Industrial energy consumption is primarily for process heat, lighting, and miscellaneous uses, with steam and electricity generation being the two end uses. The pulp and paper industry in Maine consume about 75% of all energy in the state.*

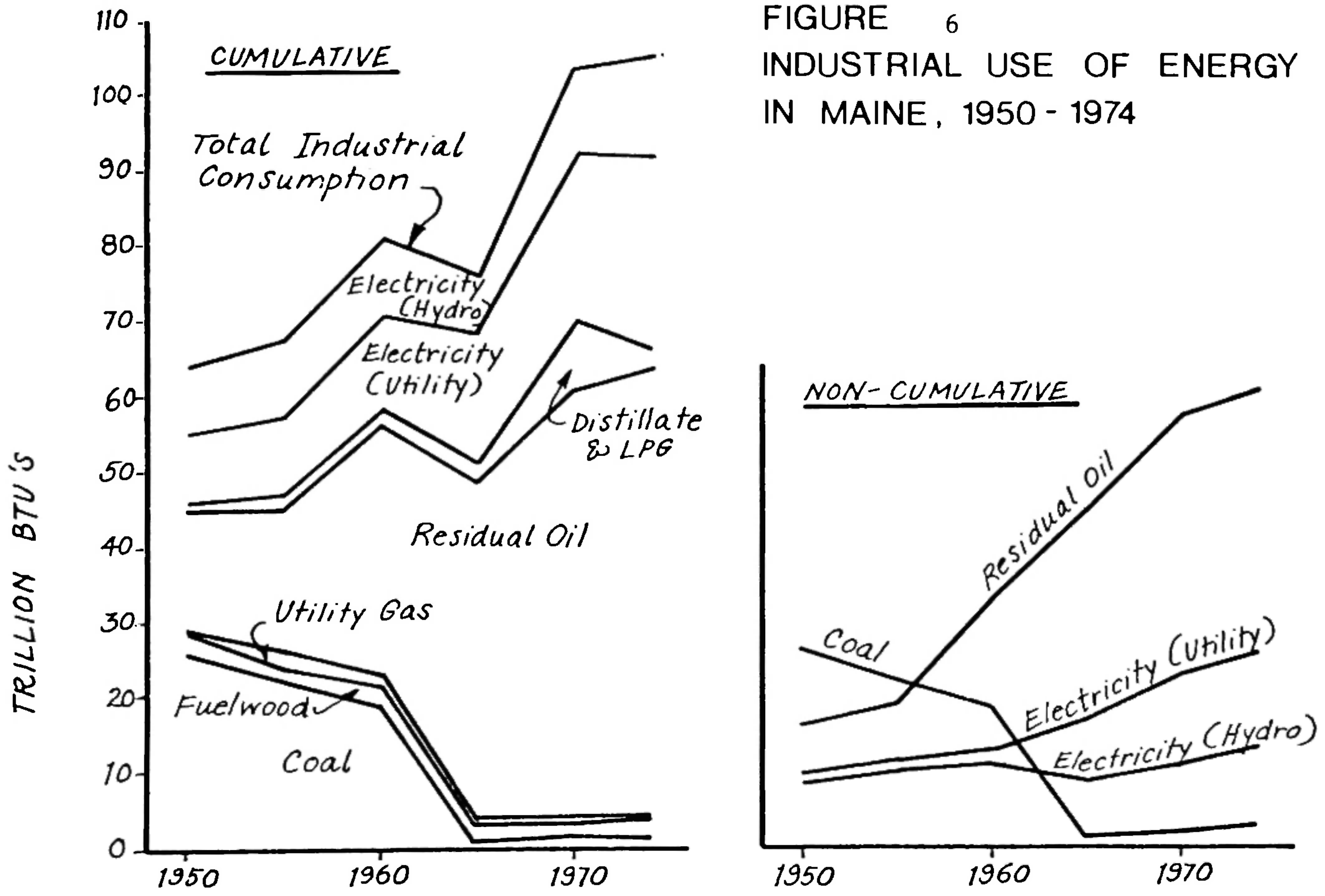
FIGURE 6
INDUSTRIAL USE OF ENERGY IN MAINE, 1950 - 1974

Figure 6 shows the industrial sector consumption trends. The data from which Figure 6 was drawn are contained in Table 5 in the Appendix.

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*PARC Report, 1973

### Coal Declining -

Within the industrial sector, coal declined from 26.1 trillion BTU (40.1%) in 1950 to 1.1 trillion (1.1%) in 1970, then increased slightly again to 1.2 trillion BTU (1.1%) in 1974.

### Fuelwood Holding On -

Industrial fuelwood consumption increased very slightly from 1.9 trillion BTU (3.0%) in 1950 to 2.2 trillion BTU (2.1%) in 1974. The increase in absolute levels of fuelwood consumption are assumed to be due to expansion of the pulp and paper industry and the use of bark and waste-wood burners in that industry, which accounts for most of the industrial fuelwood consumption in the State. Sawmills and other wood processing firms also burn some bark and wastewood.

### Gas Declines -

Between 1950 and 1965, industrial use of utility gas (manufactured and mixed gas) increased from 681 billion BTU (1.0%) to 1.5 trillion BTU (1.9%). Natural gas was introduced between 1965 and 1970, and it's use increased from 460 billion BTU (0.4%) in 1970 to 503 billion BTU (0.5%) in 1974. Note, however, that the 1974 consumption represents a 66% decrease from the 1965 levels of utility gas use.

### Petroleum Use Peaks -

Industrial consumption of petroleum, consisting mostly of residual oil, increased from 26.7% of industrial energy consumption in 1950 to 64.2% in 1970, but decreased to 59.5% in 1974. The reduced petroleum consumption has been offset by increased use of electricity, so that total industrial consumption of energy increased slightly in 1974 over 1970.

### Electricity Growth Steady -

Industrial consumption of electricity has shown steady increased in BTU values, although its relative growth rate has been less consistent. Relative industrial electrical growth did not keep pace with the growth in industrial oil consumption until the 1970-1974 interval, when electrical demand increased sharply while oil consumption declined almost equivalently.

Most of the electrical growth has been furnished by the utilities, with a lesser growth of in-house generation by the industrial firms. Industrial electricity consumption grew from 19.0 trillion BTU (29.2%) in 1950 to 39.0 trillion BTU (36.8%) in 1974, with the greatest relative growth occurring between 1970 and 1974 (32.3% in 1970 to 36.8% in 1974), offsetting the reduction in oil consumption described above.

## Historical Energy Demand in the Miscellaneous Sector

Energy consumption by the miscellaneous sector in Maine (for military and other governmental use, and for unspecified purposes) grew considerably in the late 1950's and through the 1960's, falling off again dramatically between 1970 and 1974. Consumption in this sector rose from 3.0 trillion BTU in 1950 to 24.7 trillion BTU in 1970, declining to 5.7 trillion BTU in 1974. This rise and decline coincides with the greatly increased use of jet fuel at the major military installations and the closing of Dow Air Force Base in the late 1960's.

FIGURE 7

MISCELLANEOUS USE OF ENERGY IN MAINE, 1950 - 1974

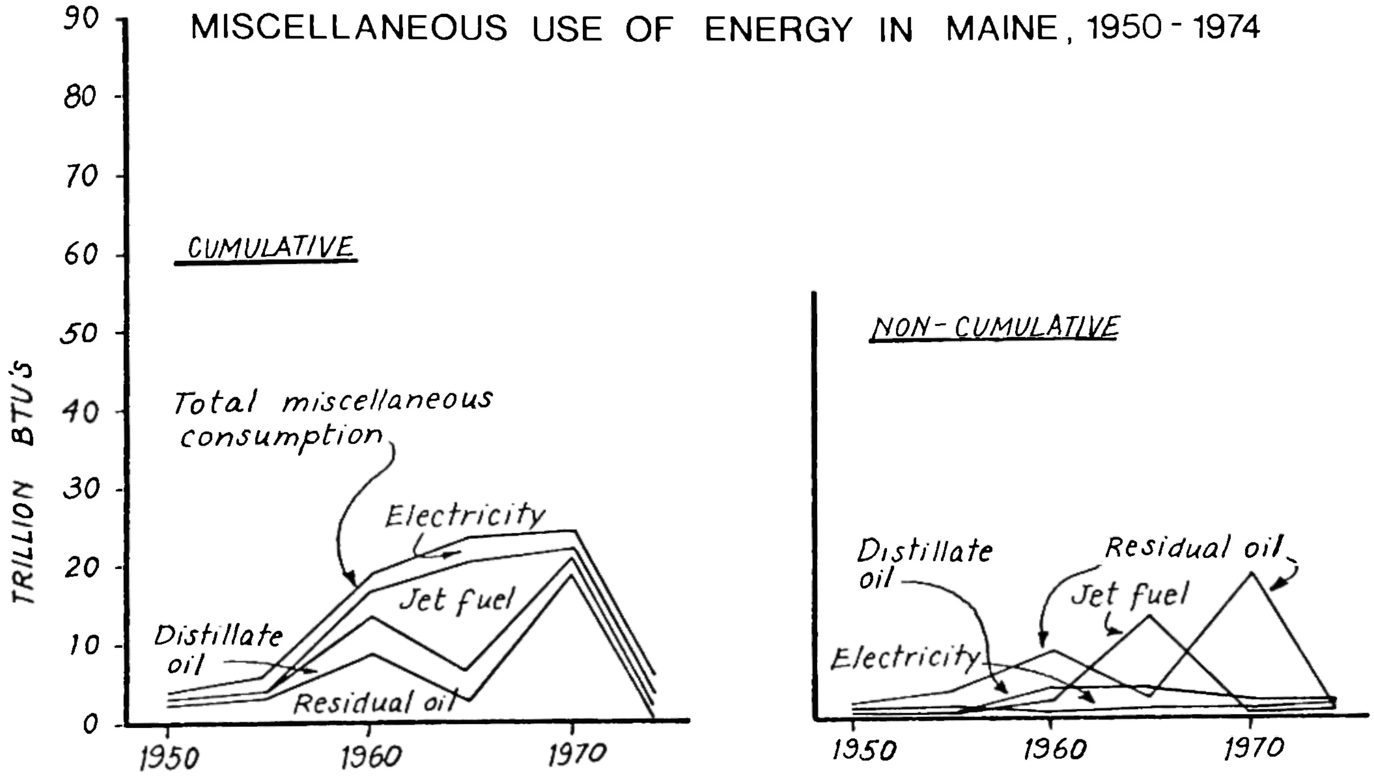

Figure 7 graphically displays the miscellaneous sector consumption trends. The data from which Figure 7 was drawn are contained in Table 6 in the Appendix.

## Historical Energy Demand in the Miscellaneous Sector, (Continued)

Petroleum constitutes the largest block of energy consumption within the miscellaneous sector. The primary petroleum products used are jet fuel (for military jet aircraft flights) and residual and distillate fuel oils (plus a small amount of LPG), used primarily for space heating at military and government installations. Petroleum consumption rose from 2.3 trillion BTU (76.4% of total miscellaneous demand) in 1950 to 22.2 trillion BTU (89.5%) in 1970, declining to 3.3 trillion BTU (56.9%) in 1974.

### Residual Fuel Unsteady -

Consumption of residual fuel oil rose from 2.2 trillion BTU (71.9% of the sector total) in 1950 to 9.6 trillion BTU (51.2%) in 1960, fell to 2.8 trillion BTU (11.9%) in 1965, rose again to 18.5 trillion BTU (74.8%) in 1970, then fell again to 610 billion BTU (10.6%) in 1974. Much of this seeming erratic behavior of the data in the miscellaneous sector is believed to be due to changes in the reporting criteria by the Bureau of Mines and other data-gathering agencies.

### Distillate Peaks , Declining -

Consumption of distillate fuel oils rose dramatically during the decade of the 1950's, from 134 billion BTU (4.4%) in 1950 to 4.2 trillion BTU (22.1%) in 1960, then declining steadily to 1.2 trillion BTU (21.6%) in 1974.

### Brief LPG History Shows Falling Trend -

LPG consumption in the miscellaneous sector does not appear in data until 1970, and fell from 102 billion BTU (0.4%) in that year to 57 billion BTU (1.0%) in 1974.

### Jet Fuel Peaks, Falls -

Military jet fuel consumption rose from 3.1 trillion BTU (16.3%) in 1960 to 14.1 trillion BTU (58.9%) in 1965, declined to 923 billion BTU (3.7%) in 1970, and rose again to 1.4 trillion BTU (23.6%) in 1974. As discussed above, this trend tends to follow the history of military jet aircraft use from the major bases in Maine.

### Electricity Peaks, Falls -

Electricity consumption in the miscellaneous sector follows the same general trend as the distillate fuel use. Electricity rose from 714 billion BTU (23.6%) in 1950 to a peak use of 3.1 trillion BTU (13.0%) in 1965, declining to 2.5 trillion BTU (43.1%) in 1974. The miscellaneous electricity consumption is used primarily for municipal street lighting and other governmental uses.

# CHAPTER 1 - PART 2

## HISTORICAL DEMAND BY FUEL TYPE

The preceding section described historical consumption trends for the various sectors of Maine's economy. An alternative method of describing historical energy use is by fuel type, rather than by consuming sector. Describing consumption by consuming sector indicates the historical demand for the various energy forms and fuel types. Describing consumption by fuel types sums up the demand for each fuel from all the consuming sectors. In this way, the demand growth pattern for each fuel, the factors contributing to the development of that pattern, and the extent of dependency on the various energy sources can be shown.

Maine's total energy input virtually doubled between 1950 and 1974, increasing by 88.6% from 168.5 trillion to 317.8 trillion BTU's. The largest increase took place in the use of petroleum, which rose 154% from 95.9 trillion to 243.7 trillion BTU's. During the same period, generation of hydropower increased slightly (by 4.9 trillion BTU's or 17.1%), while consumption of coal and fuel-wood declined. Use of natural gas rose from zero in 1965 to 1.7 trillion BTU's in 1970 and 1974. Generation of nuclear power rose from zero in 1970 to 38.1 trillion BTU's in 1974.*

### All Fuel Types:

The direct consumption of energy for all ultimate purposes, plus the BTU's needed to produce manufactured gas and electricity, are summarized by source in Table 7 in the Appendix. The dramatic increases in the use of electricity and most forms of petroleum are shown in Figures 8 and 9. The drastic decline in coal for direct use and to produce gas also is indicated, as well as the moderate decline in reported fuelwood consumption.

Uses of the various types of fuel and the derivation of the data are described on the following pages.

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Note: The 38.1 trillion BTU's of Nuclear generation in Maine in 1974 includes all of the Maine Yankee Plant generation. However, half of this output, or about 19 trillion BTU's equivalent, went to utilities in other New England states who are joint owners of the plant. Maine utilities are also joint owners of three nuclear power plants in other New England States, and Maine's share of generation in these plants in 1974 was about 436 million kilowatt-hours, or 4.6 trillion BTU's equivalent. In addition to the nuclear imports, Maine imported about 706 million kilowatt hours of electricity from other generating sources outside Maine's borders, so that the net exports of electricity were 645 million kilowatt-hours of electricity, or 7.1 trillion BTU's equivalent. This net export figure is equivalent to about 18% of the Maine Yankee output.

FIGURE 8
SOURCES OF ENERGY IN MAINE, 1950 - 1974

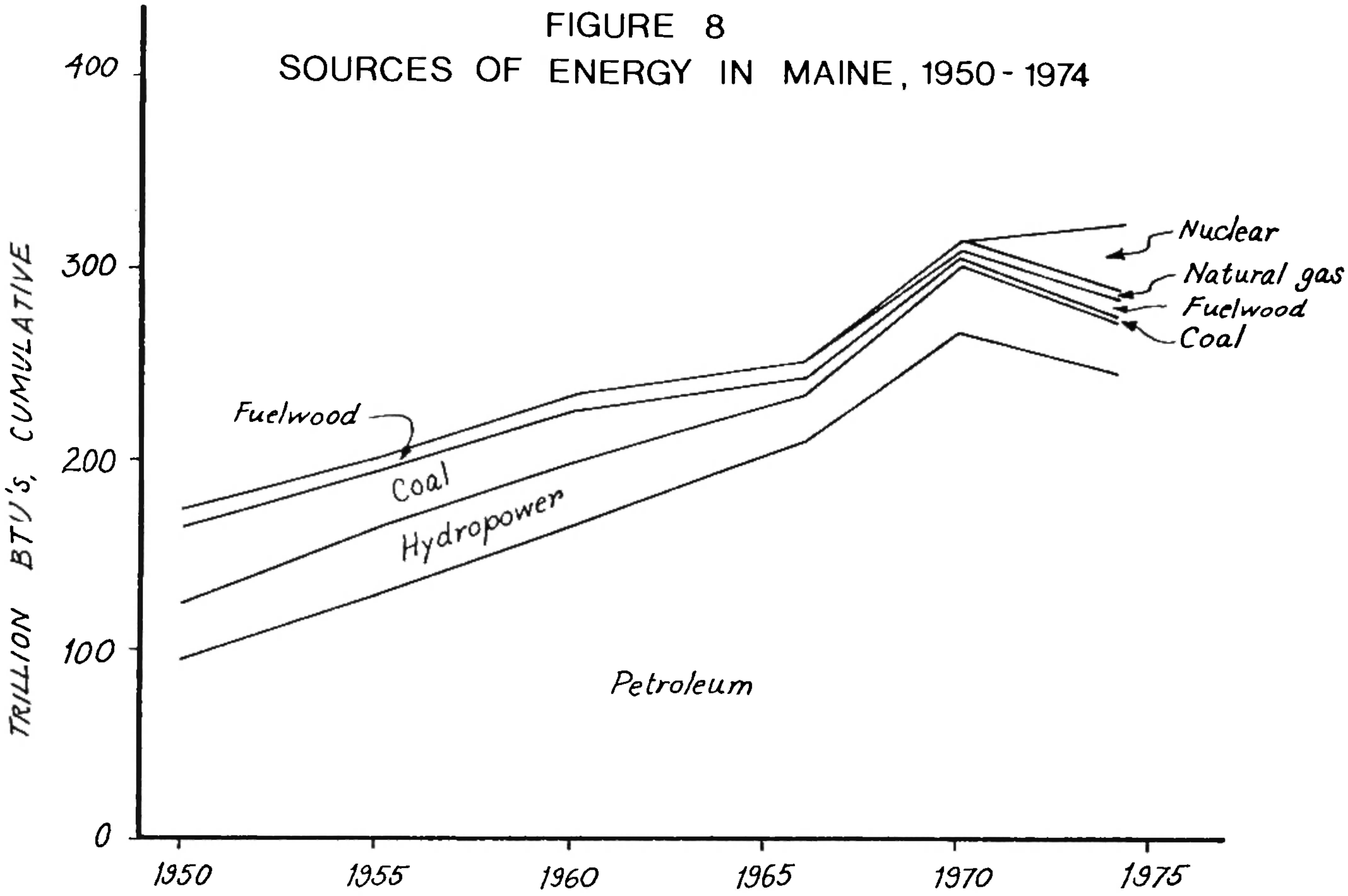
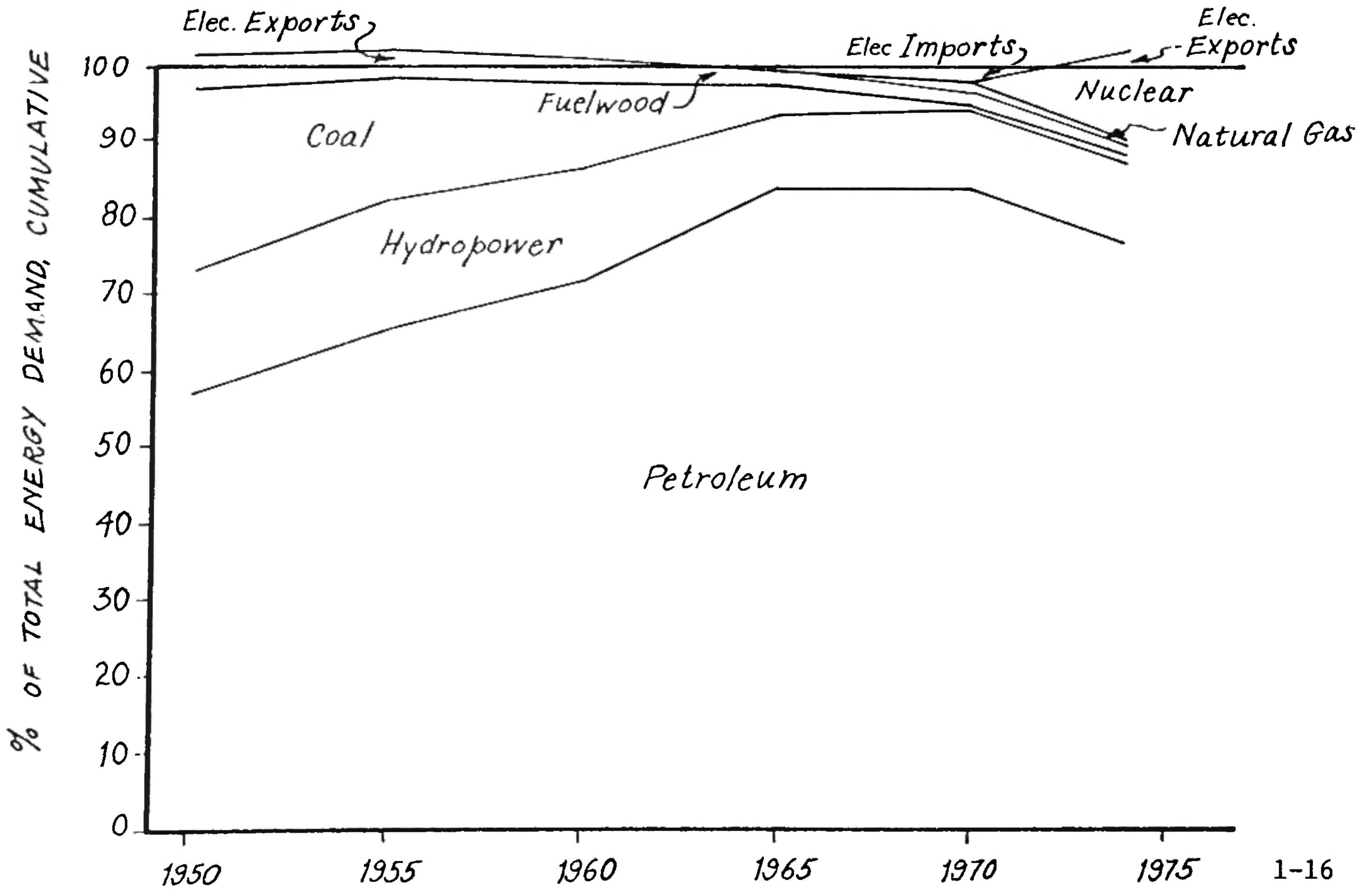


FIGURE 9
SOURCES OF ENERGY IN MAINE, 1950 - 1974
(As Percent of Total Energy Demand)



### Coal Declines

Use of coal in Maine declined from 1.5 million tons (22.9% of total energy consumption) in 1950 to only 57,000 tons (0.4%) in 1974. Most of this fuel was consumed in the past by industries (primarily for electric power and steam generation), and for the production of manufactured gas. Use of coal for residential space heating and for transportation (in railroad locomotives) has almost disappeared. Table 8 in the Appendix details the coal sales trends by demand sector.

### Fuelwood Contribution Minor

The reported cut of wood used for fuel is relatively small, and declined from 438,000 cords (5.0%) in 1950 to 328,000 (2.0%) in 1970, but increased again to 349,000 cords (2.1%) in 1974. This rise probably all came in 1973 - 1974, when people rushed to put in wood stoves and fireplaces as a result of the oil embargo. It is likely that most of the wood cut by small woodlot owners for use in homes has not been reported, so that the volumes stated here are conservative estimates.

Table 9 in the Appendix details fuelwood sales to the residential and industrial sectors.

### Utility Gas Peaks, Declining

Sales of utility gas in Maine rose 61% between 1950 and 1974, but the latter year was a 3.7% decline from 1970. While the sales of gas increased, the BTU's input required to generate the gas declined considerably after 1965. The rapid decline indicated in Table 14 ("All Uses of Energy") does not compare with the data in Table 10 ("Sales of Utility Gas to Consumers") due to the inefficiencies of conversion of coal and residual oil to manufactured gas prior to it's replacement by natural gas in the late 1960's.

Historically, more gas has been used for residential purposes than in the commercial or industrial sectors. However, after the introduction of natural gas, residential use fell while commercial and industrial use grew, so that the ratios of residential use to commercial and industrial use are not as great as they were during the manufactured/mixed gas era.

Table 10 in the Appendix details utility gas sales by demand sector.

### Hydro Power

The total contribution of hydro power has been relatively constant at 33 trillion BTU's (2.5 to 3 billion kwh annually) since 1950. About 84 MW of hydro-electric capacity has been added in this period.

### Nuclear Power Added

Nuclear generation has been contributing to Maine's electrical energy requirements since 1961, when the Yankee Atomic Electric plant at Rowe, Massachusetts began operation. The nuclear age came to Maine on December 28, 1972 when the Maine Yankee plant was placed into service. In 1974, Maine Yankee accounted for 3.6 billion kwh, or 34.1% of the State's total electricity consumption (12% of total energy consumption).

## Petroleum Peaks, Declines

From the data presented earlier, it is clear that Maine is extremely dependent on petroleum to satisfy its energy needs, both in direct use and in indirect use through conversion to electricity. Petroleum provided more than 75% of Maine's energy in 1974, as compared to just over 50% in 1950.

As we saw previously, transportation has historically been the largest petroleum consuming sector in Maine, and now accounts for about 38% of the total petroleum consumption. Next in importance are industrial (10.0 million barrels), residential (10.0 million), electricity generation (4.1 million), commercial (3.2 million), and miscellaneous uses (576,000 barrels).

Not only is Maine highly dependent on petroleum but a large portion of the petroleum supply to Maine comes from foreign sources (principally Venezuela) either through Carribean refineries or through U.S. refineries.

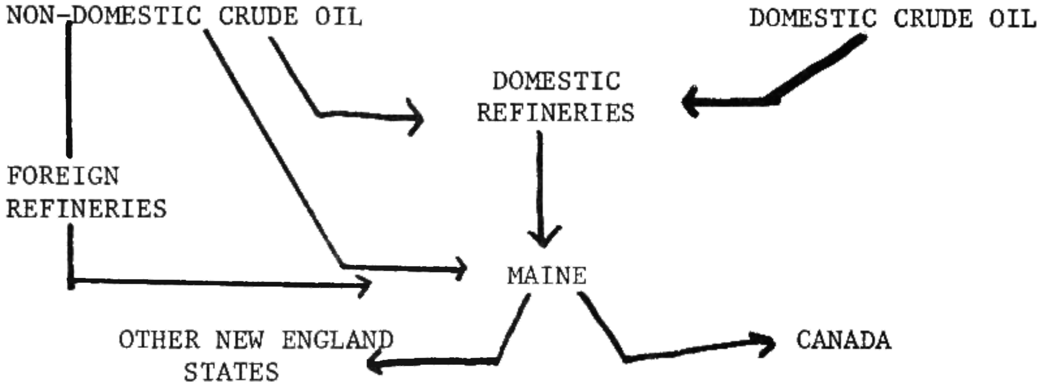


Figure 10 - Schematic of Petroleum Flows

Crude oil and petroleum products arrive in Maine by ship and products also are imported by truck and railroad tank car. The principal ports are Portland Harbor (accounting for 100% of the crude oil and 51% of the total products imported in 1974), Searsport Harbor (27% of product) and the Penobscot River (Bucksport, Bangor and Brewer - 22%).

All of the crude oil entering Maine is transshipped by pipeline to Montreal refineries. Some of the products imported through Searsport travel by pipeline to Loring Air Force Base but the quantity fluctuates considerably. These transshipments to Canada and Loring are not available for Maine use and are thus excluded from further analysis.

During the 1950-1974 period, coastwise receipts from Mid-Atlantic and Gulf Coast refineries increased from 14.8 million to 33.9 million barrels. On the other hand, direct imports from Venezuela and other non-U.S. sources rose much faster, from only 3.9 million barrels in 1950 to 16.8 million in 1974.
In other words, direct imports to Maine of petroleum from foreign countries increased from 20.7% to 33.1% of Maine's total waterborne receipts.

Total U.S. imports of foreign crude petroleum and petroleum products have risen from 13% of domestic consumption in 1950 to 36% in 1975, and were reported to have approached 50% in March of 1976. The products which Maine receives from domestic refineries thus also reflect an increasing input of foreign crude oil.

By far the largest share (76%) of Maine's imported petroleum now consists of residual oils. The 12.8 million barrels of residual oil imported from foreign refineries in 1974 are followed in magnitude by 1.8 million barrels of gasoline, 1.6 million of distillates, and 0.6 of kerosene.

The most significant petroleum products used in Maine are residual oils (industrial and electric utility fuels), distillate oils, and gasoline. Kerosene, jet fuel, and liquified petroleum gases (LPG) are used in considerably smaller quantities than the other three petroleum-based fuels.

### (a) Residual Oils

Use of residual oils in Maine rose from 4.3 million barrels in 1950 to 15.3 million in 1974. About two thirds of these oils are utilized for industrial power and steam generation, with the remaining one-third employed by the electric utilities or used for ship bunkering.

### (b) Distillates

Consumption of petroleum distillates increased from 3.5 million barrels to 11.5 million during the period under consideration. Over half of this consumption is used by residential oil burners, while most of the remainder is used to heat offices and stores or to power trucks and boats.

### (c) Kerosene and Liquified Petroleum Gases

These fuels are used primarily to heat homes. As kerosene has declined in use (from 3.2 million barrels to 1.1 million), LPG has increased (from 321,000 barrels to 763,000 barrels). While it is not clear whether LPG has been employed as a replacement fuel for kerosene, data indicate that the substitution could have been made in some cases where kerosene became unavailable or economically unattractive.

### (d) Jet Fuel

Used to power both commercial aircraft and military planes, jet fuel consumption increased from zero in 1950 to 949,000 barrels in 1974.

### (e) Gasoline

Utilized primarily by automobiles, but also, to a lesser extent, by trucks, boats, lawn mowers, construction equipment, etc., gasoline consumption increased without interruption by 129%, from 5.4 million barrels in 1950 to 12.4 million in 1974.

Table 11 in the Appendix details petroleum sales in Maine by demand sector and by specific petroleum products. Further details on waterborne petroleum receipts are found in Table 12 in the Appendix. Table 13 in the Appendix lists sales of residual oil in Maine by end use since 1940, with projections to 1985.

## Electricity -

Generation of electricity in Maine rose 291% from 2.7 billion kilowatt-hours in 1950 to 10.5 billion KWH in 1974. Almost three-fourths of the 1974 total was produced by utilities, while the remainder was generated by industrial plants (mostly pulp and paper mills). Although hydro-electric generation increased 55% during this period, it represented only 28% of the total generation in 1974 in contrast to 70% in 1950. Thermal generation (i.e., steam generating plants and internal combustion) increased 828% in this period, while the transition was made from hydro and oil fuel, with some coal use, to oil and nuclear as the principal fuels. Tables 14 and 15 in the Appendix detail the generation of electricity in Maine by source and the sales by demand sector. The following graphs show electricity production by fuel type and sales by demand sector.

FIGURE 11
GENERATION OF ELECTRICITY BY
TYPE OF FUEL, 1950-1974

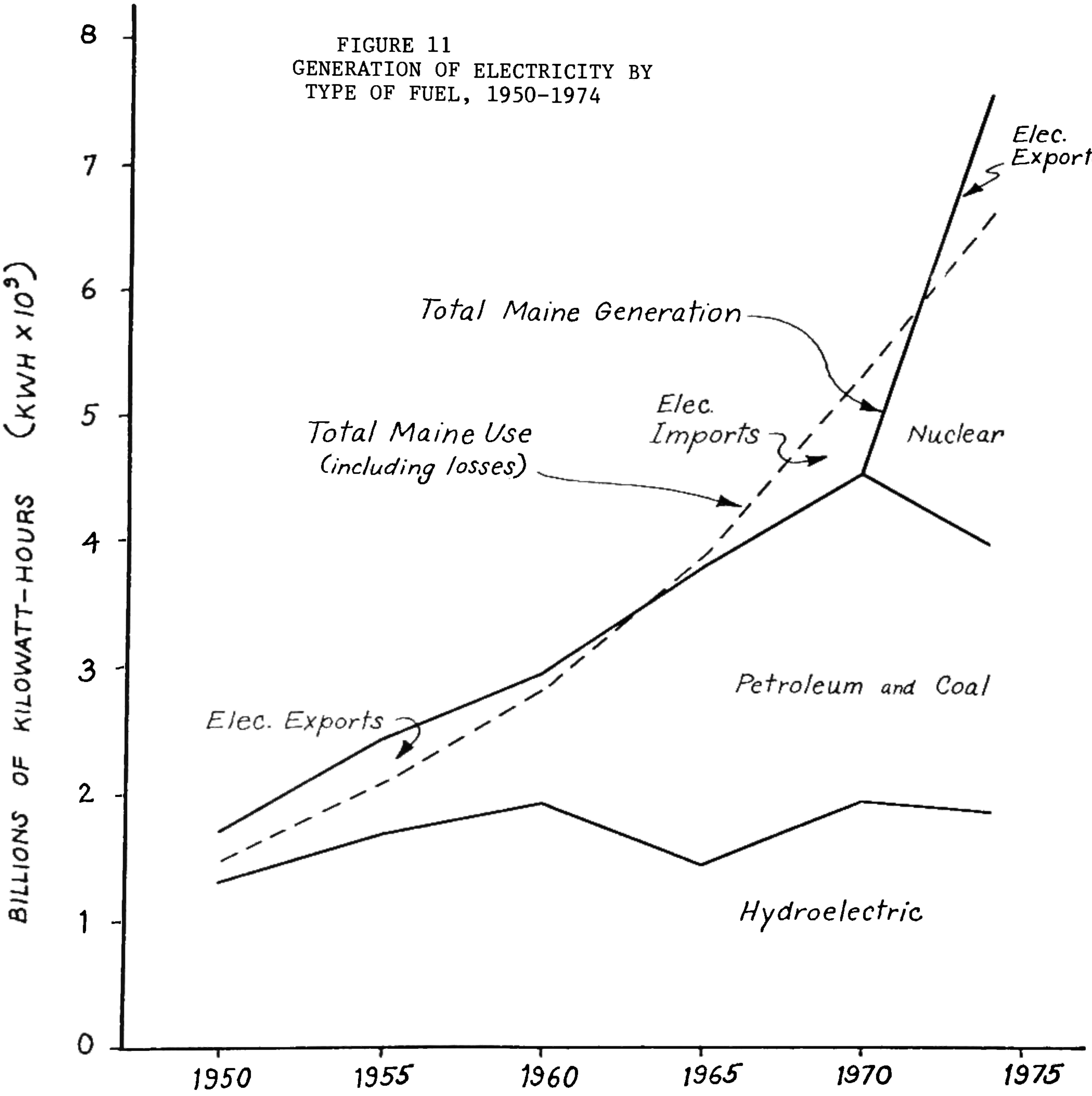
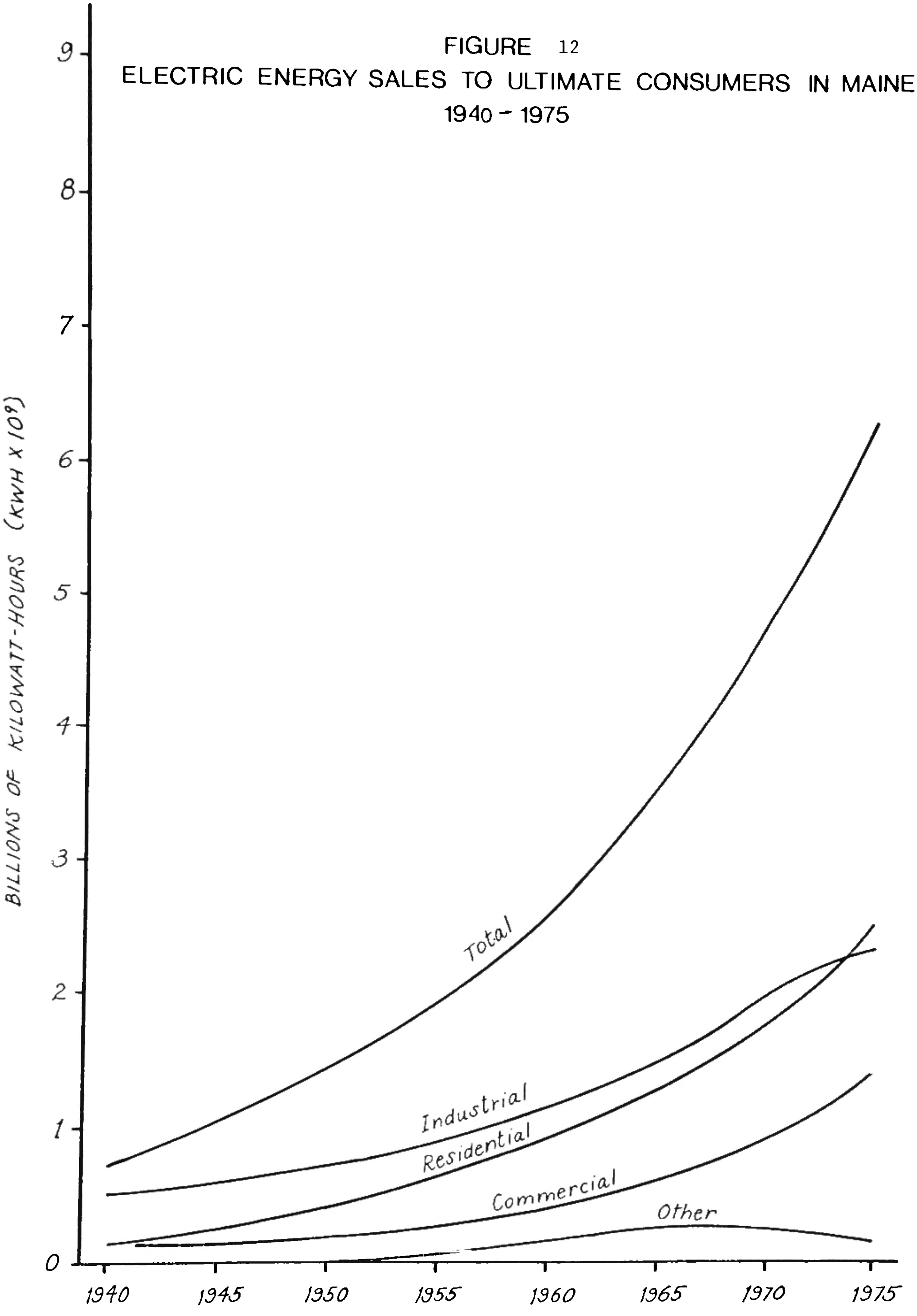


FIGURE 12
ELECTRIC ENERGY SALES TO ULTIMATE CONSUMERS IN MAINE
1940 - 1975



# CHAPTER I - PART 3

## HISTORICAL ENERGY PRICES

It would serve the cause of elegance and completeness of this report if we could parallel the previous description of historical energy demands with a good description of historical price trends. Unfortunately, it has been extremely difficult to obtain information on historical energy prices, and the data we have collected thus far is by no means complete.

However, we do not feel that this lack of information is a serious deterent to the achievement of the purposes of this document. During the period from 1950-1973, energy was a much smaller part of everyone's budget than it is today. The important thing to know is not so much what energy prices were, (although that is of historical interest) but rather what energy prices are likely to be in the future. Some information on future energy price trends is covered in Chapter III along with future demand forecasts, and some current price information is covered in Chapter II.

The best historical price data is available for electricity, through PUC and FPC records. Tables 16, 17, and 18 in the Appendix show typical electric bills for residential, commercial and industrial ratepayers for various areas of the State and for various years between 1972-1976. The interested reader is invited to consult the tables to determine the pre-embargo trends in electricity prices.

To the best of our knowledge, no complete historical (1950-1974) data collection has been previously compiled for all petroleum product prices throughout Maine. The limited data available show a fairly broad range of prices for various parts of the state, and a generally rising pre-embargo price trend in concert with overall inflation.

Table 1 shows the pre-embargo price trends for selected petroleum products and for coal as a fuel for New England utilities. The data in the table indicates that #2 and #6 fuel prices rose faster than gasoline prices between 1970 and 1973, and that coal and fuel oil prices to electric utilities rose at the highest rates of any of the fuels indicated. The reasons for these differences in price increases are thought to be due to the economic conditions of the marketplace and the changing competitive conditions among the fuels. The demand for residual and distillate fuel oils has grown at a much faster rate since 1950 than has the demand for gasoline, as homes and industries turned to these fuels to replace the previously used coal. The mounting demand thus exerted upward pressure on prices. Through the 1960's and early 1970's, utilities turned increasingly to residual fuel oil as a replacement for the dirtier, less convenient coal for electric generation. Thus, stronger upward pressure was exerted on utility fuel oil prices. Coal prices increased due to rising transportation costs, increased labor costs, and the lack of improved productivity to meet escalating national demand for coal.

## TABLE - 1

### PRICES OF SELECTED PETROLEUM PRODUCTS AND COAL-1950-1973

| Gasoline - Regular Grade (Cents/Gallon) | 1950 | 1960 | 1970 | % Change 1950-70 | % Change per year | June 1973 | % Change 1970-73 | % Change per year |
|---|---|---|---|---|---|---|---|---|
| 1. Price at Portland, Net of tax. | 18.26 | 18.07 | 25.73 | + 40.8% | + 67 | 26.50e | + 3.0 | + 1.0 |
| Federal and State Taxes | 7.50 | 11.00 | 12.00 | + 60% | + 24 | 13.00 | + 8.3 | + 2.7 |
| Price Including Taxes | 25.76 | 29.07 | 37.73 | + 46.5% | + 1.9 | 39.50e | + 4.7 | + 1.5 |
| 2. Price - U. S. Average Net of Tax | 20.08 | 20.99 | 25.20[1] | + 25.5% | + 1.1 | ----- | ----- | ----- |
| Federal and State Taxes, Average | 6.68 | 10.14 | 11.24[1] | + 68.3% | + 2.6 | ----- | ----- | ----- |
| Price Including Taxes | 26.76 | 31.13 | 36.43[1] | + 36.1% | + 1.6 | ----- | ----- | ----- |
| **No. #2 Fuel Oil (Cents/Gal.)** | | | | | | | | |
| Average Refinery Price at Portland | 8.65 | 9.68 | 11.37 | + 31.4% | + 1.4 | 14.05e | + 23.6 | + 7.3 |
| Average Retail Price at Portland | ----- | 14.40e | 17.60e | + 22.2% | + 2.0 | 21.40e | + 21.6 | + 6.7 |
| Average Retail Price, U.S. | ----- | 15.02 | 18.48 | + 23.0% | + 2.1 | ----- | ------ | ----- |
| **No. #6 Fuel Oil Dollars/BBL.)** | | | | | | | | |
| Average Refinery Price at Portland (2% - 3% Sulfer Content) | 2.16 | 2.70 | 3.05 | + 41.2% | + 1.7 | 3.67 | + 20.3 | + 6.4 |
| **Fuel Oil to Electric Utilities (Cents/Million BTU)** | | | | | | | | |
| Average, New England | 32.9 | 36.1 | 35.6 | + 8.2% | + 0.4 | 71.7 | +101.4 | + 26.3 |
| Average, United States | 31.8 | 34.3 | 39.8 | +25.2% | + 1.1 | 78.3 | + 96.7 | + 25.3 |
| **Coal to Electric Utilities (Cents/Million BTU)** | | | | | | | | |
| Average, New England | 36.0 | 36.6 | 34.9 | - 3.1% | - 0.2 | 52.5 | + 50.4 | +14.6 |
| Average, United States | 26.9 | 26.0 | 31.2 | +16.0 | + 0.7 | 41.9 | + 34.3 | +10.3 |

1/ 1971 Data
e/ Estimated by PARC

Sources: American Petroleum Institute; Platt's Oil Price Handbook; Bureau of Labor Statistics; Informal Sources in Portland area: Edison Electric Institute, Statistical Year Book of the Electric Utility Industry; Public Affairs Research Center, Bowdoin College.

Historical Energy Prices (Continued)

There have been many theories put forth regarding the relationship between energy use and economic growth. Historically, the total energy use in the United States seems to follow, very closely, the Gross National Product of the country. We felt that this document should contain a similar analysis for Maine so that we could, at least in a broad sense, draw some conclusions about the relationship between dollars and BTU's in the State.

Figure 13 indicates the historical relationships between energy consumption, economic growth, and population growth in Maine since 1950. The economic data have been normalized to constant 1974 dollars by the ratio of the Implicit GNP Price Deflator for 1974 to the Price Deflator for the other years under consideration. The Price Deflators were obtained from U.S. Bureau of Economic Analysis data, as published in the 1975 Statistical Abstract of the United States. The economic data are reduced to constant 1974 dollars to eliminate the illusory growth due to inflation.

Curve 1 - Plots total energy consumption in Maine in trillions of BTU's annually
Curve 2 - Plots per capita energy consumption in Maine in millions of BTU's annually
Curve 3 - Plots total Gross State Product (one measure of economic activity) in millions of constant 1974 dollars.
Curve 4 - Plots per capita GSP in constant 1974 dollars
Curve 5 - Plots total personal income in Maine (another measure of economic activity) in millions of constant 1974 dollars
Curve 6 - Plots per capita personal income (a measure of relative prosperity) in constant 1974 dollars

As the graphs clearly show, there seems to be a direct relationship between economic indicators and energy use levels in the State. We believe, however, that a close examination of this relationship is necessary. Although the overall figures seem to "track" very closely, we think a more detailed examination should show a more definite correlation between certain economic indicators and the energy consumption levels in the different consuming sectors. For example, industrial energy use should exhibit a close relationship to Product Value while having little direct relation to personal income. Energy used by commerce, on the other hand, should show a much higher correlation to Personal Income statistics*. These relationships, once established, should give us some good ideas as to how economic changes may affect or be affected by energy consumption patterns in the various sectors of the State. The reason for the continued rises in GSP and PI after 1970, while energy consumption fell, probably reflects the reduction in wasteful and unproductive energy use brought about by the higher prices and increased conservation efforts following the OPEC embargo. The Maine trends seem to run counter to the national trends in which GNP fell along with energy consumption**. However, the GNP decline probably reflects impacts on the automobile and petroleum industries which would not show in Maine's GSP figures. The national figures also reflect a general economic slowdown, and it is difficult to separate the recessionary trends from the energy trends.

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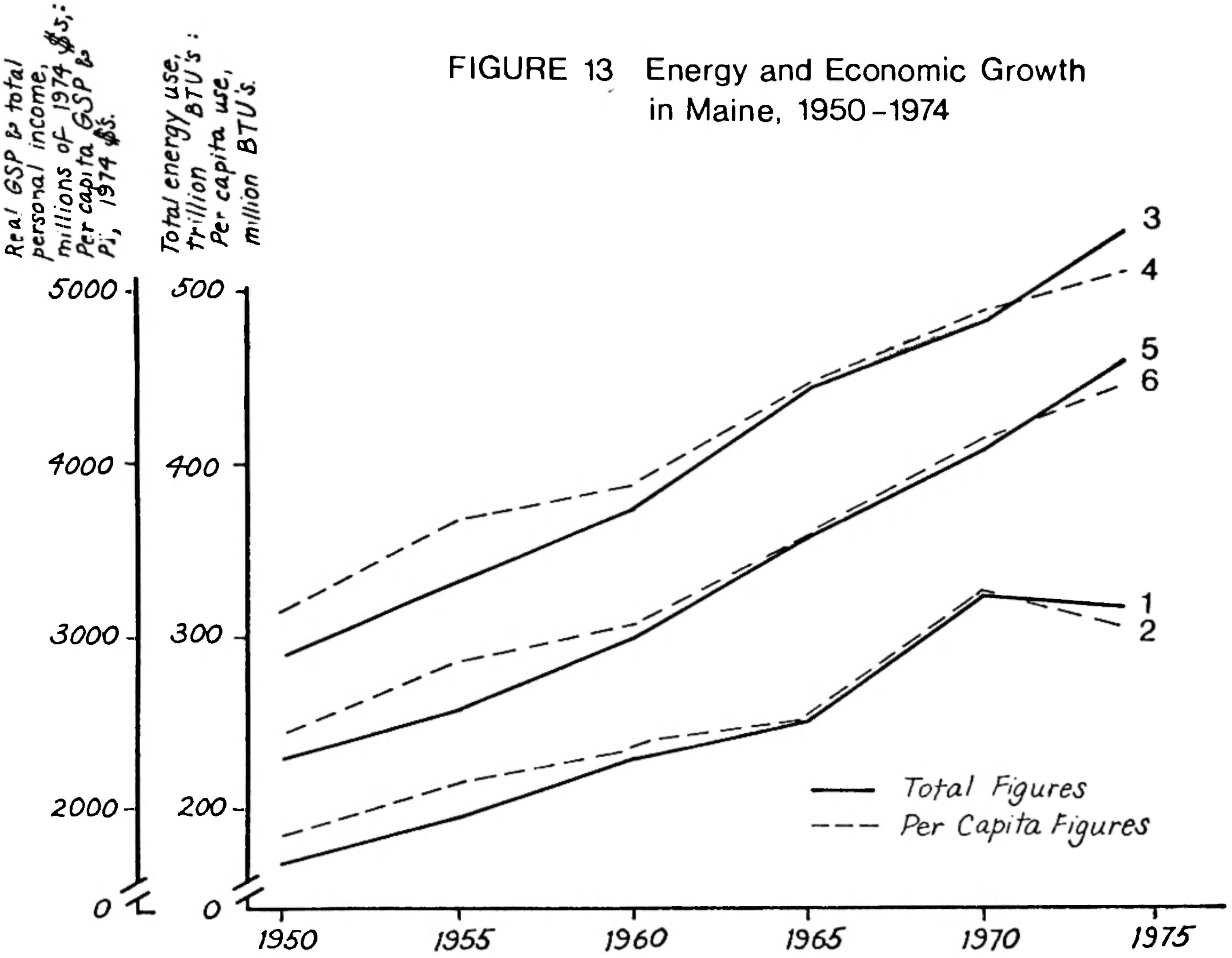
** "Energy Report from Chase", The Chase Manhattan Bank, September 1976

FIGURE 13 Energy and Economic Growth in Maine, 1950-1974



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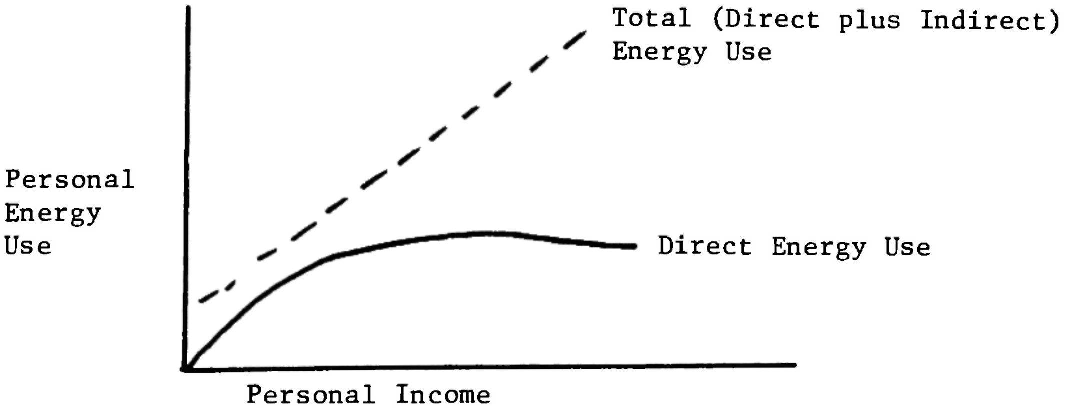
*A recent study has shown that personal energy consumption can be separated into two categories, direct and indirect. Direct consumption levels off as income rises (in other words, no matter how wealthy you are you can apparently only use so much energy to heat your home, drive your car so many miles, etc.). However, indirect consumption of energy, which results from purchase of items that consume energy in their production and marketing, seems to increase steadily with increasing income (see Graph below). This may be an important factor in the economic/energy equation.



* By Sam Schurr, Resources for the Future

## CHAPTER I

## SUMMARY

In summary, there are a number of significant consumption and supply trends which are shown in this chapter:

(1) In the period between 1950 and 1970, energy demand in Maine increased at an annual rate of 3.3% per year. Energy prices during this period rose at a lower rate than consumption. The significant downward trend in energy consumption and upward trend in price between 1970 and 1974 is attributable to the Arab Oil Embargo of 1973.

(2) While the Industrial Sector remains the largest consuming sector in terms of total BTU's, both the Transportation Sector and the Commercial Sector show higher growth rates. This may have significant implications for future demand and supply scenarios.

(3) Energy demand in the Industrial Sector appears to follow trends in the national economy. Residential energy use follows more closely population and general income trends. Commercial and Transportation consumption trends tend to be geared more to the general income level.

(4) Net direct imports and exports of electricity during the period 1950-1974 were small, varying between a maximum import of 2.7% of total energy consumption in 1970 to a maximum of 2.2% exports in 1974. The latter figure was due primarily to exports of generation capacity provided by the Maine Yankee Atomic Power Plant to out-of-state owners.

(5) In the supply sectors, electricity is growing rapidly as an end-use energy source. This growth is due mainly to the cleanliness, convenience and reliability of electricity as perceived by the public.

(6) Maine has become increasingly dependent on petroleum as a primary energy source. Oil now supplies over three quarters of Maine's energy demand.

(7) The use of kerosene has declined steadily. This is probably related to an increased demand among Maine homeowners for #2 heating oil and electricity as home heating sources.

(8) Fuelwood and coal have shown steady declines over the last 20 years. The latter has not shown any marked upswing recently. Wood, however, has shown recent trends of increased use. This increase is due primarily to the ready availability of wood and the high price of oil and electricity.

(9) The historical close tracking of energy consumption and gross state product seems to have taken a different turn in recent years, with gross product and per capita income rising while energy consumption fell in 1974. Whether this is a trend or a transient will have to await analysis of more recent data.

Examining the historical energy demand and supply trends for Maine gives us an insight into what we might expect in the future. To be sure, there are many events, such as the embargo of 1973, which could not be predicted by examining historical trends. However, unless some similar significant, unforeseen event takes place, history gives us the most reliable data on which to base future projections.

In Chapter 2, we delineate the flows of energy in the 1974 reference year. The subsequent chapters discuss the probable energy supply and demand pictures for Maine in the next decade. These projections, or scenarios, will describe the most likely situations which might occur in Maine. The scenarios are based on both historical trends and on newly enacted state and federal laws aimed at encouraging energy conservation. The projections can be used by decision-makers at all levels of government as a basis for programs aimed at assuring Maine's people of an adequate, reliable supply of energy at reasonable prices.

# CHAPTER II

# THE FLOW OF ENERGY IN MAINE
# 1974 REFERENCE YEAR

## INTRODUCTION

Before we can develop our scenarios of possible energy futures for Maine, it is necessary to know where we have been with respect to energy consumption patterns, and where we are now. In the previous chapter, the historical energy consumption patterns for the period 1950-1974 were developed to describe where we have been. In this chapter, we will develop the detailed energy flow patterns for 1974, which shall be used as the reference year. The reason for selecting 1974 for the reference year is that it is the latest period for which relatively complete energy and economic data are available.

It must be emphasized that in no way can 1974 be considered a "typical" energy year. In that sense, it is a poor base from which to draw comparisons for future energy growth. However, when considered as the most recent year of a 25-year trend of historical consumption, and as a base period from which future energy trends will develop, 1974 provides some good perspectives for energy analysis. For example, the 1974 data provides the following:

(1) Records of actual conservation efforts from which feasible conservation levels may be deduced.

(2) Information on energy shortage vulnerability, from which economic and social impacts of future shortages can be predicted.

(3) Rapid energy price escalation data and the impacts of such volatile price behavior on various segments of society.

(4) A measure of fuel substitution capabilities based on experience.

## CHAPTER II - PART 1

## 1974 ENERGY CONSUMPTION PATTERNS

### Energy Supply

Maine consumed an estimated 318 trillion BTU's of energy in 1974. Of that amount, over three-fourths (77%) consisted of various petroleum products, the most important of which were residual oils (30%), distillates (21%), and gasoline (20%). The remaining petroleum consumption consisted of smaller quantities of kerosene, jet fuel, and LPG. The most significant non-petroleum fuels were nuclear energy (12%), hydropower (11%) and fuelwood (2%). Use of natural gas and coal were negligible. The above figures (77% petroleum, 12% nuclear, 11% hydro, and 2% fuelwood) total 102%, the 2% excess being accounted for by the 7.1 billion BTU's equivalent of net electricity exports. This apportionment among fuel types is shown on the circle graph to the left in Figure 14.

### Energy Demand

On the demand side, approximately one-third of the state's total energy input (34.1%) is utilized ultimately for industrial purposes. The next largest energy consuming sector is transportation (28% of the total), followed by residential (25.2%), commercial (10.8%), and miscellaneous (1.8%). This apportionment among demand sectors is shown on the circle graph to the right in Figure 14.

Figure 15 diagrams energy flows in Maine for the reference year 1974. The left side of the diagram indicates the energy sources as primary fuel inputs, expressed in trillions of BTU's. The right side of the diagram indicates energy use by consuming sectors, also expressed in trillions of BTU's. In between the sources and final uses are the flow paths followed by the various fuel inputs, including the flows of oil, hydropower, and nuclear power to intermediate conversion to electricity. Not shown on the diagram yet, but to be added in the near future, are the conversion efficiencies for the various fuels at the points of intermediate and final use. Addition of this data on conversion efficiencies will enable the reader to gauge the effectiveness of energy resource utilization along each flow path.

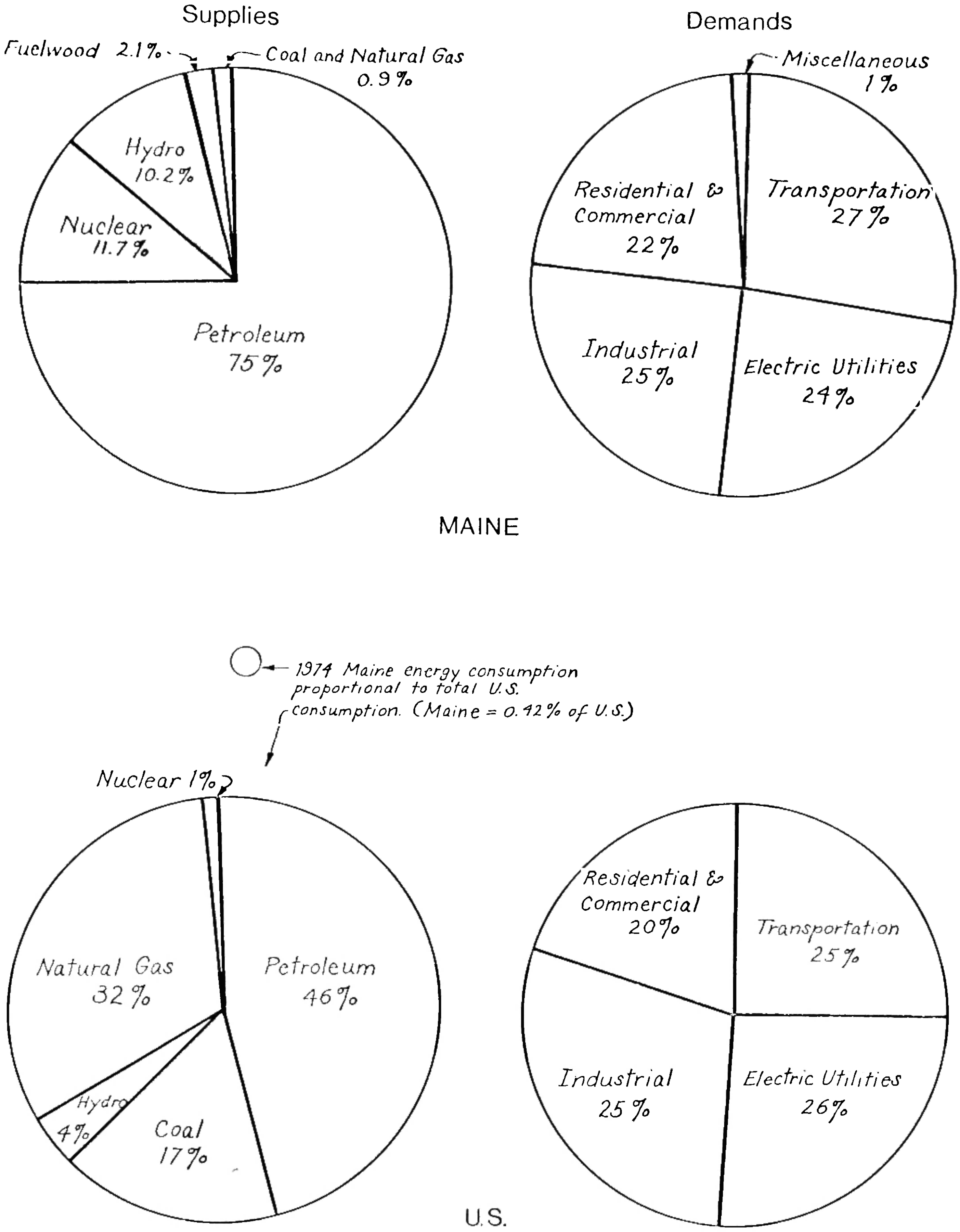
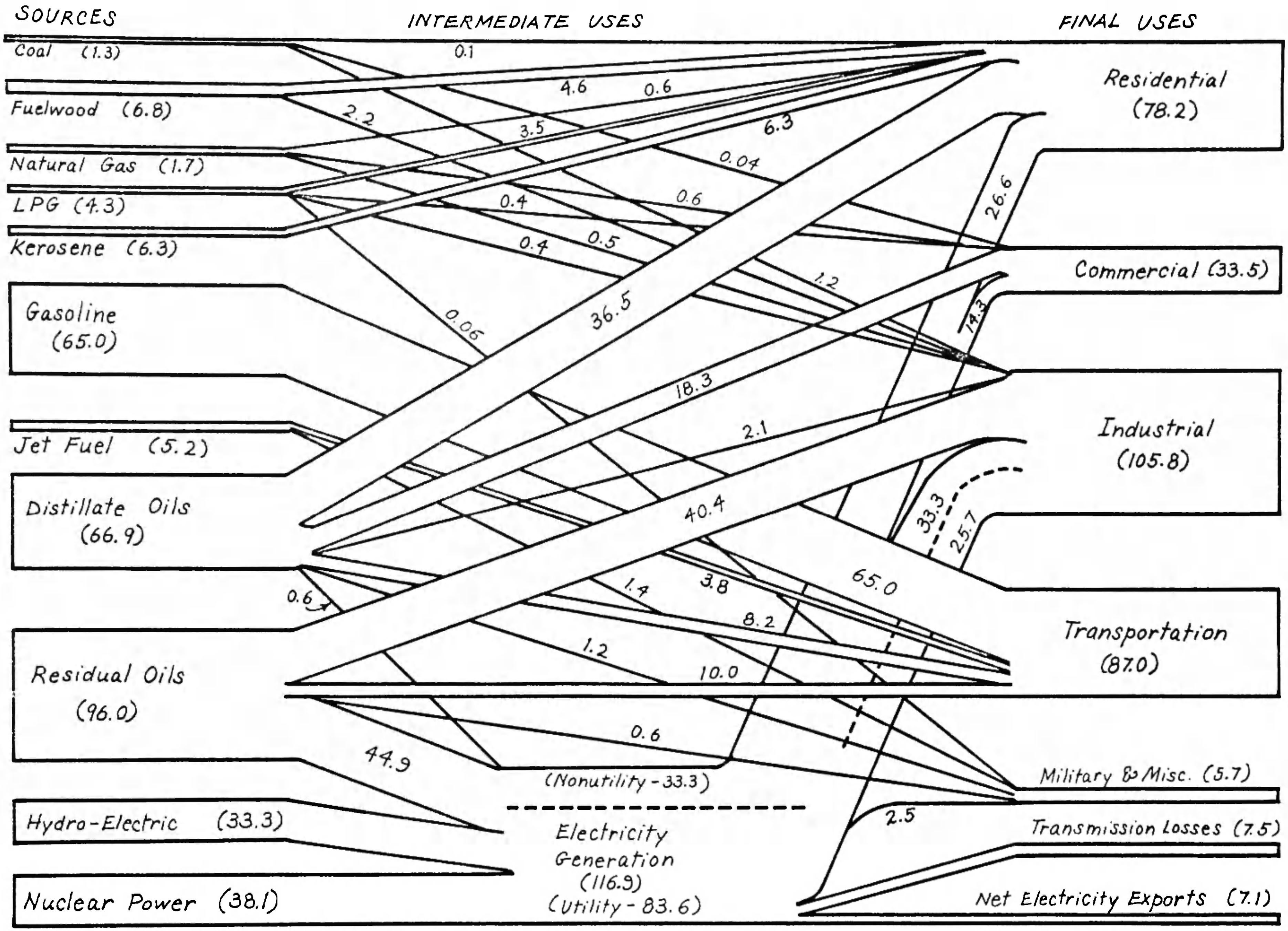


FIGURE 14 1974 Energy Supplies and Demands, Relative Values, for Maine and the United States

Figure 15

ENERGY FLOWS IN MAINE, 1974



Note: All data in trillion BTU's; Approx. Scale: 1 vertical inch = 100 trillion BTU's

## Consumption by Demand Sector (Right Side of Figure 15)

Residential: Residential energy consumption in 1974 totaled 78.2 trillion BTU's. Of this amount, 46.3 trillion BTU's (59.3%) was petroleum products (36.5 trillion BTU's of distillate oils, 6.3 trillion BTU's of kerosene, and 3.5 trillion BTU's of LPG). The remainder of the 1974 residential energy consumption consisted of electricity (26.6 trillion BTU's, or 34.0%), fuelwood (4.6 trillion BTU's, 5.8%), natural gas (600 billion BTU's, 0.8%), and coal (90 billion BTU's, 0.1%).

Commercial: The commercial sector consumed 33.55 trillion BTU's of energy in 1974. Of this total amount, 18.6 trillion BTU's (or 55.5%) was petroleum products (18.3 trillion BTU's of distillate fuel oils and 300 billion BTU's of LPG), with 14.3 trillion BTU's (42.6%) electricity, 600 billion BTU's (1.8%) natural gas, and 50 billion BTU's (0.1%) coal.

Industrial: In 1974, the industrial sector maintained it's traditional position as the leading energy consuming sector in the state, at a consumption level of 105.8 trillion BTU's. As in the residential and commercial sectors, petroleum was the principal fuel providing the industrial sector with an input of 62.9 trillion BTU's, or 59.5% of the total industrial use. The major petroleum product used was residual fuel oil, at 60.4 trillion BTU's, followed by distillate oils (2.1 trillion BTU's) and LPG (400 billion BTU's). Electricity provided the second largest energy input to the industrial sector, contributing 39.0 trillion BTU's or 36.8% of the sector total. Of this amount of electricity consumption, 25.7 trillion BTU's were furnished by the utilities and 13.3 trillion BTU's by industrial hydro generation. (A large portion of the above residual fuel consumption was burned in boilers to provide steam for process heat, space heating and electricity generation. Much of the steam thus produced was passed through turbines for electric generation, extracted from the cycle before reaching the condenser, and used for the heating applications. Since the same steam flow, in such cases, was used for both electrical generation and process and space heating, no attempt has been made here to attribute any portion of the oil input specifically to electric generation as a final end use in the industrial sector. Such use is merely given recognition here, and left for more detailed development at a later time).

Following petroleum and electricity, in order of importance, were fuelwood (2.2 trillion BTU's, or 2.1% of the total), coal (1.2 trillion BTU's, or 1.1%), and natural gas (500 billion BTU's or 0.5%).

Transportation: All of the transportation energy in 1974 (87.0 trillion BTU's) was provided by petroleum products. The major fuel used was gasoline (65.0 trillion BTU's, or 74.6% of the total), followed by residual fuel oil (10.0 trillion BTU's, or 11.5%), distillate fuel oil, meaning diesel fuel (8.2 trillion BTU's or 9.5%), and jet fuel (3.8 trillion BTU's or 4.4%).

Miscellaneous: Miscellaneous energy consumption in 1974 (for such purposes as military and governmental use, street lighting, etc.) totaled 5.8 trillion BTU's. Petroleum products again provided the major input, supplying 3.3 trillion BTU's, or 56.9% of the sector total. Specific petroleum products used were: jet fuel (1.4 trillion BTU's), distillate oils (diesel and furnace oil) (1.2 trillion BTU's), residual oil (600 billion BTU's), and LPG (100 billion BTU's). Miscellaneous electricity consumption, primarily for street lighting, was 2.5 trillion BTU's, or 43.1% of the sector total.

Total Supplies by Fuel Type (Left Side of Figure 15)

The following table lists the total inputs by all fuels in 1974 and shows the relative contributions of each fuel to Maine's 1974 energy consumption:

TABLE 2
1974 MAINE ENERGY INPUT BY FUEL TYPE

| Fuel | Trillions of BTU's | % of Total |
|---|---|---|
| Coal | 1.3 | 0.4 |
| Fuelwood | 6.8 | 2.1 |
| Natural Gas | 1.7 | 0.5 |
| Petroleum | 243.7 | 75.1 |
| Hydropower | 33.3 | 10.2 |
| Nuclear Power | 38.1 | 11.7 |
| Total inputs-All Sources | 324.9 | 100.0 |
| Net Electricity Exports | (7.1) | (2.2) |
| Net Maine Consumption | 317.8 | 97.8 |

About 37% of Maine's total energy input is now employed in the generation of electricity. This figure includes about 10% (33.3 trillion BTU's) for hydro-electric power generation by utilities and industries, 12% (38.1 trillion BTU's) for electricity generated by nuclear energy, and 14% (45.5 trillion BTU's) for oil-fired electric power generation by utilities and industries. Approximately 29% of the 117 trillion BTU's needed to generate electricity, or 33.3 trillion BTU's, was received by the ultimate users of electricity. Half of all the electricity generated in Maine is now sold to, or generated by, industrial users. Total industrial electrical consumption rose 216% between 1950 and 1974. Of 5.3 billion KWH used by industry in 1974, 2.3 billion was supplied by utilities and 2.9 billion by the industries themselves. The next most significant users of electricity were residential, whose consumption rose 6 times during the last 24 years, and commercial, which increased almost five-fold.

Table 1 in the Appendix to this chapter details the 1974 energy flow data for Maine.

Having discussed the consumption and supply patterns for Maine in 1974, we should now look at distribution of energy resources among the end use Sectors. Table 3 displays the distribution of 1974 energy consumption by fuel type and by consuming sector.

The rows of the table represent consuming sectors, and the columns are the energy demands by fuel type. The columns under the fuel types are divided diagonally. The percentage figure above the diagonal in each block is the percentage of the input of that specific fuel that is consumed in the indicated sector. The number below the diagonal is the percentage of the total sectoral demand that is provided by the fuel in that column.

The numbers above the diagonal (for the fuels) add vertically to 100%, and the numbers below the diagonal (for the demand sectors) add horizontally to 100%.

As an example of how to read the table, the block under coal in the residential demand row says that 7.00% of the total coal consumption goes into the residential sector, but that only 0.12% of the total residential demand is supplied by coal.

As another example, reading across the industrial demand row to the petroleum column, we read that 28.84% of the total petroleum consumption is consumed by the industrial sector, and that 59.48% of the total industrial energy demand is provided by the direct consumption of petroleum.

The box at the bottom of the "Use" column contains the totals of the sectoral demands (and fuel inputs) before and after electrical transmission losses. The total boxes at the bottom of the fuel columns show the total inputs of each fuel, in billions of BTU's, and the percentage figures below these totals show the relative contributions of each fuel to total 1974 energy consumption.

The "Electricity" column total does <u>not</u> include transmission losses or electricity exports.

## TABLE 3

## 1974 SUPPLY/DEMAND PERCENTAGE DISTRIBUTIONS BY DEMAND SECTOR AND BY FUEL TYPE

KEY

% OF TOTAL SUPPLY

% OF TOTAL FOR USE SECTOR

| SUPPLY SECTOR / USE SECTOR | USE IN BTU x $10^9$ | % OF TOTAL CONSUMPTION | COAL | WOOD | GAS | PETROLEUM | ELECTRICI |
|---|---|---|---|---|---|---|---|
| RESIDENTIAL | 78,242 | 25.2% | 7.00%<br>0.12% | 67.34%<br>5.83% | 37.41%<br>0.82% | 21.23%<br>59.18% | 32.36%<br>34.05% |
| COMMERCIAL | 33,502 | 10.8% | 3.50%<br>0.14% | | 33.41%<br>1.72% | 8.54%<br>55.59% | 17.3<br>42.55% |
| INDUSTRIAL | 105,757 | 34.1% | 89.15%<br>1.11% | 32.66%<br>2.09% | 29.18%<br>0.48% | 28.84%<br>59.48% | 47.3<br>36.84% |
| TRANSPORTATION | 87,021 | 28.0% | | | | 39.89%<br>100.0% | |
| MISCELLANEOUS | 5,726 | 1.8% | | | | 1.49%<br>56.86% | 3.0<br>43.14% |
| LOSSES | 7,532 | 2.4% | | | | | |
| TOTALS | 310,248*<br>317,780** | | 1,315 | 6,773 | 1,724 | 218,144 | 82,322 |
| | | | 0.42% | 2.18% | 0.56% | 70.30% | 26.53% |

* Does not include losses

** Total including losses
(Not used for computing
Supply/Use percentages)

Data Source: Public Affairs Research Center, 1976

## Maine Energy System Analysis

As more information becomes available on the ultimate sources and uses of energy in Maine, it will be necessary to refine our methods of describing energy flows within the State. To do this the Office of Energy Resources is developing the Maine Energy System Analysis (MESA) program.

The MESA flow chart illustrated in Figure 16 is patterned after the National Reference Energy System (RES) developed at Brookhaven National Laboratory, with slight alterations to better depict Maine's energy system. MESA is similar to the energy flow diagram depicted in Figure 15, but with more detail added to define energy flow paths more accurately. Brookhaven has developed a computer model called the Energy System Network Simulator (ESNS, pronounced "essence") that computes flows along the various paths in the RES network for various scenarios, and also computes pollutant emissions for environmental impacts of each scenario.* The program cannot allocate resources to satisfy energy demands, but can aid in computing the effects of resource allocations that are specified by the analyst.

The dotted line that runs vertically from top to bottom Figure 15 (beginning at the top in the "Transport and Storage" column) represents the geographical border of Maine, and separates those processes and resources that occur external to Maine from these that occur internally. It can be seen that the nuclear and fossil fuels all enter Maine in the "Transport, and Storage" stage, and that Hydropower and Wood are assumed to lie wholly within Maine. Thus, the nuclear and fossil fuels are forms of energy that must be "imported" to Maine, while the hydropower and wood represent energy forms that are native resources.

While solar, wind, and tidal energy are not represented on the diagram, they, too, would generally lie wholly to the right of the line and be classed as native resources.

When MESA is fully developed, we can use it as an input to ESNS or a similar program. This will provide an important tool for projecting energy futures for Maine. Such a tool will allow us to ask an almost infinite number of "what if" questions. The answers to these questions will provide valuable information for the States policy makers and the public as a whole.

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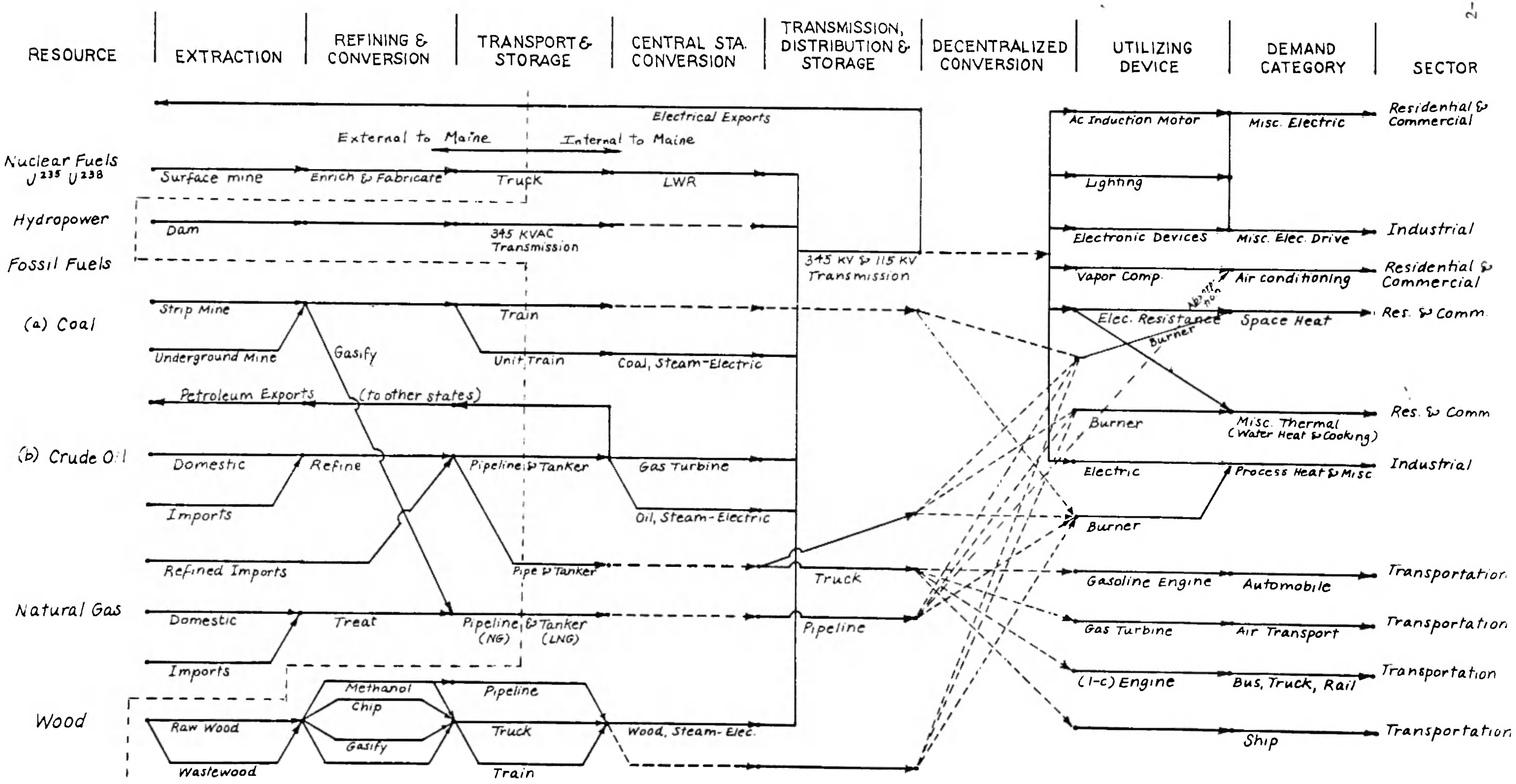
* Another program, called "BESOM" for Brookhaven Energy System Optimization Model, is available to compute resource allocations. Unfortunately, both of these programs are constructed for National and Northeast Regional energy studies and require some modification and manipulation for use in New England level and Maine's state-level energy flow analysis. BESOM is being programmed into the NEEMIS facility and will be used to analyze Maine's energy system when ready. It is hoped that ESNS will be similarly available in the near future. The availability of these two computer models will enable the rapid analysis of any number of possible alternative future scenarios, and the potential environmental and resource depletion consequences of each.

FIGURE 16

MAINE ENERGY SYSTEM ANALYSIS (MESA)



## CHAPTER II PART 2

## EFFECTS OF OIL EMBARGO ON MAINE
## 1973-1974

The embargo on petroleum exports by several Arab Nations during the winter of 1973-1974 had serious effects on the economy of Maine, (as well as the rest of the world). A review of the impacts of that experience is useful in this summary of Maine's recent energy history as well as an aid in determining the potential impacts of another embargo, should one be imposed.

A report prepared for Governor Kenneth M. Curtis by the University of Maine * indicates that 11% (17 firms) of a sample size of 153 manufacturing and transportion firms (7% of the State total) laid off employees because of direct or indirect energy shortages. Another 8% of the firms in the sample (or 13 additional firms) expected significant layoffs in their work force as a result of the energy situation. Twenty-six firms (17% of the sample) curtailed expansion plans while only 3 firms (2% of the sample) said that there was a better-than-even-chance of their operations being terminated. Thirty-two firms (21% of the sample) said that they had energy substitution possibilities, while 12 firms (8%) said that fuel substitutions were actually being undertaken.

The report concluded that "electricity is in many respects the most crucial energy input to manufacturing, since it is the single source used by all respondents". It further concluded that a 10% reduction in energy supply could be absorbed with little effect on production or employment, but that employment would feel the impact of higher energy reductions before production would be curtailed. A 30% cut in energy supplies would require the discharge of as many employees as possible short of a complete shutdown, and an energy reduction of 40% or more would result in widespread shutdowns.

The report went on to state that journeys to work by automobile would not be seriously affected by curtailment of gasoline supplies, since well over three-quarters of the firms responding reported that less than half of their employees commuted more than 10 miles to work. The 10 mile distance was selected because a gasoline rationing plan that limited consumers to 35 gallons per month or less, would severely affect people who commute more than that distance.

Pulp and paper plants are by far the greatest consumers of fuel among manufacturing establishments in Maine. Six of the 19 firms responding in this category (32%) reported that they had actually substituted fuels during the crisis, while the remaining 13 firms (68%) did not. Of the same 19 respondents, 11 (or 58%) said that fuel substitutions were possible while 8 firms (or 42%) said that they could not substitute fuels. The survey did not determine the types and quantities of fuel that would be involved in any substitution efforts. The pulp and paper respondents indicated that they might be seriously hampered by reductions in residual oil or electricity supplies (reducing production by over 30% for a 40% cut in electricity supply for 12 of the 19 respondents), but less affected by reductions in

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* Social Science Research Institute of the University of Maine at Orono, The Energy Vulnerability of Maine Industries: Manufacturing and Transporation, May 1974.

distillate oils or LPG. Employment apparently falls more rapidly than production when severe shortages of energy occur.

Of the industries surveyed, food processing firms seemed most likely to close down under the conditions of 30-40% cuts in their energy supply.

Another survey of 90 firms (including 15 in Maine) prepared for the New England Regional Commission,* concluded that:

> (1) "While the impact of the energy crisis on output, employment, and profits cannot be easily separated from the cyclical downturns affecting the U.S. and New England economics, New England is in a far worse position today relative to regions which depend upon and have access to natural gas than it was during the pre-energy crisis period."
>
> (2) "Within New England, New Hampshire and Rhode Island suffered higher energy-related unemployment relative to their total employment than Massachusetts and Connecticut. The overall impact on Maine and Vermont was minimal."
>
> Note: The weekly peak energy-related initial unemployment during the embargo was 151 persons in Maine or about .04% of the total non-agricultural employment of 352,000. In contrast, Connecticut had a weekly peak energy-related initial unemployment about seventeen times greater (8940 persons, or about .7% of the total non-agricultural employment of 1,242,000).
>
> (3) "The chemicals and rubber and plastics industries experienced strong employment, sales, and profit pictures during the energy crisis period. The paper and textile industries were the most severely impacted during the energy crisis period, primarily because of higher costs and material shortages as opposed to lack of direct energy availability. Most durable goods and non-manufacturing sectors continued strong during the energy crisis period, but are now feeling the impact of the recession more fully".**
>
> (4) "Higher energy prices have contributed greatly to the overall inflation affecting all people, particularly the poor. Limited resources have been devoted to the poor, with only a fraction of the target poverty population reached by winterizing and cash grant programs." ***

---

* Ernst and Ernst, Analysis of the Impacts on New England of Recent Energy Shortages and Price Increases, January 1975.

** This statement applied at the time the report was prepared, that is, January 1975.

*** (CSA estimates that about 10% of those eligible in Maine have been reached by these programs, which are still in progress).

Another study, by the U.S. Department of Labor,* revealed that national unemployment attributable to energy shortages during the embargo was relatively mild overall. However, between November 1973 and March 1974 a number of industries were impacted directly. Among the industries that impact on Maine's economy, the most severely affected were gasoline service stations, special trade contractors, laundries and dry cleaning, real estate, miscellaneous plastic products, and water transportation. Industries with negative indirect employment effects from the embargo included motor vehicle dealers, hotels and other lodging places, miscellaneous transportation equipment, metal stampings, miscellaneous textiles, and aircraft.

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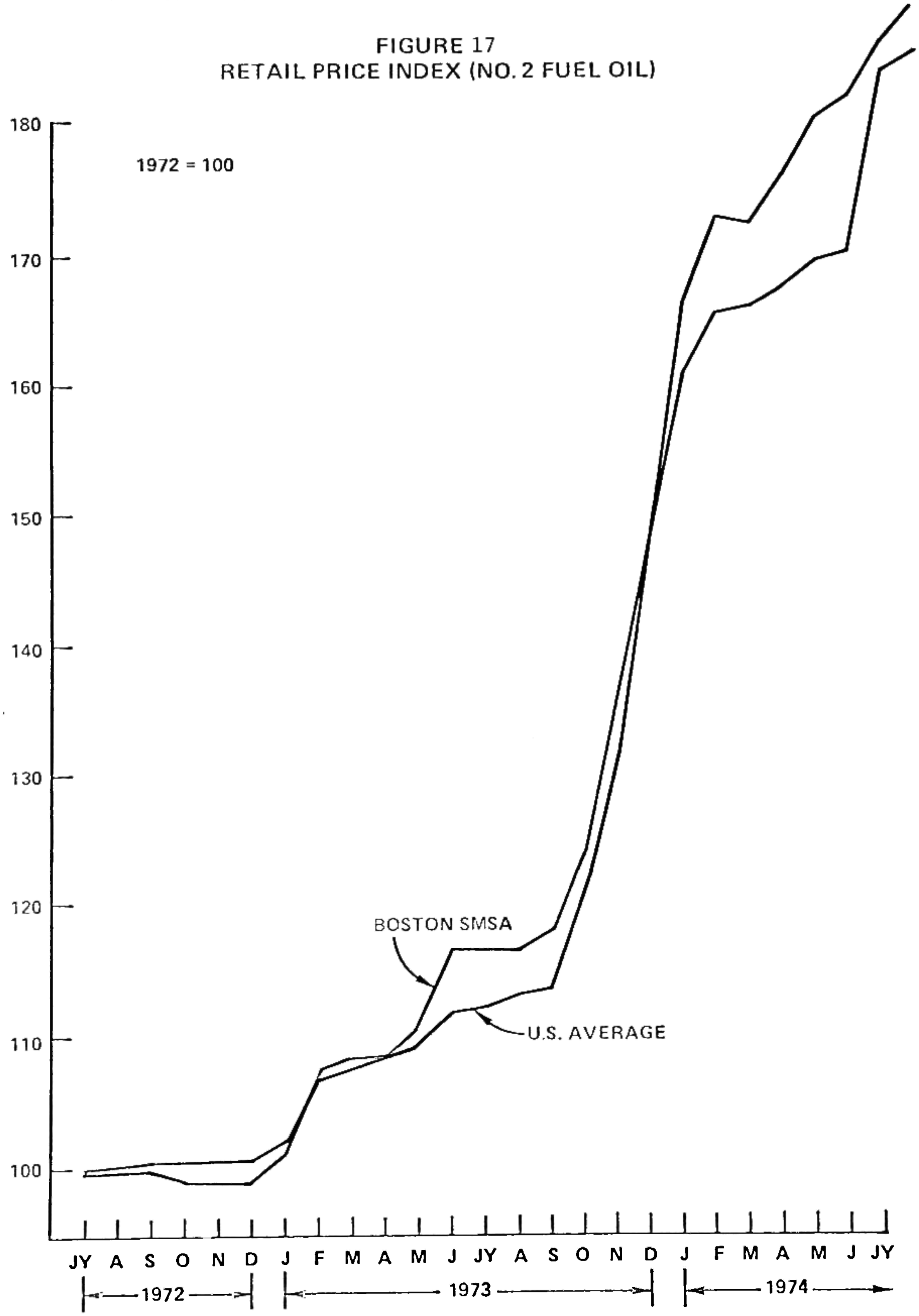
* John F. Early, "Effect of the Energy Crisis on Employment", in Monthly Labor Review, August 1974.

## CHAPTER II - PART 3

### "CURRENT" ENERGY PRICES

A direct result of the embargo of 1973 was a sharp rise in the price of almost all forms of energy. A dramatic indication of that rise is depicted in Figure 17 for #2 fuel oil:

FIGURE 17
RETAIL PRICE INDEX (NO. 2 FUEL OIL)



SOURCE: BUREAU OF LABOR STATISTICS

The sharpest price rise in petroleum products occurred between January of 1974 and January of 1975. (Current prices (fall of 1976) are approximately 2-5¢ per gallon higher than they were in January 1975).

There is a certain amount of variation in energy prices from one area of Maine to another. An indication of the extent of that variation, as well as the trend toward higher prices is shown in Table 4 for two home heating fuels.

TABLE 4
AVERAGE PRICE FOR HOME HEATING FUELS

| | # 2 Fuel Oil | | | | Kerosene | | | |
|---|---|---|---|---|---|---|---|---|
| CITY | 1/70 | 1/71 | 1/74 | 1/75 | 1/70 | 1/71 | 1/74 | 1/75 |
| Limestone | .189 | .212 | .281 | .399 | .207 | .230 | .273 | .419 |
| Caribou | .192 | .212 | .281 | .399 | .202 | .227 | .270 | .419 |
| Presque Isle | .192 | .212 | .281 | .399 | .207 | .227 | .270 | .419 |
| Houlton | .187 | .207 | .276 | .389 | .197 | .222 | .265 | .409 |
| Bangor | | .200 | | | | .218 | | |
| Calais | .189 | .209 | .278 | .385 | .204 | .224 | .272 | .424 |
| Lubec | .189 | .205 | .272 | .379 | .199 | .215 | .258 | .410 |
| Machias | .189 | .199 | .278 | .405 | .209 | .229 | .277 | .429 |
| Belfast | .181 | .198 | .267 | .379 | .196 | .213 | .261 | .409 |
| Bath | .176 | .194 | .248 | | .196 | .214 | | |
| Waterville | .179 | .195 | .263 | .387 | .199 | .215 | .267 | .419 |
| Rumford | .189 | .209 | .282 | .389 | .207 | .230 | .272 | .414 |
| Gardiner | | | .276 | .399 | | | .289 | .438 |
| Augusta * | | | | | | | | |
| Lewiston/ * Auburn | | | | | | | | |
| Portland * | | | | | | | | |
| Kittery * | | | | | | | | |

For example, fuel oil in January of 1975 ranged from a low of 37.9¢ per gallon in Belfast and Lubec, to a high of 40.5¢ in Machias, an increase of 7%. In addition, kerosene ranged from 40.9¢ per gallon in Belfast and Houlton to 43.8¢ in Gardiner, also in January 1975. Many factors influence the price of fuels in various markets, including the source of supply, transportation cost, and competition levels. The specific factors causing these intrastate variations have not yet been determined. Recent average prices of various fuels are shown in table 5.

---

* At the time of printing of this report, these numbers were not yet available.

## TABLE - 5

## "CURRENT" PRICES OF SELECTED PETROLEUM PRODUCTS AND COAL, 1973-1976

| Gasoline - Regular grade (Cents/Gallon) | June 1973 | Average 1974 | Average 1975 | Average 1976 | % Change 1973-1976 | Average Rate of |
|---|---|---|---|---|---|---|
| Price Including Taxes | | | | | | |
| Approx. Average | 39.5 | 54.18 | 56.82 | 56.9 | +44.1% | + |
| Approx. Range: Low | ---- | 48.9 | 49.9 | 52.9 | ----- | |
| High | ---- | 59.9 | 62.9 | 59.9 | ----- | |
| **No. 2 Fuel Oil (Cents/Gallon)** | | | | | | |
| Approx. Average Retail Price | 21.4 | 35.0 | 42.0 | Est.<br>42.0 | +96.3% | + |
| **No. 6 Fuel Oil (Dollars/Barrel)** | | | | | | |
| (2.8% Sulfur @ Portland) | | | | | | |
| Approx. Average | 2.97 | 9.83 | 10.89 | ---- | +267.0% | + |
| Approx. Range : Low | 2.92 | 9.75 | 10.84 | ---- | ------ | |
| High | 3.02 | 9.90 | 10.94 | ---- | ------ | |
| **Fuel Oil to Electric Utilities (Cents/ Million BTU )** | | | | | | |
| Average, Maine | 29-30 | 144.5 | 176.3 | (9/76)<br>173.6 | +479% | + |
| Average, New England | 71.7 | 186.4 | --- | ---- | ---- | |
| Average, U.S. | 78.3 | 183.0 | --- | ----- | ---- | |
| **Coal to Electric Utilities (Cents/Million BTU)** | | | | | | |
| Average, New England | 52.5 | 110.3 | (8/75)<br>148.8 | (9/76)<br>125.4 | +139% | + |
| Average, U.S. | 41.9 | 67.8 | 76.9 | ---- | ---- | |

Sources-Gasoline Prices - Daily Kennebec Journal Files, Augusta, Maine; and Platt's Oil Handbook and Oilmanac
No. 2 Fuel Oil - Estimated from OER contacts with various selected fuel distribu
No. 6 Fuel Oil - Platt's Oil Handbook and Oilmanac
Fuel Oil and Coal to Electric Utilities - FPC Form 423, "Electrical Week", and Utility sources.

The reader is encouraged to compare Table 5 with Table 1, p. 1-23.

The impact of these recent price trends on the Maine consumer is fairly easy to determine.

The average Maine home burns about 1200-1300 gallons of fuel oil per heating season. For simplicity, this number can be rounded to 1000 gallons to show the total impact of the fuel oil prices rise. A homeowner in Waterville, for example, would have had a fuel bill of $195 in 1971, $263 in 1974, $387 in 1975, and about $430-$450 at current prices, a tremendous increase by any standard. *

The rise in price of gasoline, while not so well documented, has been similar to that for fuel oil. Typical prices in 1973, before the embargo, were in the 30¢-35¢ range for regular gas, and 33¢-39¢ range for premium (unleaded gas was not widely available at that time). Today's prices are 20¢-30¢ per gallon higher. The average driver, driving 12,000 miles per year in a 12 mile per gallon automobile, pays an additional $200-$300 annually for the 1,000 gallons of gasoline that he consumes.

The consumer has also had to bear a higher indirect energy bill as the cost of energy to industry has also risen and been reflected in higher product prices. While industry generally pays lower unit costs for energy due to the large volumes consumed, the proportional increases have been approximately the same for industry as for individuals, and have even, in some cases, been worse. A case in point is the cost of #6 fuel oil for electricity generation by utilities. The barrel of residual oil that cost Central Maine Power $1.73 in 1973 rose to more than $10 after the embargo, and remains near that level. The impact of such a drastic price rise on the consumer has been softened considerably because fuel cost is only a fraction of the total cost of generating electricity. Electricity prices have obviously not increased by a factor of five since 1973. The full impact of this rapid rise in fuel costs has also been softened by the generation mix, or the proportionate contribution from hydro and nuclear plants, which were not materially affected by the rise in fossil fuel costs.

Table 2 in the Appendix to this chapter compare typical electric bills for various utilities, classes of customer, and consumption levels within the state, and average electric bills in Maine with those in the other five New England States and the national average. The data given are for January 1, 1972 and January 1, 1976 to compare pre-"energy crisis" and post-"energy crisis" data. The data given do not include rate increases granted in 1976. These figures show that while the price of electricity has risen substantially, the increase has not been nearly as drastic as it has been for petroleum products. The average Maine residential customer consuming 500 KWH per month paid a monthly bill of $12.01 in January 1972 and $18.02 in January 1976, an increase of $72 per year or 50% over the four year period.

Although the fuel oil and gasoline price data are not for the same time periods as the electricity data, one can readily conclude that the total energy bill for the typical consumer has increased by more than $500 per year between 1971 and 1976. And that increase only counts the <u>direct</u> energy costs and not the indirect costs of higher energy prices to industry and transportation that are passed through to the consumer.

---

* At today's prices, an investment in increased home insulation would pay for itself in 2-5 years. (See appendix)

# CHAPTER II - PART 4

## EXISTING MAJOR ENERGY FACILITIES IN MAINE

The following maps indicate the location of major energy facilities in Maine. Included are the following:

### Petroleum Storage Facilities

Figure 8 is a map of Maine showing the total number of barrels of petroleum storage available in the various Maine counties. This storage capacity is currently being inventoried in much greater detail. Detailed information on storage is expected to be critically needed in the event of another embargo.

### Energy Pipelines

Figure 9 shows the approximate locations of all bulk oil and gas pipelines.

### Electric Generating Plants and Transmission Lines

Figure 20 shows the location and type of all generating plants and the voltage of existing transmission lines. (Projected plans to 1985 for new lines are also included). Not included on this map are the electric generating plants owned and operated by major industries solely for their own use. Further details on existing hydroelectric dams and other electric generating facilities are found in the Appendix to Chapter 2.

### Electric Utility Service Areas

These are shown on Figure 21.

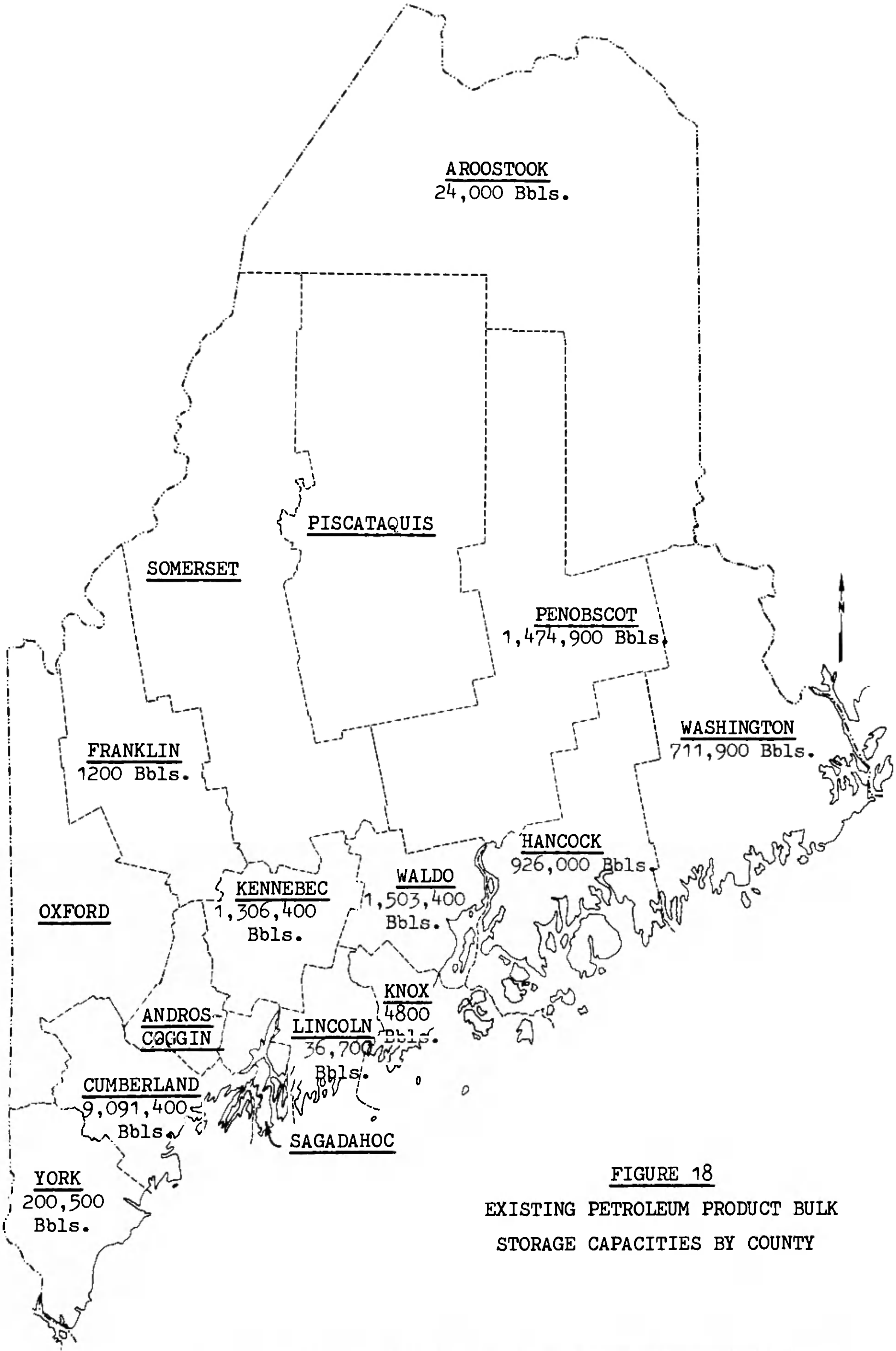
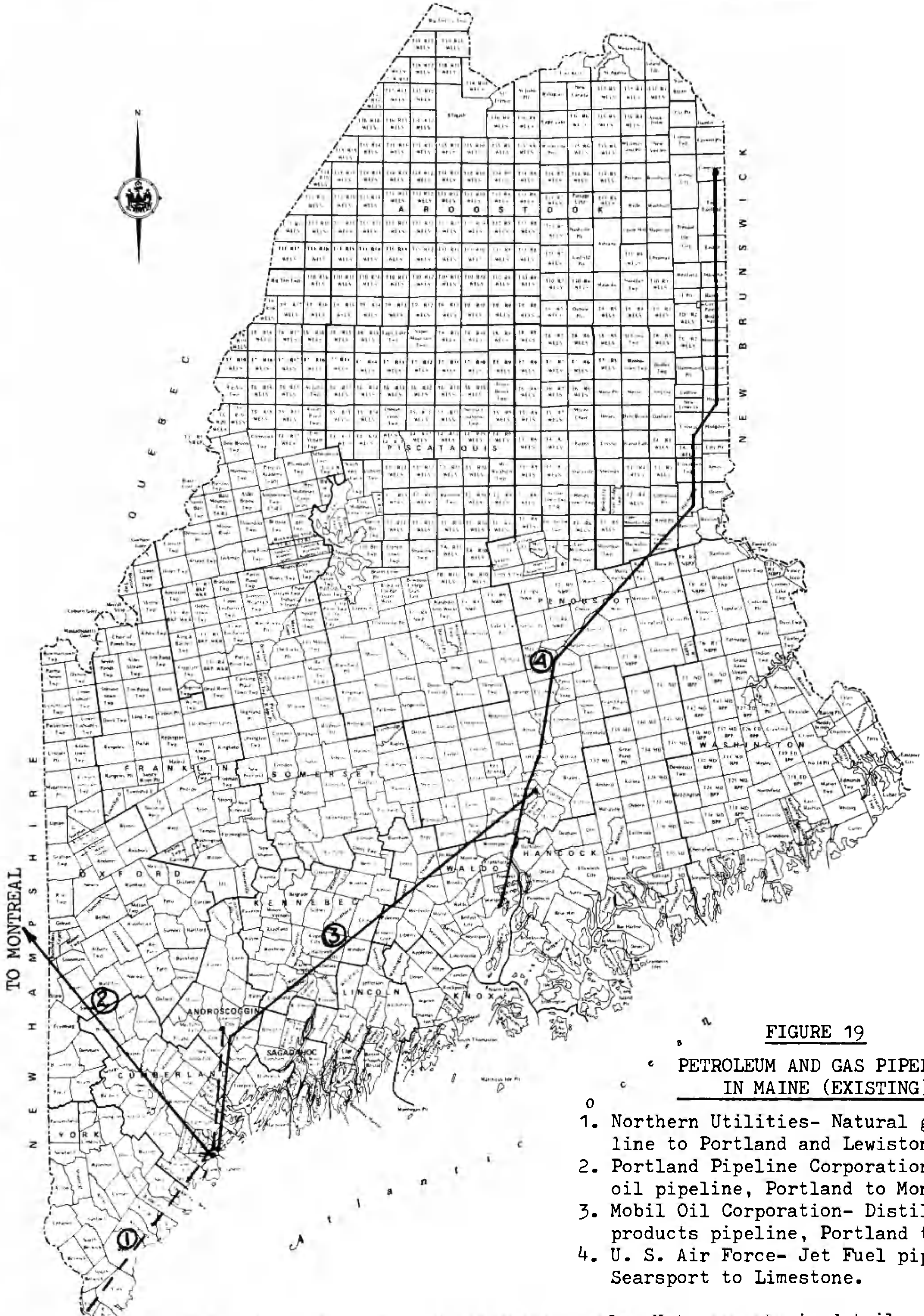


FIGURE 18

EXISTING PETROLEUM PRODUCT BULK STORAGE CAPACITIES BY COUNTY



## FIGURE 19

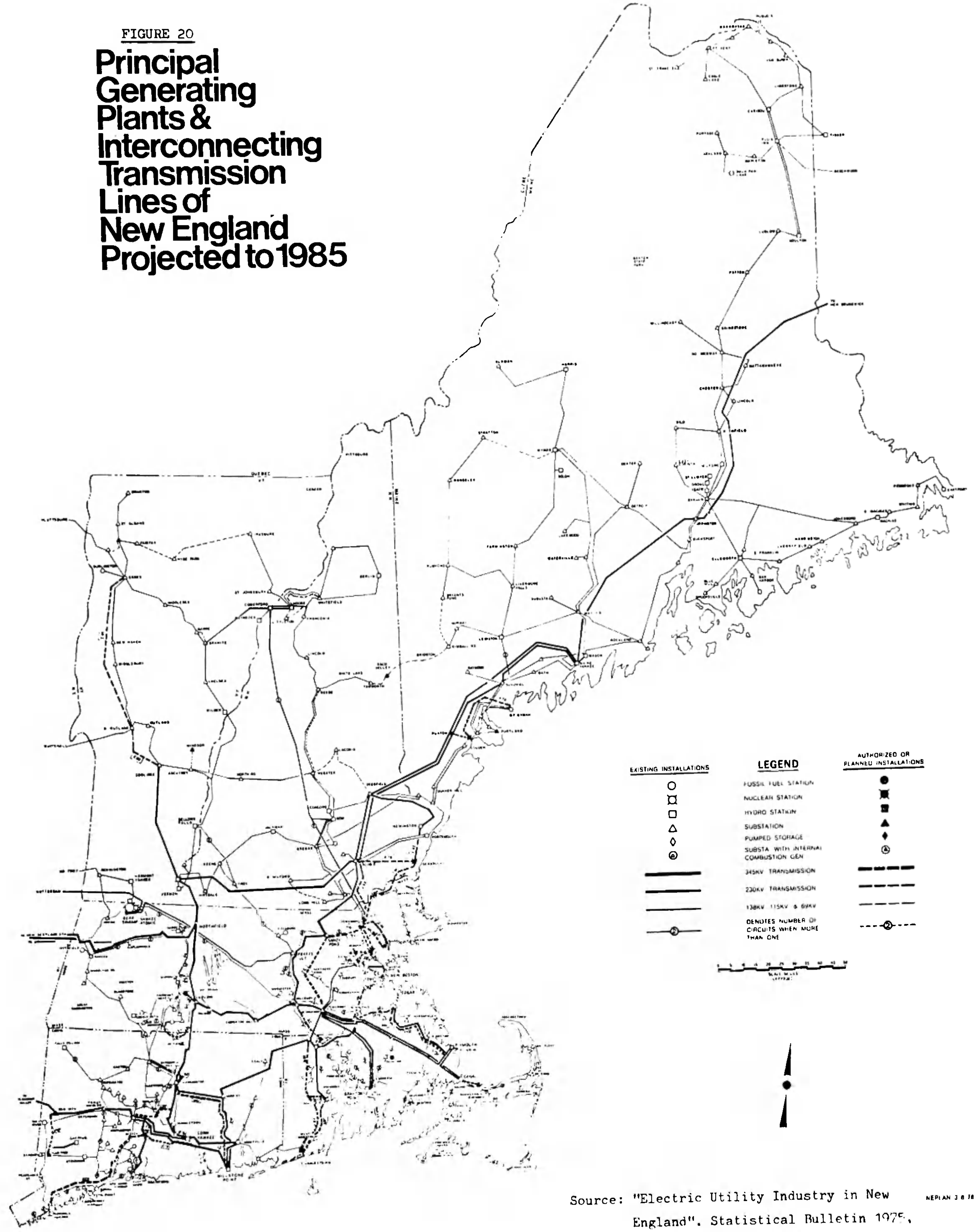
## PETROLEUM AND GAS PIPELINES IN MAINE (EXISTING)

1. Northern Utilities- Natural gas pipeline to Portland and Lewiston-Auburn.
2. Portland Pipeline Corporation- Crude oil pipeline, Portland to Montreal.
3. Mobil Oil Corporation- Distillate products pipeline, Portland to Bangor
4. U. S. Air Force- Jet Fuel pipeline, Searsport to Limestone.

NOTE: Routing schematic and approximate only. Not accurate in detail.

FIGURE 20

# Principal Generating Plants & Interconnecting Transmission Lines of New England Projected to 1985



Source: "Electric Utility Industry in New England". Statistical Bulletin 1975, from the Electric Council of New England (ECNE)

Map No. 25

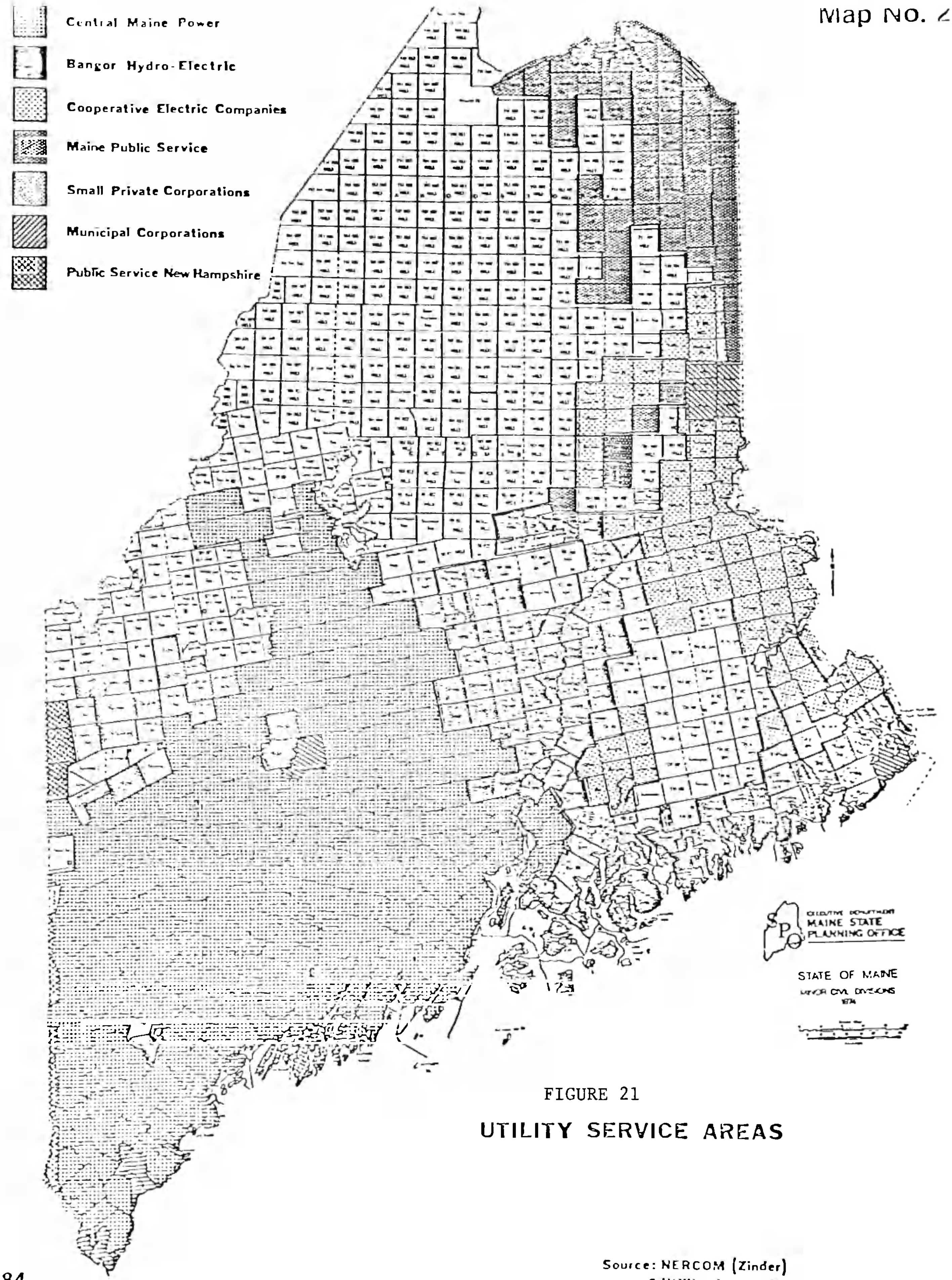


FIGURE 21

UTILITY SERVICE AREAS

Source: NERCOM (Zinder)
& Utility Annual Reports

## SUMMARY

In this chapter we have discussed aspects of the recent (1974) energy situation. We can draw conclusions about some of the more important aspects as follows:

(1) Maine is almost totally dependent on energy sources which are not native to the state. (See the graphical representations on the following page). Only 12.3 percent of our energy requirement is supplied by two native sources, hydro power and wood.

(2) Although we can trace our supply and consumption patterns to some degree, Maine needs a better defined and more accurate energy accounting system. Accurate, usuable information about the flow of energy in Maine is vital to the decision makers of the State.

(3) Because of our heavy dependence on oil, Maine is especially suceptable to long-term supply and price variations brought on by international "petroleum politics". This fact became all too clear during the 1973-1974 embargo period.

(4) Currently, Maine has sufficient electric generation capacity to meet the states needs. Similarly, we appear to have an adequate storage capacity for most of the different types of petroleum products used in the State.* Natural gas and residual fuel for industrial use and electric generation appear to have a high vulnerability to short-term supply disruptions, with no available alternatives to replace them in the event of any such cutoff of supplies.

This chapter forms a point of departure for the remainder of the Plan. The information and conclusions presented in this chapter are used as a basis for the scenarios developed in succeeding segments. We recognize that the baseline data presented herein is in a rough form and that the actual numbers may not be completely accurate. As this plan evolves, we will refine and improve our data base. This will allow better definition of our present situation and better projection of future scenarios.

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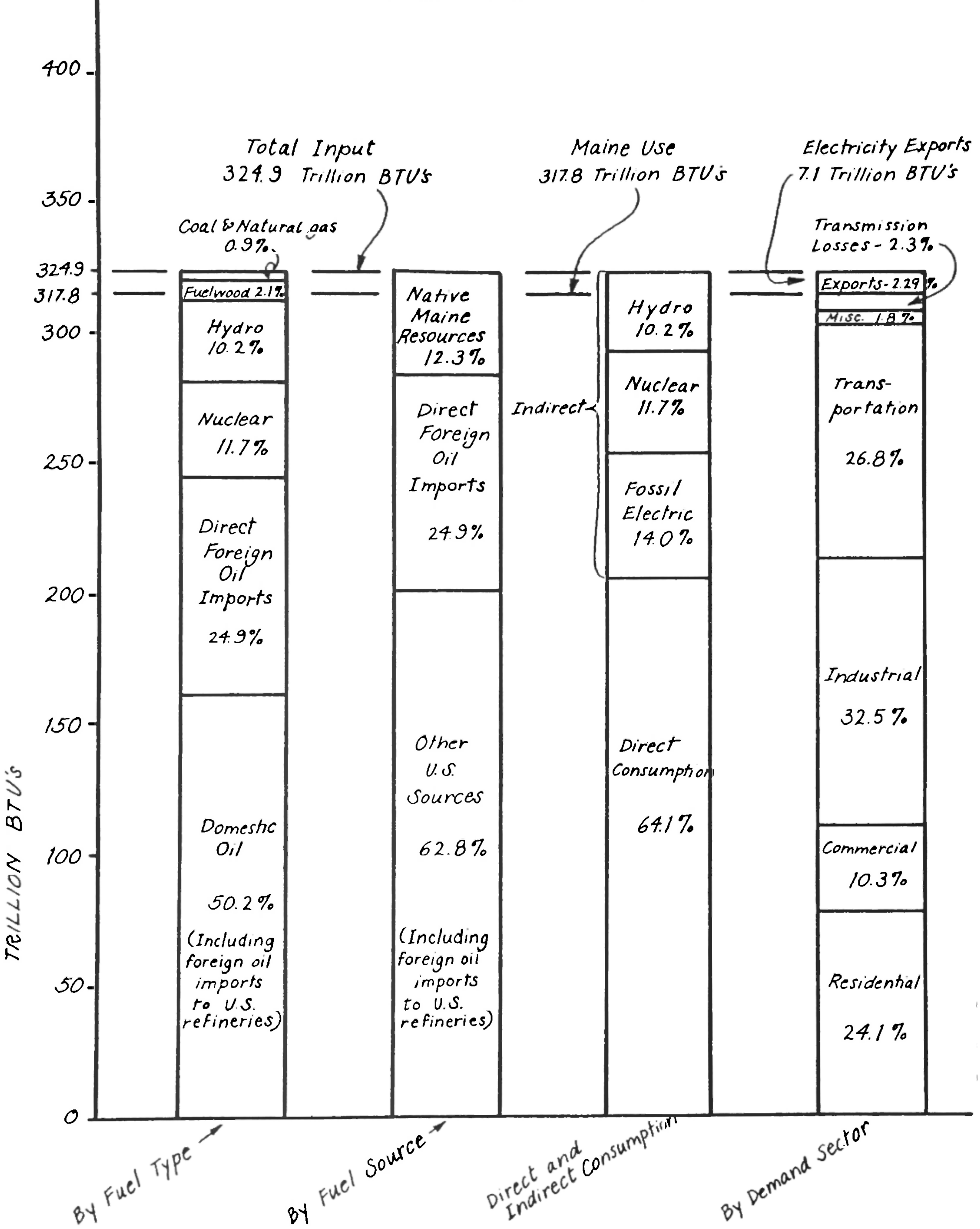
* OER is conducting an assessment of the amount of storage capacity available for each petroleum fuel type. Currently nearing completion, the study shows adequate storage capacity for all but industrial residual fuels. However, inventory levels at any instant in time are not generally available. This points out one example of the need for an improved energy accounting system (expressed in point 2 above.)

FIGURE 22

MAINE ENERGY USE PATTERNS - 1974



# CHAPTER III

# FUTURE DEMAND PROJECTIONS

## INTRODUCTION

Recent events have alerted us to the hazards of attempting to forecast the future by the extrapolation of historical trends and patterns. We must be cautious about making plans on the basis of a singular or a very limited range of objectives. This is particularly true in view of recent and current international developments and uncertainties of our domestic political and economic situation. Political and public pressures concerning resource extraction and development, opposition to further nuclear energy development, and uncertainties about discoveries of new deposits of non-renewable resources further complicate matters.

The energy future of Maine is obscured by uncertainties such that any attempt to predict the future would be highly presumptuous and might imply forecasting capabilities that do not exist. Such efforts might, further, have disastrous consequences in their economic, social, political and technological implications. We must, therefore, remember that Maine shares an uncertain energy future with the rest of the nation and the world.

The following projections should not be interpreted as predictions or forecasts of future trends or events. They are presented here solely to suggest events that can and may occur. Further, they outline that sequence of actions that could lead to their occurrence. These scenarios can also be used as guidelines in policy development that will tend to produce the desired outcomes of stable economic growth, low unemployment levels, and the availability of adequate energy resources at reasonable cost without undue and undesirable social and environmental impacts.

It is our contention, and an assumption underlying this plan, that energy systems development and growth in Maine is demand driven. That is, energy resources are developed and energy systems grow in response to consumer demands. This contention is not inconsistent with economic and technological precedents, and the professional judgement of others in the field. As an example, the energy systems computer models developed at Brookhaven National Laboratories for ERDA's Northeast Regional Energy Studies Program are demand driven, ostensibly to simulate occurrences in the real world.

The alternative to this contention is that energy systems development is supply driven, which is to say that the resources and systems are developed first, and then the market for them is created. While this may be true in a very limited sense, and was probably the dominant case in some historical development, it seems far more reasonable to assume that energy producers perceive and assure the market for their goods prior to the investment of the large quantities of capital required for the development of modern energy technologies and systems.

On the basis that the energy growth responds to a growth in demand, several alternative demand scenarios are developed. Demand is characterized as falling into three categories - full recovery, business-as-usual, and low growth. These categories are based on assumptions of population and economic growth, and consumption patterns which are functions thereof.

## TABLE - 5

## POSSIBLE ENERGY FUTURES FOR MAINE: BASED ON THEORITICAL COMBINATIONS OF ENERGY PRODUCTION AND CONSUMPTION IN MAINE

| | MAINE ENERGY CONSUMPTION | | |
|---|---|---|---|
| MAINE ENERGY PRODUCTION | HIGH<br>1. High Economic Growth<br>2. High Population Growth<br>3. Unchanged or decreased efficency of Energy Use | MODERATE<br>1. Moderate Economic Growth<br>2. Moderate Population Growth<br>3. Unchanged or slightly increased efficiency of use | LOW<br>1. Low Economic Growth<br>2. Low Population Growth<br>3. Increased efficencies in energy use. |
| HIGH<br>l. Maximum Development of all lternative resources<br>. OCS Finds<br>3. Maximum Nuclear Growth | High Consumption & High Production = Full Recovery Scenario | | Consumption less than Production (Maine becomes an Energy Exporter) |
| MODERATE<br>1. "Business as Usual"-Extrapolation of Historical Trends and Implementation of Current Plans<br>2. New Electric Generation | | Moderate Consumption & Moderate Production = "Business as Usual" Scenario (Continuation of Historical Trends) | |
| LOW<br>1. National Conservation Program<br>2. State Restrictions on Production<br>3. No OCS Finds<br>4. Nuclear Moratorium | Consumption Exceeds Production (Increased Reliance on Imported Energy) | | Low Consumption & Low Production = Conservation Scenario |

# CHAPTER III - PART I

## ENERGY DEMAND SCENARIOS

Table 6 shows a range of possibilities for demand and production combinations. The "most likely" combinations fall on the diagonal of the chart and are shown in shaded boxes. Should an event occur that causes production to be greater than demand, Maine could become a net exporter of energy. This would put us above and to the right of the diagonal on the diagram.

However, as we saw in the previous chapter, Maine "imports" about 88% of its total energy from sources outside the state. This figure includes about 12% due to Maine Yankee since the uranium necessary to run the reactor is derived from out of state sources. Maine uses native resources (wood and hydroelectric power) to supply only 12% of Maine's demands.

If our demand continues to increase in excess of our ability to produce energy, we will continue to import even more energy than we do now and will continue to be to the left of the diagonal on the chart.

### Demand "Scenarios"

Given the uncertainties and hazards of attempting to predict future events based on past trends, it is nevertheless essential to recognize that the future is, to a large extent, dependent upon the past. Demand growth alternatives are, therefore, developed here in relation to historical trends and patterns. Such patterns are modified to a degree by the imposition of certain economic, technological, political and social constraints. The increased awareness on the part of the consumer that he, ultimately, is the determining factor in energy growth further modifies the historical patterns.

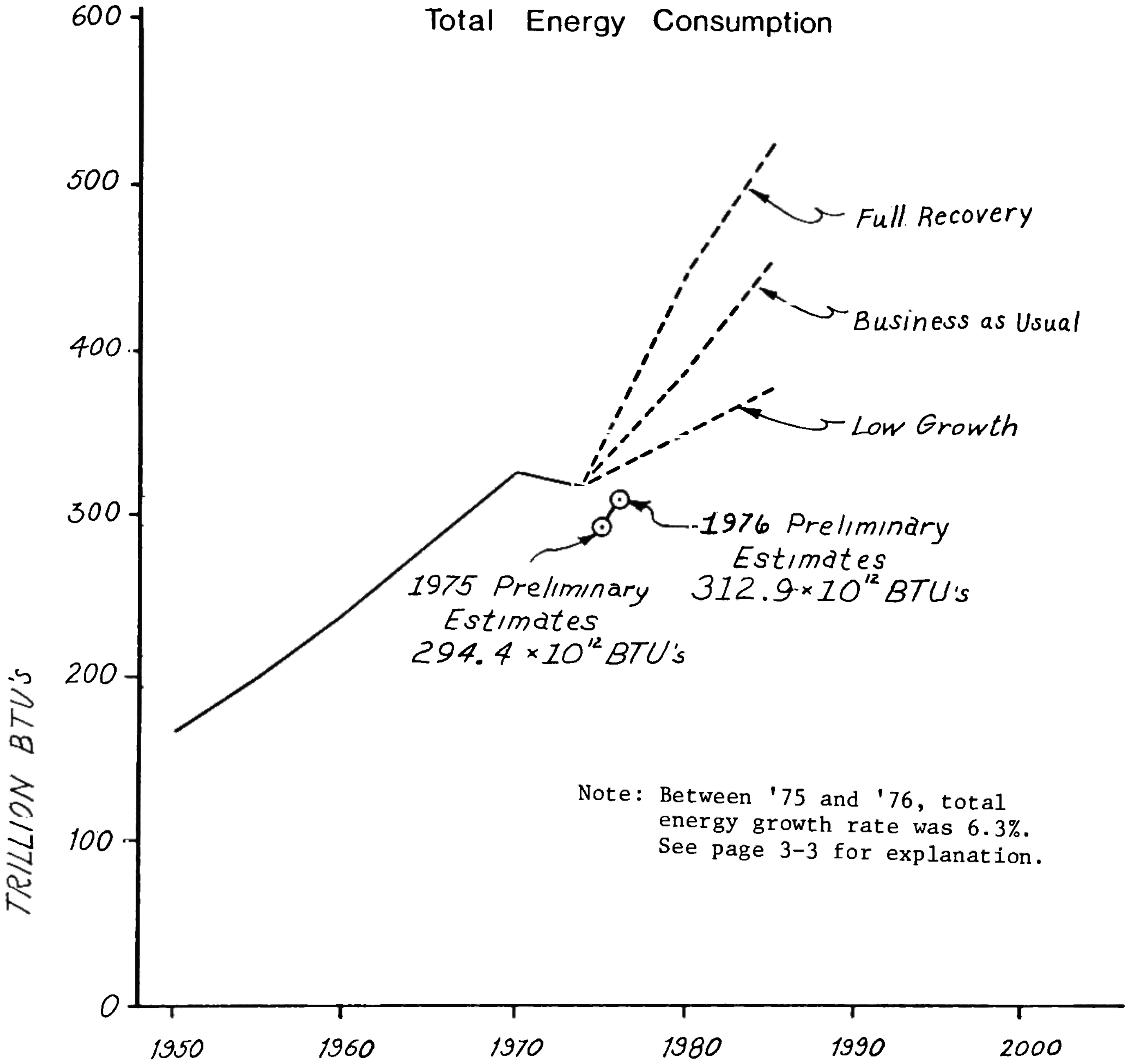
Figure 23 graphically shows the energy consumption trends from 1950 through 1974 and the three future scenarios which are described herein.

Table 7 gives the overall state energy growth rates for the three scenarios. However, if we look at the historical distribution of energy use between the different consuming sectors, we find that each sector has been increasing its energy use at a somewhat different rate. Thus, when we project the energy use of each sector into the future, the percent of total demand due to each sector will change. The tables accompanying each of the three forecasts show the pre-embargo growth rate for each sector and the percent of total demand each sector will require at a given year in the future.

---

Note: 1975 estimates are from preliminary Bureau of Maines data and subject to verification. 1976 estimates are projected from 1975 data, based on reported electrical growth by Maine utilities and FEA fuel delivery reports. Coal, wood and natural gas were assumed to grow by 5% in 1976 over 1975.

## FIGURE 23
## MAINE ENERGY GROWTH SCENARIOS - Total Energy Consumption



Note: Between '75 and '76, total energy growth rate was 6.3%. See page 3-3 for explanation.

---

### TABLE - 7

### MAINE TOTAL ENERGY CONSUMPTION - 1974-1985

| Scenario | 1974 | % Annual Growth | 1980 | % Annual Growth | 1985 |
|---|---|---|---|---|---|
| "Business as Usual"(BAU) | | | | | |
| Base Case | 317,780 | 3.3% | 385,975 | 3.3% | 453,551 |
| "Full Recovery" Case | ------- | 6.0% | 450,892 | 3.3% | 531,378 |
| "Low Growth"Case | ------- | 1.58% | 349,077 | 1.58% | 377,254 |

## "BUSINESS AS USUAL" (BAU) CASE

The business as usual forecast is taken as an extrapolation of historical growth rates in all demand categories, using the sectoral 1974 energy consumptions as base values for the extrapolations. This assumption results in an increase in total energy demand of 3.3% per year. The underlying assumption behind this forecast is that the embargo and "energy crisis" of the mid-1970's has served only to offset the energy consumption growth curve by about five years. In the future, consumption will continue to grow, in a stabilized world energy market, at pre-embargo rates. It is further assumed that full recovery to pre-embargo consumption levels will not occur.

The economic factors behind the sectoral re-apportionment indicated in Table 8 are those of declining manufacturing and an increased suburban/rural services-oriented economy. Thus, the projected trends indicate relative declines in the residential and industrial sectors. Of course, since the growth rates are all positive, the absolute number of BTU's required in all sectors will rise. These trends are continuations of the past two decades of economic activity in Maine.

TABLE 8

TRENDS IN DISTRIBUTION OF ENERGY USE BY SECTOR
(BUSINESS AS USUAL CASE)

| | % Pre-Embargo Growth Rate | % of Total Demand 1974 | % Growth Rate | % of Total Demand 1980 | % Growth Rate | % of Total Demand 1985 |
|---|---|---|---|---|---|---|
| Residential | 2.2 | 24.6 | 2.2 | 23.0 | 2.2 | 21.8 |
| Commercial | 4.8 | 10.5 | 4.8 | 11.4 | 4.8 | 12.1 |
| Industrial | 2.4 | 33.3 | 2.4 | 32.2 | 2.4 | 31.4 |
| Transportation | 4.4 | 27.4 | 4.4 | 28.9 | 4.4 | 30.1 |
| Miscellaneous | 11.1 | 1.8 | 11.1 | 1.8 | 11.1 | 1.7 |
| Transmission Losses & Unaccounted for | -- | 2.4 | -- | 2.7 | -- | 2.9 |
| Totals | | 100.0 | | 100.0 | | 100.0 |

## "FULL RECOVERY" CASE

The high growth scenario is taken as an extrapolation of the pre-embargo sectoral growth rates, as in the base case scenario above, except that 1970 is taken as the base consumption year from which the extrapolations are made. The extrapolated date was calculated for the years 1971-1975 to estimate the energy consumption levels that might have occurred had we not had the embargo and the economic recession of the mid-1970's. The extrapolations were then continued for 1980 and 1985 projected energy consumption levels. The methodology here assumes a full recovery to the pre-embargo consumption levels and growth trends, that is, a complete restoration of Maine's energy demands to those which had been anticipated prior to the embargo. This assumption results in equivalent annual growth rates of 5.8% from 1974-1980 (representing recovery to the historical trend) and 3.3% thereafter (continuation of historical growth following recovery).

This scenario includes zero, or possibly negative, conservation*. Given the experience of the energy dilemma from which we are only now making a recovery, it is not foreseen that growth rates higher than those preceding the embargo would occur. Therefore, it is assumed that this scenario will approximate the maximum growth in energy demand that is likely to occur.

In this scenario, recovery to the pre-embargo trend line occurs by 1980, and the 1980-1985 portion of the curve is an extension of the pre-embargo trend. A continuation of the pre-embargo sectoral consumption re-distribution, as outlined in the Base Case scenario above, is also assumed. Table 9 gives the sectoral percentages of total annual energy consumption for the base year and the same two projected years. Note that the percentage distribution is slightly different than that of the previous scenario because the higher growth rates of this scenario result in a slightly different spread in the projected figures.

TABLE 9

TRENDS IN DISTRIBUTION OF ENERGY USE BY SECTOR - FULL RECOVERY CASE

| | % Pre-Embargo Growth Rates | % of Total Demand 1974 | % Growth Rate | % of Total Demand 1980 | % Growth Rate | % of To Deman 1985 |
|---|---|---|---|---|---|---|
| Residential | 2.2 | 24.6 | 3.9 | 22.4 | 2.2 | 21.2 |
| Commercial | 4.8 | 10.5 | 8.4 | 11.9 | 4.8 | 12.6 |
| Industrial | 2.4 | 33.3 | 4.2 | 31.6 | 2.4 | 30.5 |
| Transportation | 4.4 | 27.4 | 7.7 | 29.7 | 4.4 | 31.4 |
| Miscellaneous | 11.1 | 1.8 | 19.5 | 1.6 | 11.1 | 1.6 |
| Transmission Losses & Unaccounted for | -- | 2.4 | -- | 2.8 | -- | 2.7 |
| Totals | | 100.0 | | 100.0 | | 100.0 |

---

*There is some recent evidence that demands are actually accellerating. For example electrical growth through November of 1976 experienced a 12% rise in Maine's peak energy demand and an 8% rise in energy over 1975. Nationally, the figure was 5.3%, which is a reduction from the 7% annual historical increase. Gasoline consumption through September rose about 5% from 1975, to set a new record. These recent increases could be due to a number of factors, such as an expanded state economy, budgetary adjustments to rising energy prices, weather variations, or perhaps a "last fling" syndrome. (Figuresfor all of 1976 show an overall increase in electricity sales of 8.2% above 1975. In December 1976 CMP experienced an increase in total sales of 11.2% over 1975 with a 20.9% increase in Residential Sales).

## LOW GROWTH CASE

The low growth scenario assumes an annual increase in total energy consumption of 1.58%, computed from 1974 Base Year data for Maine. This is the rate of the "most likely" growth scenario for Maine developed by Arthur D. Little Company in their work for the New England Regional Commission*. With the total annual energy consumption projected at the 1.58% rate, sectoral distribution of the totals were made in the same proportions as resulted from the sectoral projections in the base case above, under the assumption that whatever the total energy consumption growth rate may be, the relative sectoral growth rates will, for the foreseeable future anyway, continue their historical trends.

Tabulated below are the sectoral percentage distributions of the total annual energy consumption for the low growth scenario.

TABLE 10

TRENDS IN DISTRIBUTION OF ENERGY USE BY SECTOR (LOW GROWTH CASE)

| | Pre-Embargo Growth Rate | % of Total Demand 1974 | % Growth Rate | % of Total Demand 1980 | % Growth Rate | % of Total Demand 1985 |
|---|---|---|---|---|---|---|
| Residential | 2.2 | 24.6 | 1.05 | 23.1 | 1.05 | 21.8 |
| Commercial | 4.8 | 10.5 | 2.3 | 11.4 | 2.3 | 12.1 |
| Industrial | 2.4 | 33.3 | 1.15 | 32.2 | 1.15 | 31.4 |
| Transportation | 4.4 | 27.4 | 2.1 | 28.8 | 2.1 | 30.1 |
| Miscellaneous | 11.1 | 1.8 | -- | 1.8 | -- | 1.7 |
| Transmission Losses & Unaccounted for | -- | 2.4 | -- | 2.7 | -- | 2.9 |
| Totals | | 100.0 | | 100.0 | | 100.0 |

---

*The original "most likely" growth scenario developed by A.D. Little included a combination of voluntary conservation and some fuel substitution. Subsequent to this interim report, ADL, under a separate contract with NERCOM, explored several alternative nuclear growth scenarios and concluded that some of the assumptions of the nuclear subcases were more realistic than those of their previously designated "most likely" case. However, the analysis was not done in as great detail as the earlier studies, and the results were not disaggregated by states, as the earlier results were. Therefore, although it may be possible to make some inferences for Maine from the New England data in these ADL cases, an incorporation of this data into Maine's energy plans will await more complete analysis of the nuclear growth scenarios. This report merely adopts the 1.58% compound annual growth rate in total energy consumption on the basis of moderate conservation and fuel substitution.

Table 11 gives the total energy demanded by each sector under each of the three possible scenarios, for two future years (1980 and 1985), with 1974 consumption levels included for comparison.

### TABLE - 11

### MAINE ENERGY GROWTH SCENARIOS:SECTORAL ENERGY DEMANDS

(Billion BTU's)

| SECTOR | SCENARIOS | 1974 | 1980 | 1985 |
|---|---|---|---|---|
| Residential | BAU Case | 78,242 | 88,777 | 98,947 |
| | Low Growth | ------ | 80,647 | 82,314 |
| | High Growth | ------ | 101,133 | 112,637 |
| Commercial | BAU Case | 33,502 | 44,003 | 54,920 |
| | Low Growth | ------ | 39,780 | 45,688 |
| | High Growth | ------ | 53,017 | 67,058 |
| Industrial | BAU Case | 105,757 | 124,288 | 142,520 |
| | Low Growth | ------ | 112,437 | 118,562 |
| | High Growth | ------ | 143,458 | 161,882 |
| Transportation | BAU Case | 87,021 | 111,550 | 136,619 |
| | Low Growth | ------ | 100,547 | 113,654 |
| | High Growth | ------ | 134,102 | 166,597 |
| Miscellaneous | BAU Case | 5,726 | 6,948 | 7,716 |
| | Low Growth | ------ | 6,284 | 6,419 |
| | High Growth | ------ | 7,128 | 8,382 |
| Electric Transmission Losses and Unaccounted For | BAU Case | 7,532 | 10,409 | 12,829 |
| | Low Growth | ------ | 9,382 | 10,617 |
| | High Growth | ------ | 12,054 | 14,822 |
| Total Demand | BAU Case | 317,780 | 385,975 | 453,551 |
| | Low Growth | ------ | 349,077 | 377,254 |
| | High Growth | ------ | 450,892 | 531,378 |

# CHAPTER III - PART 2

## PROJECTED SECTORAL DEMANDS BY FUEL TYPE

The proportion of total energy demand due to each demand sector has been varying in the historical trends developed in Chapter I. The proportional demands by fuel type within each demand sector have also been varying. Some stabilization of these trends in proportional consumption distribution is indicated in portions of the 1965, 1970, and 1974 data.

It has been assumed that the historical trends of fuel use will continue on a fairly even course over the next decade. Some change in the use of "conventional" fuels will occur but, unless some very unusual event takes place, the rate of change is assumed to be gradual. (The type of unanticipated event which would alter this forecast would be, for example, an extensive embargo of extremely long duration.)

The following, then, is a discussion of some likely trends in fuel use in each of the consuming sectors.

### Residential Sector

Coal: The brief upward trend in coal use is not expected to continue, and will possibly even reverse again. However, coal demand in the residential sector for space heat will be assumed to stabilize at about 100 billion BTU through 1985.

Fuelwood: For initial growth estimates, the relative fuelwood input of 5.8% of total sectoral demand, used entirely for space heating, is assumed to hold through 1985.

Natural Gas: The decline in natural gas use is projected to continue to 500 billion BTU in 1980 and to disappear by 1985. This decline has been brought on by the continually deteriorating national situation with respect to natural gas supply. Maine's geographic disadvantage in competing for the available supply, along with the lack of a Federal program to distribute equitably the available supply among the regions of the U.S., have also influenced the decline. The shift away from natural gas is assumed to be divided among the other available fuels. It is further assumed that: (1) no new major gas finds will be developed in this period (including Outer Continental Shelf Gas); (2) Liquified Natural Gas will not be economically competitive in Maine; and (3) no Federal allocation of dwindling U.S. Gas reserves to New England (and, specifically, to Maine) will occur. These assumptions may be on the pessimistic side, but there is little optimism in the country today with regard to the long range future of natural gas as a fuel source. Federal gas allocation, LNG supply developments, and/or discovery and development of new domestic gas reserves could alter this forecast.

Petroleum: The relative demand for petroleum within the residential sector will probably continue to decline to 55% of the sectoral total in 1980 and 50% by 1985, as electricity continues to make inroads into oil's dominance of the space heating market. Within the petroleum fuel type, the distillate sub-type should continue to dominate, with LPG and kerosene continuing to decline, both absolutely and relatively. Distillate is expected to supply 46% of the total sectoral demand in 1980 and 45% in 1985. Kerosene and LPG are projected to supply 6% and 3% (respectively) in 1980 and 3% and 2% in 1985.

Electricity: is projected to constitute 38.5% of the total residential demand in 1980 and 44.1% in 1985, continuing its domination of the cooking and water heating end uses, and its penetration into the space heating end-use.

The projected distribution of demands in the residential sector by fuel type is summarized in Table 1 in the Appendix to this chapter.

These possible residential demands are graphically portrayed in Figure 24.

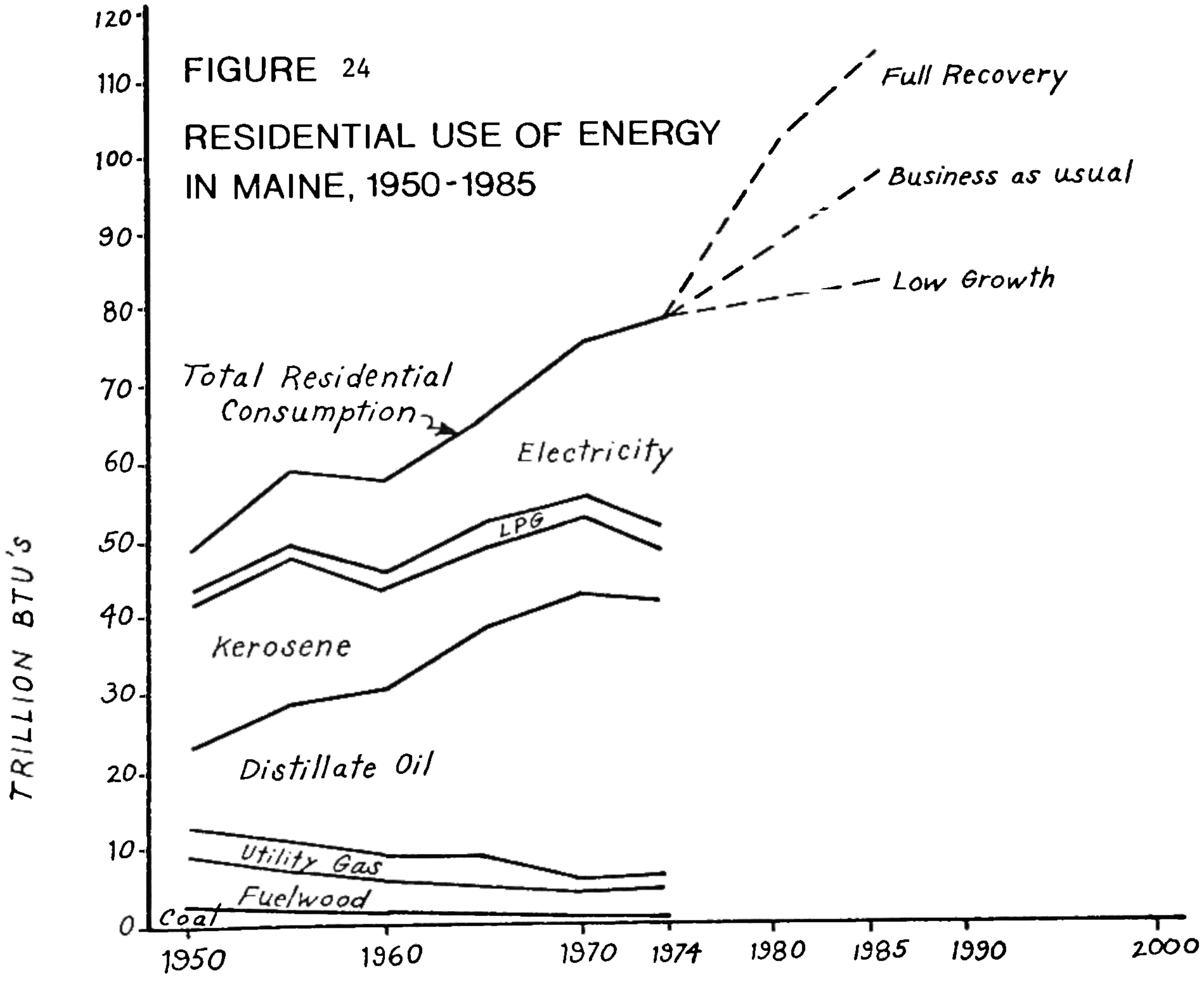


FIGURE 24

RESIDENTIAL USE OF ENERGY IN MAINE, 1950-1985

Commercial Sector

Coal is assumed to be stable at 50 billion Btu through 1985.

Natural Gas is assumed to decline again to 500 billion Btu by 1980 and to zero by 1985, as outlined in the previous section. It is assumed that oil and electricity will replace the natural gas in the space heating applications in the commercial sector.

Petroleum-The relative consumption of petroleum in the commercial sector is expected to decline still further to 52% of the sectoral demand by 1980 and 50% by 1985, with virtually all of this consumption being distillate fuels. LPG is projected to continue to supply 1.0% of the total sectoral demand.

Electricity-The relative faster growth of electricity in this sector is expected to continue through 1985.

Fuelwood-With the successful marketing of a wood fired furnace of suitable scale for use in schools and commercial establishments it is expected that fuelwood will begin to show some use in this sector, however not very noticeable before 1985.

Table 2 in the Appendix to Chapter 3 summarizes the projected distribution of demands by fuel type within the commercial sector for 1980 and 1985.

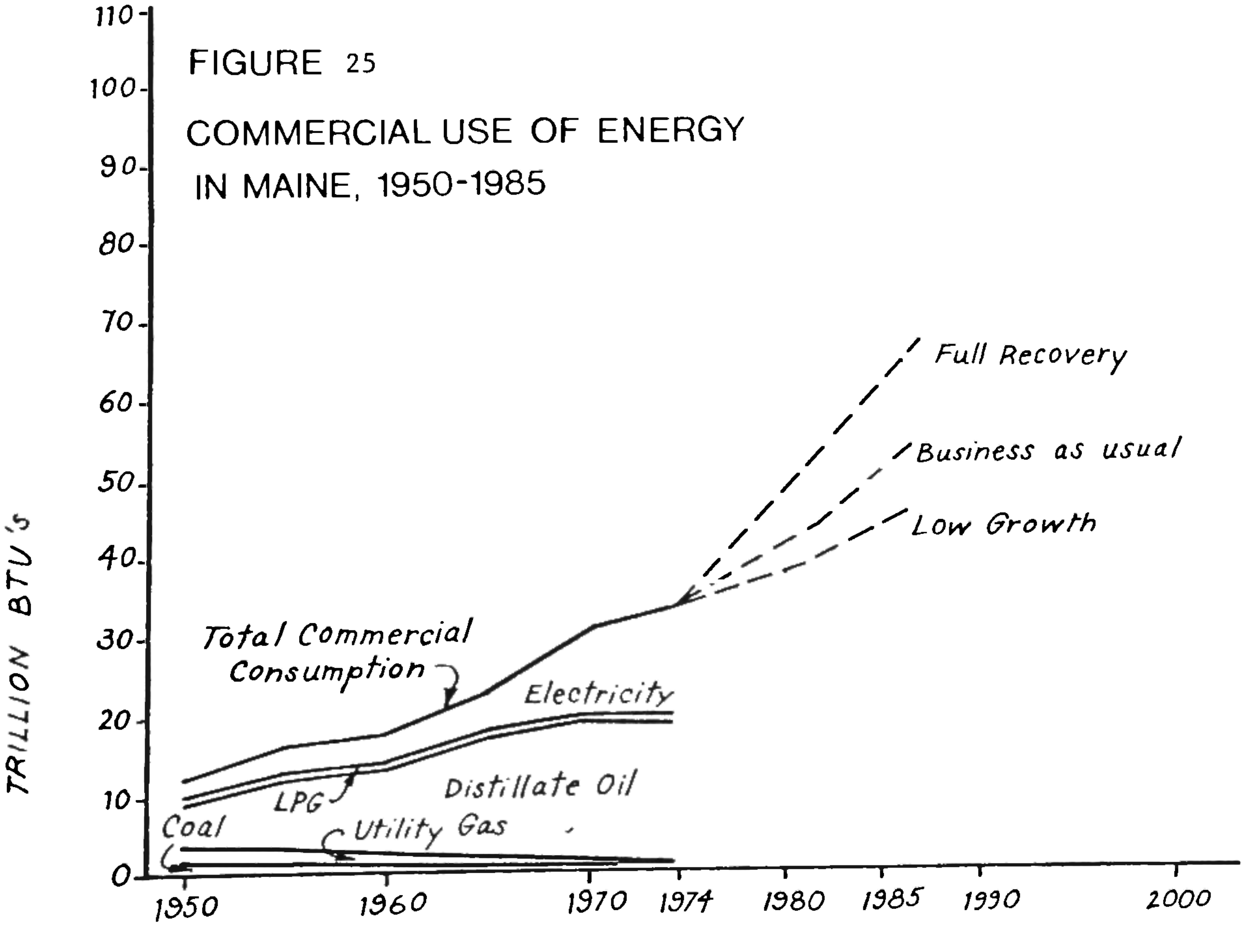


FIGURE 25

COMMERCIAL USE OF ENERGY IN MAINE, 1950-1985

## Industrial Sector

Coal-The level of industrial coal consumption is projected to remain stable at about 1.1 trillion Btu through 1985.

Fuelwood is projected to continue to contribute about 2% of the industrial energy demand thru 1985. Note that since total demand is expected to rise, this will mean an increase in the absolute number of BTU's derived from that source.

Natural Gas is projected to contribute 500 billion Btu to industrial energy demand in 1980, and to disappear by 1985, being replaced by wood, petroleum, and electricity.

Petroleum is projected to continue to contribute approximately 60% of the total industrial energy through 1985.

Electricity is expected to continue to furnish about 37-38% of industrial energy demand through 1985.

Table 3 in the Appendix to Chapter 3 summarizes the projected distribution of demands by fuel type within the industrial sector for 1980 and 1985.

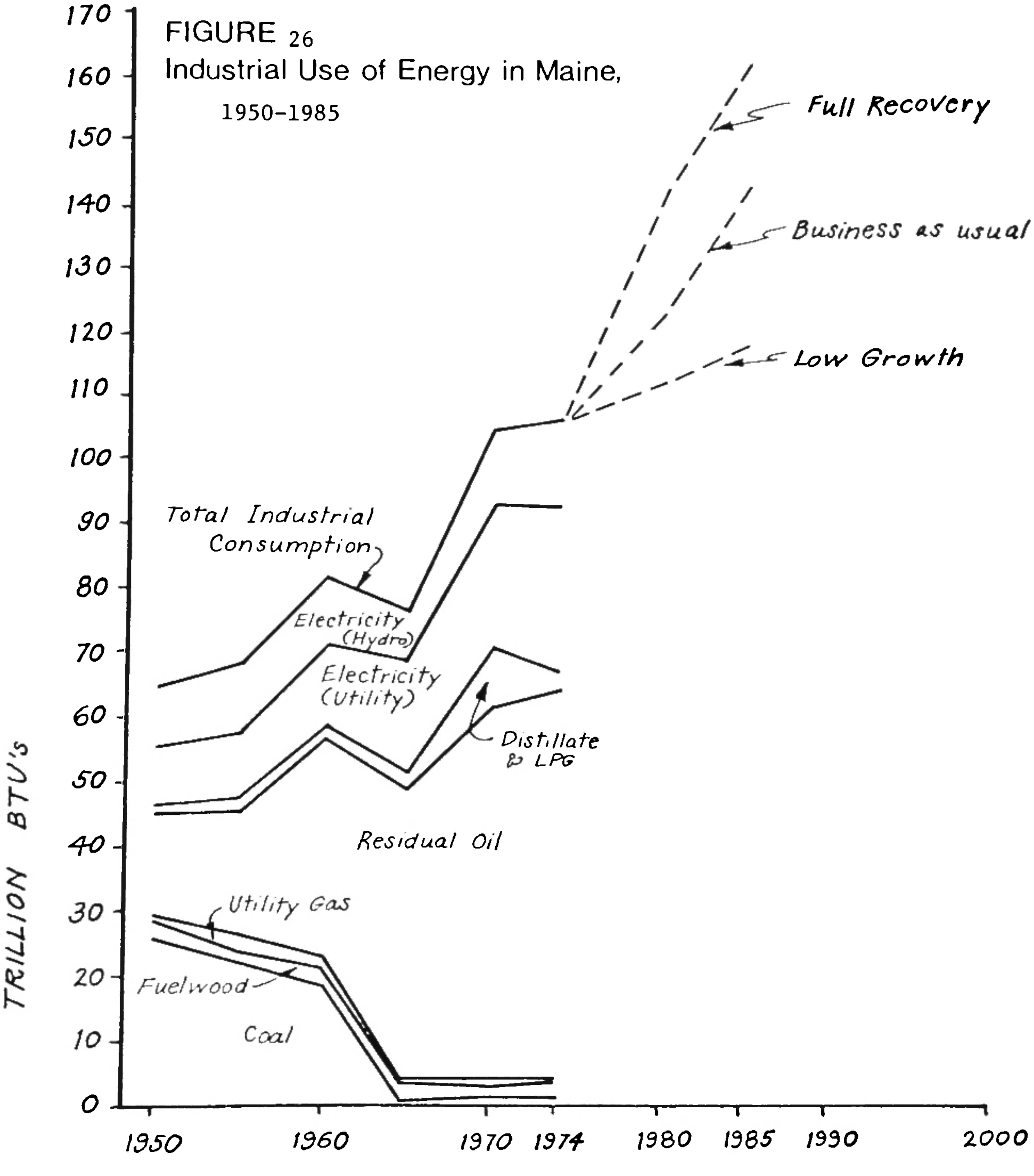


FIGURE 26
Industrial Use of Energy in Maine,
1950-1985

## Transportation Sector

Residual fuel is expected to continue to furnish 12% of the total transportation energy demand through 1985.

Distillate fuels are projected to provide 10% of the total transportation energy demand through 1985.

Jet fuel- The reduction in commercial jet fuel consumption is expected to be only temporary, and consumption of the fuel should increase to 8-10% of the sectoral total with increased air travel in the State and increased in the number of international flights refueling at Bangor International Airport. For our scenario development, jet fuel is assumed to contribute 9% of the total sectoral demand.

Gasoline is projected to again decline in relative importance in transportation energy demand, although its absolute energy contribution should continue to grow. The relative decline will be due to proportionately greater use of residual, distillate, and jet fuels, primarily for air, sea, and truck transport of freight. Gasoline is projected to contribute 69% of the total transportation energy demand through 1985.

Table 4 in the Appendix to Chapter 3 summarizes the projected distribution of petroleum demands by specific fuel type within the transportation sector for 1980 and 1985.

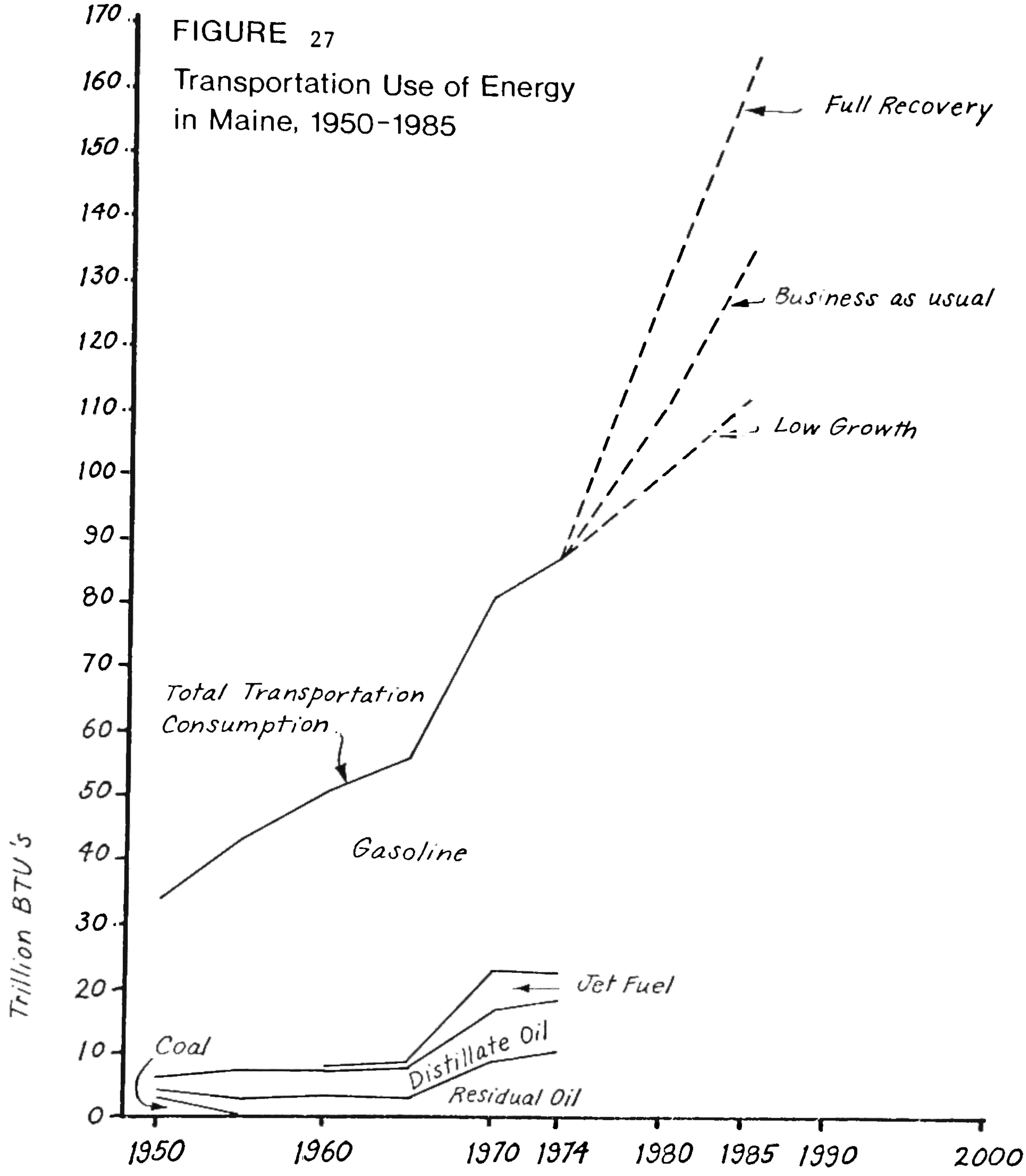


FIGURE 27

Transportation Use of Energy in Maine, 1950-1985

Miscellaneous Sector

Petroleum consumption in the miscellaneous demand sector is expected to drop sharply again with the anticipated cutback in operations at Loring Air Force Base by 1980, leaving Brunswick Naval Air Station as the only remaining major military installation in Maine. Miscellaneous petroleum demand is projected to decline to about 2.1 trillion Btu in 1980 and 1985, of which 450 billion Btu will be Residual Oil, 1.0 trillion Btu in distillate oil, 50 billion Btu in LPG, and 600 billion Btu in jet fuel.

Electricity-It is assumed that electrical consumption will make up almost all of the balance of the total sectoral demand.

Table 5 in the Appendix to Chapter 3 summarizes the projected distribution of energy demand within the miscellaneous sector for 1980 and 1985.

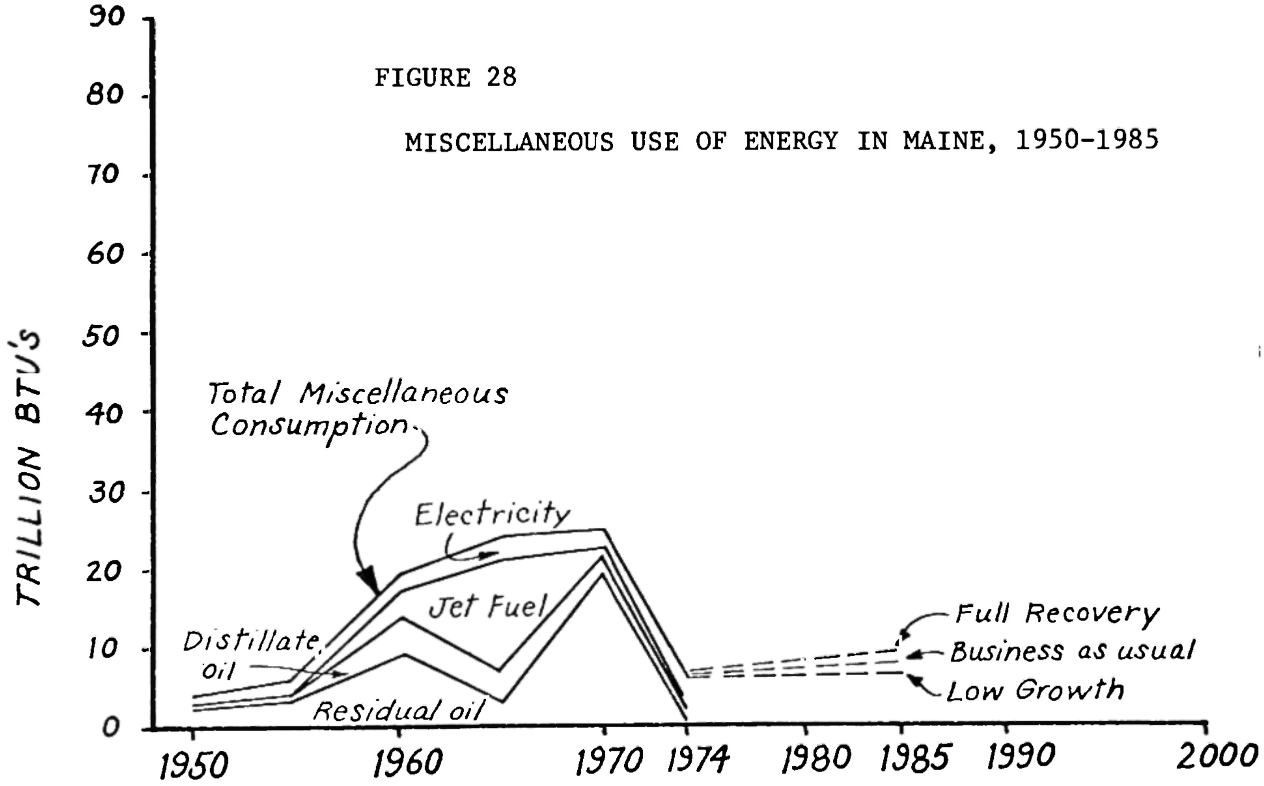


FIGURE 28

MISCELLANEOUS USE OF ENERGY IN MAINE, 1950-1985

## Electricity Requirements

Since electricity production is actually a conversion process which is capable of utilizing a number of primary fuels, and since electricity demand is rising at a rapid rate, projected electricity demands are given special attention here.

Table 12 shows present electrical capacity owned by Maine Utilities and available for sale to Maine customers.

Table 13 shows the projected requirements for electricity on a Btu basis. This has also been converted to gigawatt-hours * by dividing the Btu values, by the heat rate which is assumed to be 10,500 ** BTU/KWH for 1980 and 1985.

To convert GWH into the projected capacity requirements shown in Table 14, the GWH are divided by the projected load factor *** times the number of hours in a year (8760). This gives estimated peak loads.

In order to maintain system reliability, some reserve margin of capacity over and above the anticipated peak load is required, which would be available in the event of unexpected failure of generating units in service. Current criteria allow one day in 10 years as a reliability criterion, and this equates to about a 25% reserve requirement. However, pool interconnections and greater reliability of modern generating units could make possible a reduction in the reserve margin to about 15%, without seriously compromising the system reliability. Table 14 includes projected peak loads and the capacity requirements for both 15% and 25% reserve margins.

---

* 1 GWH = $10^6$ KWH

** Average system heat rate as determined by historical data. This heat rate is a measure of thermal efficiency. At 100% efficiency, the heat rate would be 3413 BTU/KWH.

*** "Load factor" equals the average system load for a given period divided by the maximum load for that period. It is thus a measure of how fully the capacity is utilized. Maine's overall average utility load factor was 61.9% in 1974 (not including industrial generation).

## TABLE - 12
## PRESENT ELECTRICAL GENERATING CAPACITY
## (1974)

| | |
|---|---|
| In-State | 1290 MW * |
| Owned Out-Of-State | 70 MW * * |
| Total Capacity | 1360 MW |

* Note - Includes 50% of Maine Yankee owned by Central Maine Power, BH and MPS.

* * Note - Central Maine Power ownership at Massachusetts Yankee, Connecticut Yankee, and Vermont Yankee.

## TABLE-13
## ELECTRICITY PROJECTIONS -LESS INDUSTRIAL HYDRO

| | 1980 | | 1985 | |
|---|---|---|---|---|
| | BTU x $10^9$ | GWH | BTU x $10^9$ | GWH |
| Low | 90,108 | 8,582 | 103,654 | 9,872 |
| BAU | 99,858 | 9,510 | 125,119 | 11,916 |
| Full Recovery | 115,454 | 10,996 | 144,739 | 13,785 |

## TABLE - 14
## MW CAPACITY REQUIRED (ESTIMATED PEAK LOADS) FOR TWO ASSUMED LOAD FACTORS

| | 1980 | | | | | | 1985 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L.F. = .58 | | | L.F. = .65 | | | L.F. = .58 | | | L.F. = .65 | | |
| | Peak Load | +15% | +25% | Peak Load | +15% | +25% | Peak Load | +15% | 25% | Peak Load | +15% | +25% |
| Low | 1689 | 1942 | 2111 | 1507 | 1733 | 1884 | 1943 | 2234 | 2429 | 1733 | 1993 | 2166 |
| BAU | 1872 | 2153 | 2340 | 1670 | 1921 | 2088 | 2345 | 2697 | 2931 | 2093 | 2407 | 2616 |
| High | 2164 | 2489 | 2705 | 1931 | 2221 | 2414 | 2713 | 3120 | 3391 | 2421 | 2781 | 3026 |

These figures are for Maine Electric Utility Capacity and do not include industrial installed capacity.

Figure 29 graphically shows the range of these projections for 1980 and for 1985, for the three demand scenarios and for two possible load factors. Also shown on figure 29 is the total currently installed capacity within Maine and the current ownership by Maine utilities of out-of-state units. It can readily be seen that more electric energy will have to be made available under any of the demand scenarios.

Figure 30 shows the projected electrical generating capacity requirements for the three growth scenarios for Maine in 1980 and 1985, with 15% and 25% reserve margins and for 58% and 65% load factors. The 25 reserve margin is a current "target" used by utilities to maintain system reliability. The lower margin reflects improved equipment reliability and power pool interconnections, as discussed previously. The 58% load factor is the approximate current number for Maine utilities. The 65% load factor is a reasonably attainable value with load management and incentives for shifting loads to off-peak. The curves in Figure 30 graphically demonstrates that a combination of slower energy growth, lower reserve margins and improved system load factors could significantly reduce the projected electrical generating capacity requirements for Maine.

Figure 31 shows the plan which Maine utilities have made for keeping supplies in line with projected demands.

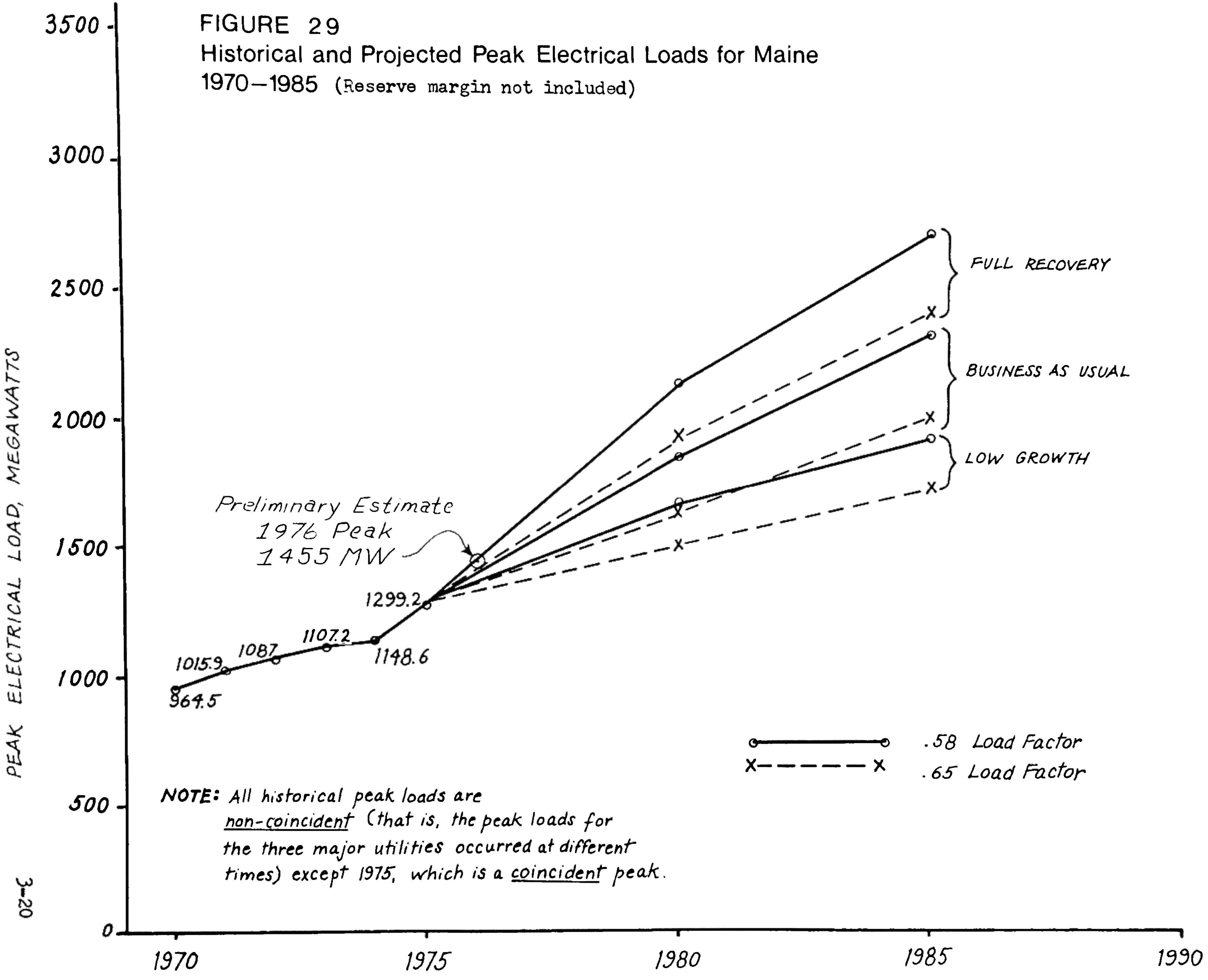
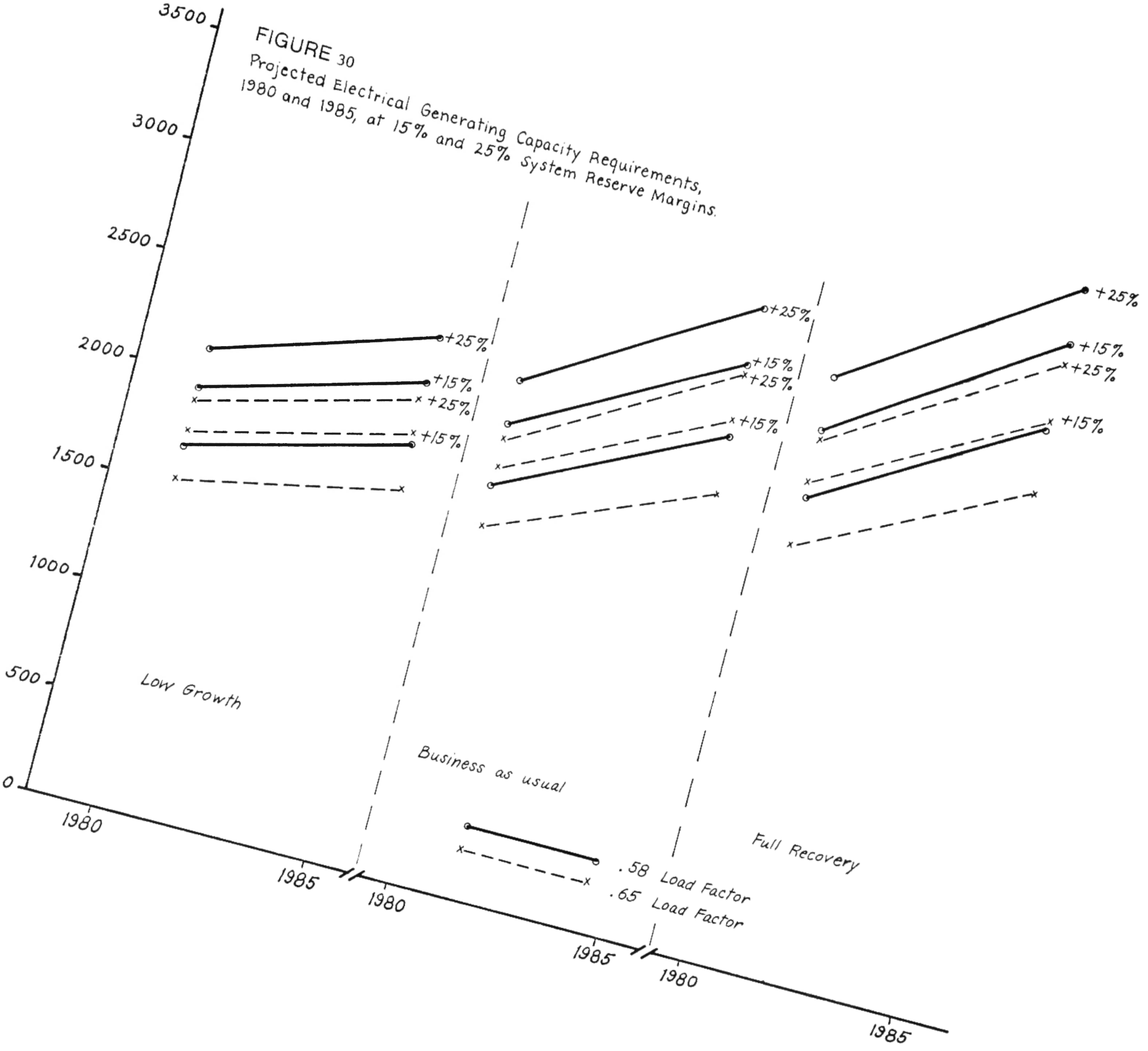


FIGURE 29
Historical and Projected Peak Electrical Loads for Maine
1970–1985 (Reserve margin not included)

**NOTE:** All historical peak loads are non-coincident (that is, the peak loads for the three major utilities occurred at different times) except 1975, which is a coincident peak.

FIGURE 30

Projected Electrical Generating Capacity Requirements, 1980 and 1985, at 15% and 25% System Reserve Margins.



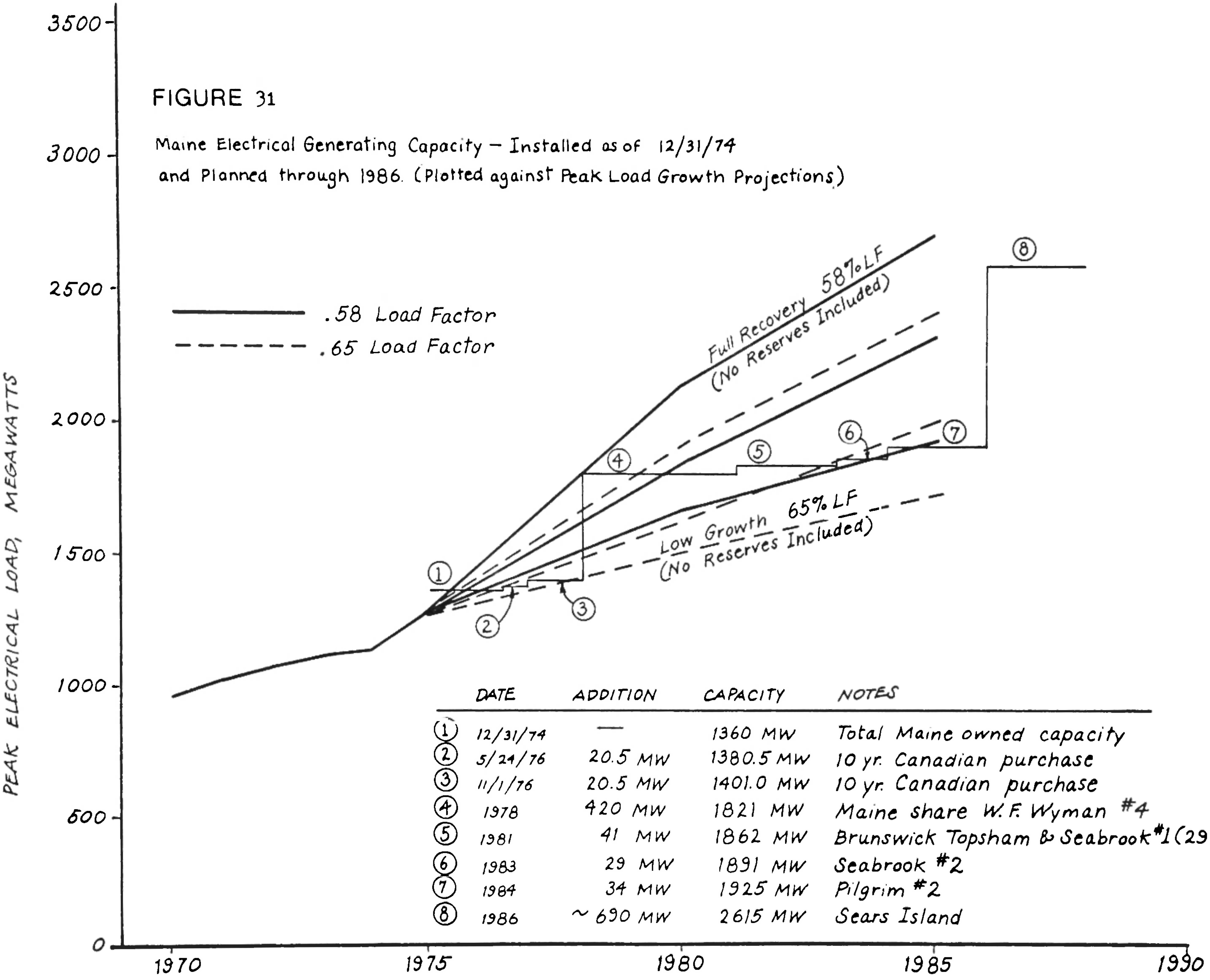


FIGURE 31

Maine Electrical Generating Capacity – Installed as of 12/31/74 and Planned through 1986. (Plotted against Peak Load Growth Projections)

| | DATE | ADDITION | CAPACITY | NOTES |
|---|---|---|---|---|
| ① | 12/31/74 | — | 1360 MW | Total Maine owned capacity |
| ② | 5/24/76 | 20.5 MW | 1380.5 MW | 10 yr. Canadian purchase |
| ③ | 11/1/76 | 20.5 MW | 1401.0 MW | 10 yr. Canadian purchase |
| ④ | 1978 | 420 MW | 1821 MW | Maine share W. F. Wyman #4 |
| ⑤ | 1981 | 41 MW | 1862 MW | Brunswick Topsham & Seabrook #1 (29 MW) |
| ⑥ | 1983 | 29 MW | 1891 MW | Seabrook #2 |
| ⑦ | 1984 | 34 MW | 1925 MW | Pilgrim #2 |
| ⑧ | 1986 | ~ 690 MW | 2615 MW | Sears Island |

## Total Projected Fuel Requirements to 1980 and 1985, By Fuel Type

Tables 15 and 16 summarize and aggregate the fuel requirements for all demand sectors and fuel types for the years 1980 and 1985, respectively. These tables indicate that the above assumptions and scenario developments will result in the patterns of fuel consumption shown in Table 17 for 1980 and 1985 relative to 1974 consumption levels, and for the BAU Case, Low Growth, and Full Recovery Scenarios.

The latter table shows that total coal consumption is expected to decline slightly (about 5%) by 1980 and stabilize through 1985, natural gas consumption may decline by 30% by 1980 and disappear altogether by 1985, and kerosene consumption may decline significantly due to high prices relative to the other available fuels.

Fuelwood and LPG consumption are projected to increase somewhat while residual, distillate, gasoline and electrical consumption are projected to increase more strongly, and jet fuel consumption is projected to increase dramatically over the 1974 level.

Table 18 shows estimated fuel requirements for 1980 and 1985 in units of measure.

# TABLE - 15

## CONSUMPTION OF ENERGY BY SECTOR AND BY FUEL TYPE, 1980, $10^9$ BTU

| Fuel Type | Scenario | Residential | Commercial | Industrial | Transportation | Misc. | Total |
|---|---|---|---|---|---|---|---|
| Coal | Low | 100 | 50 | 1,100 | --- | --- | 1,250 |
|  | BAU | 100 | 50 | 1,100 | --- | --- | 1,250 |
|  | High | 100 | 50 | 1,100 | --- | --- | 1,250 |
| Fuelwood | Low | 4,678 | --- | 2,249 | --- | --- | 6,927 |
|  | BAU | 5,149 | --- | 2,486 | --- | --- | 7,635 |
|  | High | 5,866 | --- | 2,869 | --- | --- | 8,735 |
| Natural Gas | Low | 500 | 500 | 500 | --- | --- | 1,500 |
|  | BAU | 500 | 500 | 500 | --- | --- | 1,500 |
|  | High | 500 | 500 | 500 | --- | --- | 1,500 |
| Petroleum | Low | 44,356 | 20,686 | 67,462 | 100,547 | 2,100 | 235,151 |
|  | BAU | 48,827 | 22,882 | 74,573 | 111,550 | 2,100 | 259,932 |
|  | High | 55,623 | 27,569 | 86,075 | 134,102 | 2,100 | 305,469 |
| Residual | Low | --- | --- | 64,651 | 12,066 | 450 | 77,167 |
|  | BAU | --- | --- | 71,466 | 13,385 | 450 | 85,301 |
|  | High | --- | --- | 82,488 | 16,092 | 450 | 99,030 |
| Distillate | Low | 37,098 | 20,288 | 2,249 | 10,055 | 1,000 | 70,690 |
|  | BAU | 40,837 | 22,442 | 2,486 | 11,155 | 1,000 | 77,920 |
|  | High | 46,521 | 27,039 | 2,870 | 13,410 | 1,000 | 90,840 |
| Kerosene | Low | 4,839 | --- | --- | --- | --- | 4,839 |
|  | BAU | 5,327 | --- | --- | --- | --- | 5,327 |
|  | High | 6,068 | --- | --- | --- | --- | 6,068 |
| LPG | Low | 2,419 | 398 | 562 | --- | 50 | 3,429 |
|  | BAU | 2,663 | 440 | 621 | --- | 50 | 3,774 |
|  | High | 3,034 | 530 | 717 | --- | 50 | 4,331 |
| Jet Fuel | Low | --- | --- | --- | 9,049 | 600 | 9,649 |
|  | BAU | --- | --- | --- | 10,040 | 600 | 10,640 |
|  | High | --- | --- | --- | 12,070 | 600 | 12,670 |
| Gasoline | Low | --- | --- | --- | 69,377 | --- | 69,377 |
|  | BAU | --- | --- | --- | 76,970 | --- | 76,970 |
|  | High | --- | --- | --- | 92,530 | --- | 92,530 |
| Electricity * | Low | 31,013 | 18,544 | 41,126 | --- | 4,184 | 94,867 |
|  | BAU | 34,201 | 20,571 | 45,629 | --- | 4,848 | 105,249 |
|  | High | 39,044 | 24,898 | 52,914 | --- | 5,028 | 121,884 |
| Transmission Losses and Unaccounted For | Low | --- | --- | --- | --- | --- | 9,382 |
|  | BAU | --- | --- | --- | --- | --- | 10,409 |
|  | High | --- | --- | --- | --- | --- | 12,054 |
|  | 1974 | --- | --- | --- | --- | --- | 7,532 |
| Totals-1980 | Low | 80,647 | 39,780 | 112,437 | 100,547 | 6,284 | 349,077 |
|  | BAU | 88,777 | 44,003 | 124,288 | 111,550 | 6,948 | 385,975 |
|  | High | 101,133 | 53,017 | 143,458 | 134,102 | 7,128 | 450,892 |
| Totals-1974 |  | 78,242 | 33,502 | 105,757 | 87,021 | 5,726 | 317,780 |

* Electricity - BTU's needed to generate energy; all other direct use only.

## TABLE - 16

## CONSUMPTION OF ENERGY BY SECTOR AND BY FUEL TYPE, 1985, $10^9$ BTU

| Fuel Type | Scenario | Residential | Commercial | Industrial | Transportation | Misc. | Total |
|---|---|---|---|---|---|---|---|
| Coal | Low | 100 | 50 | 1,100 | --- | --- | 1,250 |
| | BAU | 100 | 50 | 1,100 | --- | --- | 1,250 |
| | High | 100 | 50 | 1,100 | --- | --- | 1,250 |
| Fuelwood | Low | 4,774 | --- | 2,371 | --- | --- | 7,145 |
| | BAU | 5,739 | --- | 2,850 | --- | --- | 8,589 |
| | High | 6,533 | --- | 3,237 | --- | --- | 9,770 |
| Natural Gas | Low | --- | --- | --- | --- | --- | --- |
| | BAU | --- | --- | --- | --- | --- | --- |
| | High | --- | --- | --- | --- | --- | --- |
| Petroleum | Low | 14,157 | 22,844 | 71,137 | 113,654 | 2,100 | 250,892 |
| | BAU | 49,474 | 27,460 | 85,512 | 136,619 | 2,100 | 301,165 |
| | High | 56,319 | 33,529 | 97,129 | 166,597 | 2,100 | 355,674 |
| Residual | Low | --- | --- | 68,173 | 13,638 | 450 | 82,261 |
| | BAU | --- | --- | 81,949 | 16,394 | 450 | 98,793 |
| | High | --- | --- | 93,082 | 19,992 | 450 | 113,524 |
| Distillate | Low | 37,042 | 22,387 | 2,371 | 11,365 | 1,000 | 74,165 |
| | BAU | 44,527 | 26,911 | 2,850 | 13,662 | 1,000 | 88,950 |
| | High | 50,687 | 32,858 | 3,237 | 16,660 | 1,000 | 104,442 |
| Kerosene | Low | 2,469 | --- | --- | --- | --- | 2,469 |
| | BAU | 2,968 | --- | --- | --- | --- | 2,968 |
| | High | 3,379 | --- | --- | --- | --- | 3,379 |
| LPG | Low | 1,646 | 457 | 593 | --- | 50 | 2,746 |
| | BAU | 1,979 | 549 | 713 | --- | 50 | 3,291 |
| | High | 2,253 | 671 | 810 | --- | 50 | 3,784 |
| Jet Fuel | Low | --- | --- | --- | 10,230 | 600 | 10,830 |
| | BAU | --- | --- | --- | 12,296 | 600 | 12,896 |
| | High | --- | --- | --- | 14,994 | 600 | 15,594 |
| Gasoline | Low | --- | --- | --- | 78,421 | --- | 78,421 |
| | BAU | --- | --- | --- | 94,267 | --- | 94,267 |
| | High | --- | --- | --- | 114,951 | --- | 114,951 |
| Electricity * | Low | 36,283 | 22,794 | 43,954 | --- | 4,319 | 107,350 |
| | BAU | 43,634 | 27,410 | 53,058 | --- | 5,616 | 129,718 |
| | High | 49,685 | 33,479 | 60,416 | --- | 6,282 | 149,862 |
| Transmission Losses and Accounted For | Low | --- | --- | --- | --- | --- | 10,617 |
| | BAU | --- | --- | --- | --- | --- | 12,829 |
| | High | --- | --- | --- | --- | --- | 14,822 |
| | 1974 | --- | --- | --- | --- | --- | 7,532 |
| Totals-1985 | Low | 82,314 | 45,688 | 118,562 | 113,654 | 6,419 | 377,254 |
| | BAU | 98,947 | 54,920 | 142,520 | 136,619 | 7,716 | 453,551 |
| | High | 112,637 | 67,058 | 161,882 | 166,597 | 8,382 | 531,378 |
| Total, 1974 | | 78,242 | 33,502 | 105,757 | 87,021 | 5,726 | 317,780 |

## TABLE - 17

## PROJECTED FUEL CONSUMPTION INCREASES, 1974 to 1980 and 1985

| | | 1974 Billion BTU's | 1980 Billion BTU's | % Increase (Decrease) 1974-1980 | 1985, Billion BTU's | % Increase (Decrease) 1974-1985 |
|---|---|---|---|---|---|---|
| Coal | Low | --- | 1,250 | (4.9) | 1,250 | (4.9) |
| | BAU | 1,315 | 1,250 | (4.9) | 1,250 | (4.9) |
| | High | --- | 1,250 | (4.9) | 1,250 | (4.9) |
| Fuelwood | Low | --- | 6,927 | 2.3 | 7,145 | 5.5 |
| | BAU | 6,773 | 7,635 | 12.7 | 8,589 | 23.7 |
| | High | --- | 8,735 | 29.0 | 9,770 | 33.1 |
| Natural Gas | Low | --- | 1,500 | (13.0) | --- | (100.0) |
| | BAU | 1,724 | 1,500 | (13.0) | --- | (100.0) |
| | High | --- | 1,500 | (13.0) | --- | (100.0) |
| Petroleum | Low | --- | 235,151 | 7.8 | 250,892 | 15.0 |
| | BAU | 218,114 | 259,932 | 19.2 | 301,165 | 38.1 |
| | High | --- | 305,469 | 40.1 | 355,674 | 63.1 |
| Residual | Low | --- | 77,167 | 8.6 | 82,261 | 15.9 |
| | BAU | 70,980 | 85,301 | 20.2 | 98,793 | 39.2 |
| | High | --- | 99,030 | 39.5 | 113,524 | 59.9 |
| Distillate | Low | --- | 70,690 | 6.6 | 74,165 | 11.8 |
| | BAU | 66,317 | 77,920 | 17.5 | 88,950 | 34.1 |
| | High | --- | 90,840 | 37.0 | 104,442 | 57.5 |
| Kerosene | Low | --- | 4,839 | (23.5) | 2,469 | (61.0) |
| | BAU | 6,328 | 5,327 | (15.8) | 2,968 | (53.1) |
| | High | --- | 6,068 | (4.1) | 3,379 | (46.6) |
| LPG | Low | --- | 3,429 | (20.8) | 2,746 | (36.5) |
| | BAU | 4,327 | 3,774 | (12.8) | 3,291 | (23.9) |
| | High | --- | 4,331 | 0.1 | 3,784 | (12.5) |
| Jet Fuel | Low | --- | 9,649 | 86.2 | 10,830 | 109.0 |
| | BAU | 5,181 | 10,640 | 105.4 | 12,896 | 148.9 |
| | High | --- | 12,670 | 144.5 | 15,594 | 201.0 |
| Gasoline | Low | --- | 69,377 | 6.8 | 78,421 | 20.7 |
| | BAU | 64,981 | 76,970 | 18.5 | 94,267 | 45.1 |
| | High | --- | 92,530 | 42.4 | 114,951 | 76.9 |
| Electricity * | Low | --- | 94,867 | 15.2 | 107,350 | 30.4 |
| | BAU | 82,322 | 105,249 | 27.9 | 129,718 | 57.6 |
| | High | --- | 121,884 | 48.1 | 149,862 | 82.0 |
| Transmission Losses & Unaccounted For | Low | --- | 9,382 | 24.6 | 10,617 | 41.0 |
| | BAU | 7,532 | 10,409 | 38.2 | 12,829 | 70.3 |
| | High | --- | 12,054 | 60.0 | 14,822 | 96.8 |
| Total Electricity | Low | --- | 104,249 | 16.0 | 117,967 | 31.3 |
| | BAU | 89,854 | 115,658 | 28.7 | 142,547 | 58.6 |
| | High | --- | 133,938 | 49.1 | 164,684 | 83.3 |

* BTU's needed to generate, all others direct use only.

## TABLE - 18

## ESTIMATED FUEL DEMANDS, 1980 and 1985, IN UNITS OF MEASURE

| Fuel | Unit of Measure | BTU Conversion Factor | Demand Scenario | Estimated | Demand |
|---|---|---|---|---|---|
| | | | | 1980 | 1985 |
| oal | $10^3$ Tons | $23 \times 10^6$/Ton | Low | 54.3 | 54.3 |
| | | | BAU | 54.3 | 54.3 |
| | | | High | 54.3 | 54.3 |
| uelwood | $10^3$ Cords | $19 \times 10^6$/Cord | Low | 365 | 376 |
| | | | BAU | 402 | 452 |
| | | | High | 460 | 514 |
| Natural Gas | $10^3$ Therms | 100,000/Therm | Low | 15,000 | 0 |
| | | | BAU | 15,000 | 0 |
| | | | High | 15,000 | 0 |
| Petroleum | $10^3$ Barrels | As noted for Specific Type | Low | 41,238 | 44,014 |
| | | | BAU | 45,590 | 52,834 |
| | | | High | 53,627 | 62,507 |
| Residual | $10^3$ Barrels | $6.3 \times 10^6$/BBL | Low | 12,248 | 13,057 |
| | | | BAU | 13,540 | 15,681 |
| | | | High | 15,719 | 18,020 |
| Distillate | $10^3$ Barrels | $5.8 \times 10^6$/BBL | Low | 12,188 | 12,787 |
| | | | BAU | 13,434 | 15,336 |
| | | | High | 15,662 | 18,007 |
| Kerosene | $10^3$ Barrels | $5.7 \times 10^6$/BBL | Low | 849 | 433 |
| | | | BAU | 935 | 521 |
| | | | High | 1,065 | 593 |
| LPG | $10^3$ Barrels | $4.0 \times 10^6$/BBL | Low | 857 | 687 |
| | | | BAU | 944 | 823 |
| | | | High | 1,083 | 946 |
| Jet Fuel | $10^3$ Barrels | $5.5 \times 10^6$/BBL | Low | 1,754 | 1,969 |
| | | | BAU | 1,935 | 2,345 |
| | | | High | 2,304 | 2,835 |
| Gasoline | $10^3$ Barrels | $5.2 \times 10^6$/BBL | Low | 13,342 | 15,081 |
| | | | BAU | 14,802 | 18,128 |
| | | | High | 17,794 | 22,106 |
| ectricity * | $10^6$ KWH | 10,500 BTU/KWH | Low | 9,900 | 11,203 |
| | | | BAU | 10,984 | 13,537 |
| | | | High | 12,720 | 15,640 |

Includes transmission losses and unaccounted for. Does not include industrial thermal generation for own use.

## FUTURE PRICE OUTLOOK

The Federal Energy Administration, and others, have estimated some possible future prices for various energy forms. As stated several times throughout this report, it is virtually impossible to predict, with any degree of accuracy, what future prices will be. The only thing that can be said with reasonable certainty is that energy prices are most likely to rise as finite energy resources are used up, the cost of recovering the remaining lower quality resources increases, and the costs of the more complex technologies used for energy conversion increases. No one expects another drastic jump in energy prices as was experienced in the last three years. However, just how high prices will go and how fast they rise depends on a number of factors that inhibit their predictability. These factors include international politics, rate of resource discovery, and the existence of national and international energy policies, among others.

Several options are available to exercise some degree of control over price rises and buffering against the severity of the impact of the increases that do occur. Conservation, discussed in detail later in this chapter and in an appendix to this report, reduces the rate of resource consumption and the need for discovery and development of new energy resources, in addition to the obvious effect of reducing the consumer's total direct energy bill and leaving more money in his personal budget to purchase other goods and services. Conservation of energy could, in addition, reduce the capital investment required for the expansion of some energy facilities and free the limited available capital for investment elsewhere. Projections using FEA's "PIES" computer model indicate that the lowest energy prices occur in the conservation scenario.*

Another avenue available to minimize the impact of energy price increases is broadening of the energy resource base, thus diversifying the resources available and increasing the competition level between and among the various energy supplies. Competition tends to keep prices down, and competition between various energy forms, as well as among the suppliers of particular energy forms, could exert downward pressure on prices. In addition to potential price benefits, a diversified energy resource base would reduce the State's vulnerability to curtailment of the supply of any of the available energy forms.

A third avenue available to exert control over future energy prices is to increase the development and utilization of native renewable resources, which tend to be relatively less subject to inflation, as well as being relatively safe from curtailment and other influence by forces beyond our control. Development of small scale technologies for the heating and cooking needed for survival, such as wood-burning, solar heating, wind generators, and small scale hydro generation, would tend to insulate the Maine consumer against inflationary forces, labor disputes, vagaries of the weather, international politics, and other calamitous forces that are outside his immediate control.

Table 19 lists projected energy prices, and is included to show some possible price levels that may occur, given certain conditions and assumptions, including the continuation of historical trends and relationships into the foreseeable future. These prices were obtained from various sources, as cited. It should

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* "Interim Report to the New England Energy Policy Task Force", by Levy, et.al.

be noted that not all of the prices indicated are on the same basis, either in terms of base year for the dollars shown, units of measure, point of price measurement, or consuming sector. The SRI and GE prices are primarily for electrical generation use, while the FEA and CEP prices are primarily for consumer end use. The figures for distillate oil from the FEA "1976 National Energy Outlook" are apparently refinery gate prices and include no taxes, transportation, handling, or dealer mark-ups. In addition the FEA (3) prices and the GE prices are national in scope, while the others are for the New England region. None of the prices listed are specifically for Maine and none of them reflect inter-regional or intra-regional differences. However, in spite of these deficiencies, the tabulated prices do allow for some direct comparisons with current and historical energy prices, and do give some idea of how prices could trend in the future.

Of the number of documents and direct contacts consulted by the Office of Energy Resources to obtain estimates of future energy prices, one message came through above all others: any forecasts of future energy prices are merely guesses, and one guess is as good as another. There was even disagreement among members of the economic staff at some of the institutions contacted as to how much energy prices would rise in the future, or even if they would rise at all, in real terms (constant dollars). After all, prices can move downward as well as upward, given the right conditions, and even constant prices become declining in real terms when adjusted for inflation. (For example, #2 fuel oil held constant at, say, 40¢ per gallon from 1976 to 1977 would only really cost 38¢ per gallon in 1977, expressed in 1976 dollars, at an assumed 5% inflation rate.)

## Summary:

The task of forecasting future energy prices is extremely difficult and complex, and could be entirely misleading. It is probably safe to assume that energy prices will rise faster than inflation and incomes. Just how much faster they might rise is speculative. The conservative approach is to anticipate the worst and plan accordingly. Thus, measures for minimizing the impact of rising energy prices should be implemented.

## TABLE - 19

## FUTURE ENERGY PRICES

| | SRI (1) | | FEA (2) (1975 $'s) | FEA (3) (1975 $'s) | CEP (4) (1974 $'s) | | GE (5) (1974 $'s) |
|---|---|---|---|---|---|---|---|
| | 1980 | 1985 | 1985 | 1985 | 1980 | 1985 | 1975-2000 |
| Gasoline, Regular Grade, ¢/Gal. | ---- | ---- | 59.8-67.3 | 23.4-40.4 | ---- | ---- | 26.4-30.5 |
| No. 2 Fuel, ¢/Gal. | ---- | ---- | 39.9-46.9 | ---- | ---- | ---- | ---- |
| No. 6 Fuel, $/bbl. | ---- | ---- | 15.75-18.46 | ---- | ---- | ---- | ---- |
| Fuel Oil to Utilities ¢/$10^6$ BTU | 149-248 | 154-249 | ---- | ---- | ---- | ---- | 165-200 |
| Coal to Utilities ¢/$10^6$ BTU | 147-184 | 155-186 | ---- | 114.7-121.8 | 117.0 | 117.9 | 35-100 |
| Nuclear* | $40-50 Per lb. | $40-50 Per lb. | ---- | ---- | ¢/kwh 2.33 | ¢/kwh 2.33 | 40¢/million BTU |
| Electricity ¢/kwh | ---- | ---- | 2.97-3.79 | 2.82-3.02 | 4.23 | 4.37 | ---- |
| Natural Gas $/1000 Ft.$^3$ | ---- | ---- | 3.57-3.58 | 1.79-2.07 | 2.93 | 3.10 | 0.461-0.819 |
| Crude Oil, $/bbl. | ---- | ---- | ---- | $8-16 | 16.41 | 18.52 | ---- |

Sources:

(1) SRI - Stanford Research Institute, "Cost of Fuels, Labor, and Interest for Alternative Methods of Electricity Generation", by H. Attinger, G.T. Coene, C. Erickson, and B. Loukes, June 1976.

(2) FEA - "Interim Report to the New England Energy Policy Task Force, Preliminary Assesment and Results of the Application of the PIES Computer Model to Forecast Energy Flows for New England", by Paul F. Levy, Marc Hoffman, Linda Mansfield, Harvey Michaels, Fred Nemergut, and Stephen Stern, June 1976.

(3) FEA - "1976 National Energy Outlook", Federal Energy Administration

(4) CEP - "New England Energy Use Patterns in 1980 and 1985: Pilot Projections and Sensivity Analysis", by the Center for Energy Policy, Inc., Boston, Massachusetts, January 1976.

(5) GE - "Impact of Uncertainty on Long Range Generation Planning", by Dr. L.L. Garver, H.G. Stoll, and R.S. Szczepanski, Electric Utility Systems Engineering Dept., General Electric Company, April 1976.

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*ERDA data indicates that Uranium under contract in 1976 for delivery in 1980 is averaging about $15.95 per pound, and for delivery in 1985 about $19.90 per pound. This compares with $12.05 per pound in 1976 and $10.50 for 1975. (See "Information from ERDA, "Vol. 2, #44, W/E 11/12/76) "Nuclear Fuel" (Vol. 1, #1 11/1/76) reported that utilities had paid up to $59 per pound in 1976 for uranium to be delivered in 1980. Other prices paid were $46 for 1977 delivery, $53 for 1985, and $54 for 1978. It is difficult to project trends from this kind of data.

# CHAPTER III - PART 4

## ENERGY CONSERVATION AS A REDUCTION OF FUTURE DEMANDS

### INTRODUCTION:

In the development of energy scenarios for Maine, one of the most important factors which must be considered is conservation. Conservation, as used in this section, denotes an improvement in the end use efficiency of energy. This is to say that conservation means the reduction or elimination of waste.

In calculating the amount of energy that could be saved through conservation, only the reduction brought about by improving the efficiency of energy use is computed. The curtailment of use, which may result from economic restrictions or reduced supply, is not considered conservation here.

There are various programs now underway at both the State and Federal levels to promote or require conservation. Each of these programs has established a goal regarding the amount of energy which can be saved by implementing certain conservation measures.

Federal programs include automobile efficiency requirements, efficiency labeling for energy consuming products, industrial conservation programs, winterization for low-income homeowners, and the Federal Energy Management Program. State energy conservation programs include internal conservation programs and planning programs aimed at various sectors including transportation, residential and commercial. Along with these programs, there are many voluntary conservation projects going on which are sponsored by local groups and individuals.

It must be noted that conservation can best be achieved if individuals consciously make the decision to conserve. Thus, one of the most important aspects of any conservation program must be education. An energy office or organization must be able to answer the question, "Why should I conserve?"

Along with the education effort, the Office of Energy Resources must look at the ways in which conservation policies and plans can be implemented. Basically, there are three ways to implement any program:

(1) Through personal desire to "do the right thing".

(2) Through economic incentive.

(3) Through the enforcement of punitive regulations or laws.

Obviously, the first and second alternatives are best in terms of personal freedom. Unfortunately, the first method is normally ineffective in achieving the desired long term goal. The second method, while perhaps more effective than the first, costs money which must come from the pockets of the taxpayers.

The third alternative for implementing a program is by far the least desirable and most difficult. Many people rightfully balk at the thought of any new law or regulation which removes some degree of freedom from their lives. If, however, the first two implementation methods discussed are ineffective, some regulation may be necessary. If this should be required, it is most reasonable that the regulations be written and enforced by the unit of government closest to the people. This will ensure that any regulation is most sensible for the people affected by those regulations.

In preparing a conservation plan for the State, the Office of Energy Resources will develop strategies for conservation which can be implemented with the least economic/social disruption. To help ensure this, all segments of the plan will be presented for public review and comment before any portion of the plan is finalized. This will give the citizens of the State an opportunity to assess the impacts of the plan.

## Energy Conservation Potential For Maine

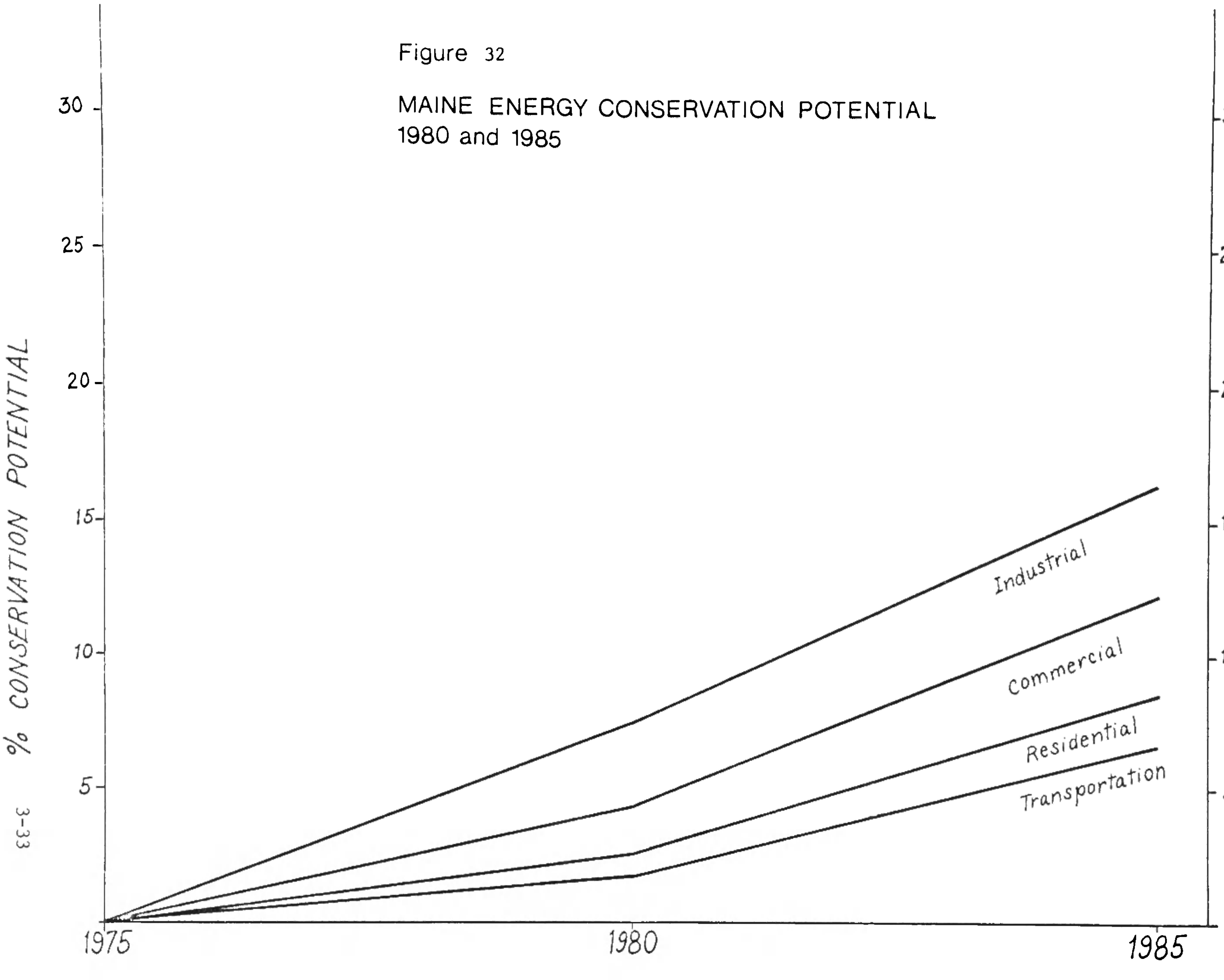
The estimation of the possible reduction of energy which can be achieved through conservation is shown in the following pages. Just as the future consumption of energy in the State is projected as a range of values, so is the conservation projected. The width of the range of conservation possibilities is governed by factors including technology, economics, and social acceptance.

The impact of conservation on the overall energy scenario for the State can best be shown graphically. Conservation can be assumed to be an additive process. A reduction in energy consumption achieved through the installation of insulation in a house, for example, will occur every year for the life of the house. Thus, the insulation of a number of homes in each year for a five-year period will produce a cumulative effect. This brings up an important point about conservation. A barrel of oil from an off-shore oil well can be burned only once: its energy content is finite. If insulation is installed in a home and that installation results in a savings of one barrel of oil per heating season, the cumulative effect of installing that insulation may equal thirty barrels of oil or more. Clearly, a dollar spent on conservation of a barrel of oil may return many more dollars than one spent on recovering a barrel of new oil.

Thus, as the effects of implementation of conservation technologies are totaled, each year should see an increasing reduction in the growth rate of total energy consumption. Presented in a graphical form, as in figure 32 , the conservation scenario appears to be a wedge. Each segment of the wedge represents the conservation expected from one element of the energy-using society. The uppermost line of the wedge represents the greatest possible conservation expected for the years projected. The lower line represents zero conservation. It is predicted that the actual amount of energy reduction which will be achieved in the ten years projected will fall somewhere between these two bounds. Derivation of this graph is presented in the next section.

Figure 32

MAINE ENERGY CONSERVATION POTENTIAL
1980 and 1985



## Conservation in End Use Sectors

To arrive at the graphical representation shown in Figure 32 the amount of energy reduction expected from conservation in each sector had to be calculated. The calculations were based on the programs currently being undertaken by Federal and State authorities as outlined in the previous section. The estimates computed in each end use sector represent the greatest reduction probable for that sector given the implementation of these programs. If new legislation should be enacted or if other factors should arise, the figures shown in this report may be lower than those actually achieved. Similarly, economic factors or social pressures may reduce the effectiveness of the current legislation and, thus, reduce conservation.

The following pages detail the energy savings expected in each sector. The calculations and assumptions which form the basis of the predictions are delineated. The final results for each sector are shown in terms of the savings achieved in that sector and in terms of total energy savings. All figures are in percentages to avoid the confusion of conversion factors. It is assumed that the breakdown of the energy used in each sector will follow the "base case" projection as outlined elsewhere in this report. Thus, if the transportation sector used 28% of the energy consumed in 1974, that fraction may not remain constant in the future but instead will follow a trend line (in this case rising to 30% in 1985).

After calculating the expected conservation levels for each end use sector, the overall projected energy savings for the State were calculated. The figures are shown for the years 1980 and 1985 as five and ten year projections. The potential savings presented and the graphical representation can then be applied to the overall energy use projections for the State and probable conservation scenarios developed. The following is a summary of the conservation expected from each end use sector. The methodology which was used to calculate the percentages shown here is included in the Appendix to this chapter.

## Transportation

Conservation projections for the Transportation sector are based on increased fuel economies mandated by Federal law and an increasing proportion of smaller automobiles. Table 20 below shows projected energy reductions in the Transportation sector relative to projected Base Case energy use.

TABLE - 20

Projected Energy Reductions in The Transportation Sector in Maine

| Year | % of Total Energy Use | %Conservation in Sector | % Savings In Maine's Total Energy |
|---|---|---|---|
| 1974 | 20.55% | -------- | -------- |
| 1980 | 21.68% | 8.25% | 1.79% |
| 1985 | 22.58% | 31.74% | 7.17% |

## Housing

Conservation in the residential sector is based on two criteria. First, it is assumed that all new housing will be built to a minimum standard of energy efficiency. Second, it is also assumed that some existing housing will be winterized to improve the efficiency. Based on these criteria the conservation expected in the residential sector is shown in the following table.

TABLE - 21
Possible Energy Use Reduction in the Residential Sector

1975-1985

| Conservation Technique | 1975-1980 | | | 1975-1985 | | |
|---|---|---|---|---|---|---|
| | % of Sector | % of Total | Billion BTU | % of Sector | % of Total | Billion BTU |
| Implement ASHRÆ for new construction | 1.88% | 0.43% | 1660 | 3.59% | 0.78% | 3494 |
| Retro-fit Program (2% of Homes per year) | 1.66% | 0.38% | 1467 | 3.32% | 0.72% | 3268 |
| Total Reduction | 3.54% | 0.81% | 3127 | 6.91% | 1.51% | 6762 |

## Commerce

The amount of conservation which can be expected from the commercial sector will come mainly from reductions in lighting and heating. Some conservation can also come through operation changes which will reduce energy consumption. The following table shows the conservation potential for the commercial sector.

TABLE - 22
Estimated Energy Use Reductions in the Commercial Sector

1975-1985

| Conservation Technique | 1980 | | | 1985 | | |
|---|---|---|---|---|---|---|
| | % of Sector | % of Total | Billion BTU | % of Sector | % of Total | Billion BTU |
| Implement Lighting Standards | 8.51% | 0.97% | 3744 | 17.02% | 2.06% | 9349 |
| Implement Operation Changes | 5.75% | 0.66% | 2548 | 11.50% | 1.39% | 6308 |
| Total | 14.26% | 1.63% | 6292 | 28.52% | 3.45% | 15657 |

## Industry

Since the embargo of 1973-1974, industries in the State of Maine have significantly cut back on their energy use. By improving efficiences in their operations and installing new equipment, this trend is expected to continue. The table below shows the expected conservation impact in the industrial sector.

TABLE - 23

Estimated Energy Use Reductions in the Industrial Sector

| | 1980 | | 1985 | |
|---|---|---|---|---|
| | % of Sector | % of Total | % of Sector | % of Total |
| Industrial Conservation Program | 10.0% | 3.22% | 15.0% | 4.17% |

## Miscellaneous

There are many additional conservation activities and programs which might be implemented in each of the four end-use sectors discussed above. However, the amount of energy conserved through these activities is not readily quantifiable. It is foreseen that continued emphasis on conservation and new programs and activities will show further reductions in energy consumption in Maine.

TABLE - 24

Overall Energy Reductions by Sector - 1975-1985

| End Use Sector | 1975-1980 % of Total | 1975-1985 % of Total |
|---|---|---|
| Transportation | 1.79% | 7.17% |
| Residential | 0.81% | 1.51% |
| Commercial | 1.63% | 3.45% |
| Industrial | 3.22% | 4.17% |
| Total | 7.45% | 16.30% |

As previously noted, these figures are subject to a number of factors which could alter the actual conservation considerably. However, based on historical consumption data, and data on housing, transportation and the other sectors, the figures shown are believed to be reasonable.

It should be noted that if energy consumption without conservation in 1985 were projected to be the same as for 1974 (that is, no growth in energy consumption), then the savings, which would result from the projected conservation levels in terms of barrels of oil equivalent, would be on the order of

44 million barrels. (Total State consumption in 1974 was 55 million barrels of equivalent energy.) It must be clearly understood that not all of the energy used in Maine is petroleum derived. However, the numbers illustrate the tremendous potential that conservation can have for the State.

Figure 33 shows an expanded view of the projected energy demand scenarios as they would be reduced by conservation. The shaded area indicates the probable range of demands within which the actual demand would fall.

TABLE - 25

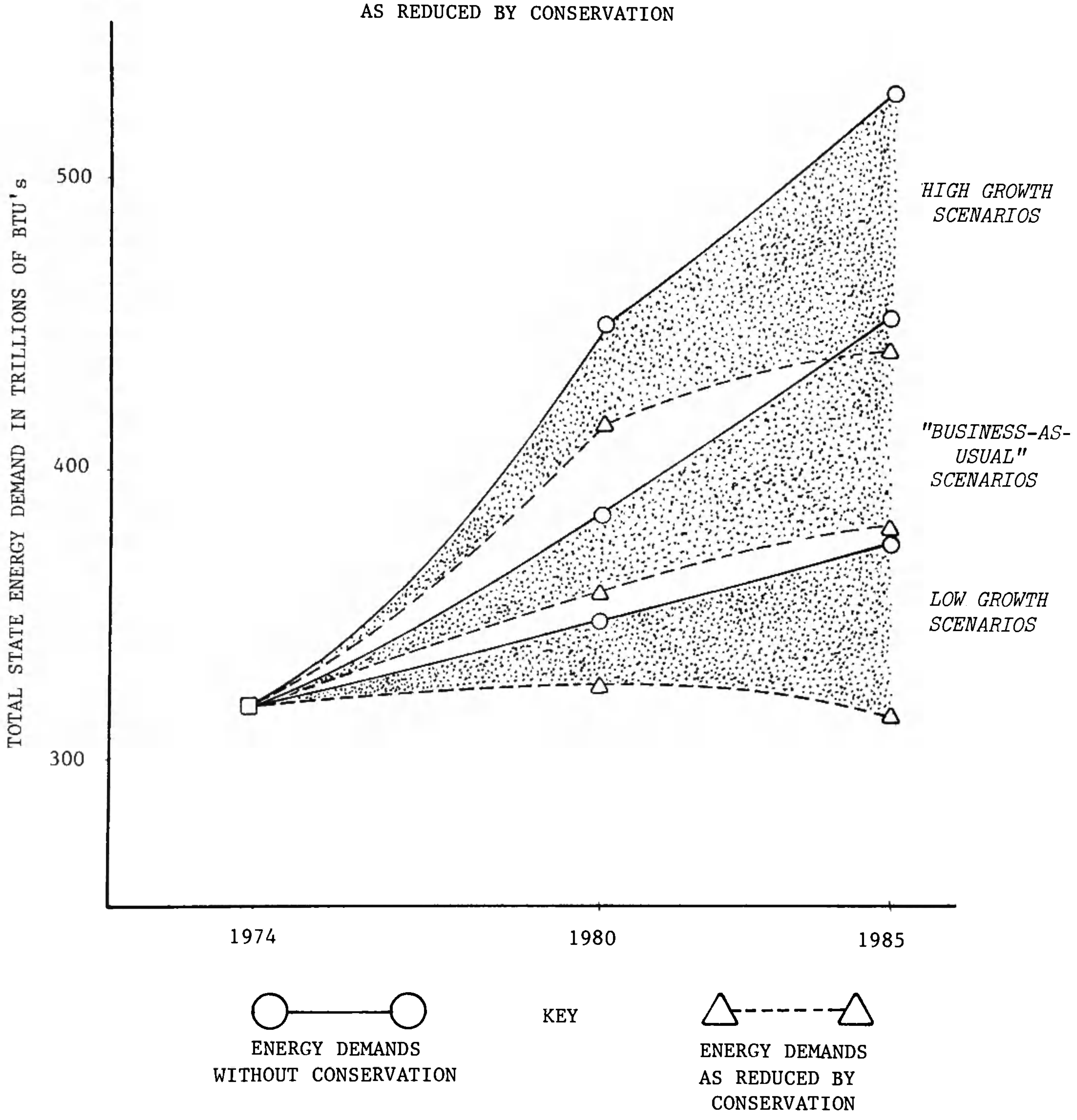
ENERGY DEMANDS AS REDUCED BY CONSERVATION
(Billion BTU)

| | 1980 | | 1985 | |
|---|---|---|---|---|
| | Without Conservation | With Conservation | Without Conservation | With Conservation |
| BAU | 385,975 | 357,722 | 453,551 | 379,622 |
| High | 450,892 | 417,300 | 531,378 | 444,763 |
| Low | 349,077 | 323,071 | 377,254 | 315,762 |

FIGURE 33

PROJECTED ENERGY DEMAND SCENARIOS

AS REDUCED BY CONSERVATION



# CHAPTER III

## SUMMARY

In this chapter, three scenarios were developed for possible energy growth in the State of Maine. These growth scenarios were developed in part from historical trends, tempered by assumptions of possible future deviations from these trends. Total energy demands for Maine were derived by summing projected demands in the residential, commercial, industrial, transportation, and miscellaneous sectors within Maine, plus electrical transmission losses. (Possible imports or exports of electricity from Maine were not included in the demand growth scenarios.)

Several conclusions are possible from the three scenarios developed:

(1) Total energy consumption in Maine is projected to grow at a rate between 1.58% and 6% per year between 1974 and 1980, and between 1.58% and 3.3% per year between 1980 and 1985. These growth rates are primarily dependent upon the rates of economic and population growth in the state, and the extent to which conservation measures can be implemented.

(2) Some shifting of relative energy demands is expected as the state's economy continues to shift slowly toward a more rural/suburban service-oriented economy, although at a slower rate than is occurring nationally and regionally. These trends will bring about relative declines in the residential and industrial sectors, and relative increases in the commercial and transportation sectors.

(3) Although total energy growth slowed, and even declined, in the years immediately following the Arab Oil Embargo (1973-1975), electrical peak loads continued to increase, and there is recent evidence of a resurgence of energy growth in 1976 that could put Maine on the path of the Full Recovery growth scenario.

From historical patterns, recent trends, and assumptions regarding future prices, availability, and consumer preferences, projections for fuel demands were developed for each demand sector and growth scenario. No major shifts in fuel consumption patterns and demands for specific fuels are foreseen (other than the possible discontinued use of natural gas by 1985) unless specific actions are taken to encourage such shifts, or unforeseen developments force them to occur.* Continuation of the status quo will most likely result in one of the projected energy consumption patterns, with petroleum continuing to supply more than two-thirds of the state's total energy demand, and strong growth in electrical consumption. Hydropower may decline in relative importance, wood will continue to contribute only about 2% of total consumption, and solar and wind will make insignificant contributions.

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* For example, accellerated price rises in petroleum will probably increase the use of wood.

Extensive development was done of possible electrical supply growth because of its position as the fastest growing supply sector, and the implications and controversy surrounding projected electrical growth and delivery systems. Several alternative electrical capacity growth projections were developed based upon the overall energy growth scenarios, variations in possible generating reserve requirements, and variations of possible system load factors. The conclusion from these developments is that generating capacity additions may possibly be postponed by a combination of slowed total energy growth, lower reserve margins, and improved system load factors.

The projected energy requirements thus developed were then aggregated into total demands for each fuel type, and the growth requirements for each fuel delivery system were computed. These fuel demands were then converted into units of measure to indicate the physical quantities of each energy resource required in 1980 and 1985 for each growth scenario.

Some projections of future energy prices are included in this chapter as indicators of future possibilities, and for their potential impacts on the economy and the consumers of Maine. While these prices consitute little more than guesses at future trends, they at least form a basis for comparisons.

Finally, extensive development is made of energy conservation as a reduction of future demands, conservation being defined as the reduction or elimination of waste. Conservation is seen as one of the most important factors to be considered in any plans for Maine's energy future, and can even be classified as a substitute for supply.

The conservation potential for Maine is estimated as a range of possibilities for each demand sector. The largest short range potential for conservation is seen in the industrial sector, where conservation efforts could reduce the State's total energy demand by up to 3.22% by 1980. This is followed by a possible 1.79% reduction in the transportation sector and 1.63% in the commercial sector. In the long run, the greatest potential for conservation is seen to be in the transportation sector, where demand reduction equivalent to 7.17% of the State's total energy consumption is possible by 1985. This is followed by a possible 4.17% reduction in the industrial sector, 3.45% in the commercial sector, and 1.5% in the residential sector.

At this point, these conservation potentials have not been translated into possible demand reductions for specific fuels within each sector. Neither have the potentials for fuel substitution and development of "personal" wind and solar energy systems been fully explored, with their impacts on demand reductions for the traditional fuels.

# CHAPTER IV

## RESOURCES AVAILABLE TO MEET FUTURE ENERGY DEMANDS

### INTRODUCTION

In the first three chapters of this report, we have summarized Maine's past energy demand, supply, and price trends and have projected what Maine's future energy demands might be. It is now useful to turn our attention to the energy resources available to meet those demands.

The energy sources on which we currently depend, both within Maine and nationally, are primarily non-renewable. Oil, coal, and natural gas are all undergoing depletion.

In the previous chapter, we saw that the overall growth in Maine's energy consumption has been accelerating at a rate of approximately 3.3% per year. It is interesting to calculate how long, at that rate of consumption, a depletable, non-renewable resource will remain available for our use and for the use of our children.

Assume for the moment that we had available to us an energy resource which, at current annual consumption levels, would provide for our needs for 1000 years into the future. If we were to accelerate our rate of use of that resource by 3.3% per year, (as is now the case) how long would that 1000-year energy supply last? The answer is 108 years. At the same increase in growth rate, a resource that would have lasted for 2000 years would last only 129 years. And, a resource "good for 10,000 years" would be gone in 178 years!

The following table gives some more examples of depletion. There are also some estimates in the Appendix to this chapter of the number of remaining years of the world's oil supply.

Table 26
Accelerated Resource Depletion at Various Growth Rates

| # years supply at current consumption levels | Consumption growth rate | Corresponding Scenario in Chapter 3 | # years supply at accelerating consumption levels* |
|---|---|---|---|
| 1000 | 1.58 | LOW | 179 |
| | 3.3 | "BAU" | 108 |
| | 6.0 | HIGH | 70 |
| 100 | 1.58 | LOW | 60 |
| | 3.3 | "BAU" | 45 |
| | 6.0 | HIGH | 31 |

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*The formula is $n=\frac{Ln\ (Nr + 1)}{Ln\ \ (1+r)}$ where n= number of years at accelerated rate
r= rate of growth, % per year (e.g.0.033)
N= number of years at current consumption

Of course this dramatic illustration of the laws of compound growth rate is simplistic when applied to a real life situation. As a resource becomes more scarce, (at least in a free market economy) the price rises, leading to a lessening in demand and a search for alternatives.

Depleteable energy resources eventually must be replaced by "ultimate" energies (solar, fusion, etc.) if our technological society is to survive in the long run. But it is probable that these "ultimate" energy sources will remain out of reach for some time. It is possible that they will not be available in large enough quantity in time to replace the foreseeable shortfall in petroleum.*

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* A rather lengthy but illuminating discussion of future energy resource availability is found in the Dec. 9, 1976 issue of <u>Energy Users Report.</u> A section from that report is quoted below:

"Assistant Interior Secretary William L. Fisher said, in remarks prepared for delivery to the Interstate Oil Compact Commission December 7 session, 'It is wearying for those of us who are professionals in the field of gathering energy fuels from the earth, to listen to the endless arguments over which energy source we should choose, which energy alternative is the right one for this nation. It is wearying to listen to and it is absolutely pointless, because the simple truth is that we are going to need all the energy alternatives we can possibly learn about, harness, and put on stream in our lifetime.

Fisher said, 'In my crystal ball, by the year 2025, petroleum (oil and natural gas) will have slipped down to about 50 percent, coal will have moved up to nearly 40 percent and atomic energy will not have increased its percentage at all. Hydroelectric energy will remain a constant, but represent a much smaller slice of a much bigger pie. Solar energy, geothermal energy and tidal energy may add up to a total of 2 percent.'

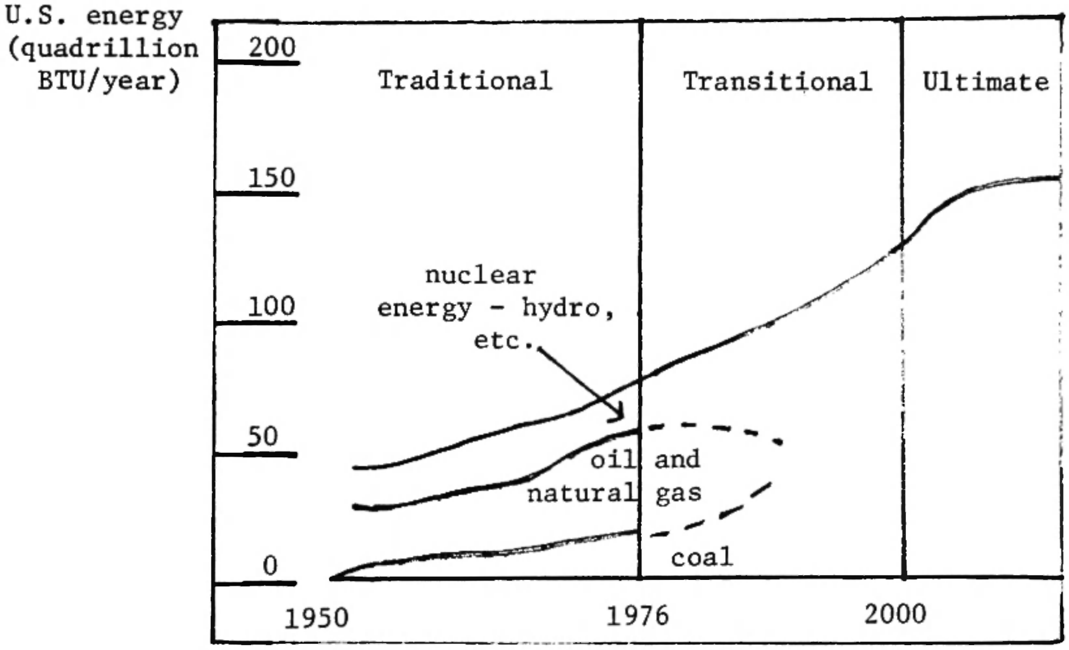
The IOCC was told that development of a new technology did not automatically result in efficient generation power from that technology. Fisher said that Robert L. Hirsch, Assistant Administrator of the Energy Research and Development Administration put the point into perspective at the President's Vail, Colo., energy symposium August 19 when he said, 'A <u>very</u> near-term technology which is <u>very</u> successful might be producing 2 percent of the country's energy needs by the year 2000.' Hirsch described a new technology as one that would come through a demonstration phase by 1985 and that 10 first-generation plants would be built by 1990 or 1995. 'If we ascribe an output of 1,000 megawatts to each plant, which would be optimistic, we would then have a contribution of 10,000 megawatts, which would amount to less than 1 percent of the energy consumption predicted for our country by that time,' Fisher said. He added that if 20 to 50 second generation plants were built, the U.S. would have reached the year 2005, invested $60 billion and be producing 2 percent of U.S. energy needs. The Interior official stressed that the displacement of the 60 to 70 percent of U.S. energy needs now supplied by oil and natural gas would require a capital investment of at least 30 times $60 billion and 'the computation just went off the right hand side of my calculator.'

Fisher said the gloomy picture of energy research and development 'is painted, not by the success or failure of new technologies, but by the immutable arithmetic of totality of energy fuel amounts, and by the hard facts of resistance to newer energy forms.' He then discussed the 'more exotic forms of energy generation' which he said have been talked about as if they were alternatives to coal and gas and oil and uranium."

Something, therefore, will have to intervene during the transition phase between the depletion of petroleum and the development of the ultimate energy sources. Conservation will be an important element of our transition strategy, and is discussed in detail in the preceding chapter. Without conservation we will probably not be able to avoid severe social and economic disruption. But even with conservation, some additional energy sources will have to be developed during the transition.

The graph below (figure 34) roughly describes the projected trends from current "traditional" energy sources, through the transitional phase, to the ultimate energy resources of the future. The declining use of oil and gas, and the increasing reliance on coal, nuclear and hydro are indicated.

Figure 34
Generalized pattern of future U.S. energy supplies



The development pattern of transitional energy sources will depend upon the reactions of millions of people and how these affect and are affected by prices, economic growth, substitution elasticity among fuels, the GNP, the conservation ethic, investments, tariffs and quotas, OPEC policy, housing and transportation choices, labor availability (miners in particular), wages, health and safety acts, Nuclear Regulatory Commission rulings, Outer Continental Shelf drilling constraints, anti-trust action, tax incentives and disincentives, product and process innovation, Interstate Commerce Commission rulings, etc., etc.

Two things are certain: the price of traditional and transitional energy will rise sharply; and no instrumentality or group of instrumentalities will or can "master mind" the transition.

Maine competes in global, national and regional markets. In this context prices and supplies are determined to a great extent by forces that are beyond our control. About the best we can do is to maintain close liaison and interaction with the controlling bodies (mostly Federal and private sector) in order to work for the institution of policies that will assure continued availability of adequate energy supplies at "reasonable" prices (*whatever* they may be) to meet the state's needs. Faced with this reality, Maine should develop policies for action in its own self-interest as we pass through this stage of development of transitional energy resources. In this chapter, we discuss the transitional energy sources available to Maine.

If we go back to the first chapter of this report, we will find a simplified equation of the State's energy balance:

$$\begin{array}{c}\text{Native Energy}\\\text{Production}\end{array} + \begin{array}{c}\text{Imported}\\\text{Energy}\end{array} = \begin{array}{c}\text{Energy}\\\text{Consumption}\\\text{in Maine}\end{array} + \begin{array}{c}\text{Exported}\\\text{Energy}\end{array}$$

In the previous chapter, we were concerned with the right-hand side of this equation. In this chapter we are concerned with the left-hand side of this equation. We will define those energy resources which we import into the State's geopolitical boundary as "exogenous" resources; and those produced within the State as "indigenous" resources. Following is a description of those resources.

# CHAPTER IV - PART I

## EXOGENOUS RESOURCES

### PETROLEUM

Petroleum has, for more than the last two decades, been the primary energy resource for Maine, in all demand sectors, and in both direct consumption and through intermediate conversion to electricity. A generally increasing percentage of Maine's total petroleum requirements, peaking at 38.8% in 1965, has been imported from foreign sources, and most of the imported oil (76% in 1974) has been residual. Much of the imported residual oil (4 million barrels in 1974) is used in steam-electric stations for the generation of electricity. Dependence on imported petroleum (up to 50% of total State petroleum requirements) is projected to continue through 1985, unless interrupted by another OPEC embargo or Federally mandated strong conservation programs and conversion to coal.

The range of possibilities for petroleum supply scenarios is virtually infinite, and much more speculative and uncertain than for most other fuels. The development of alternative scenarios for petroleum supplies will be undertaken with the aid of computer models in conjunction with the further development of conservation and fuel conversion alternatives; as well as further assessment of the potentials for nuclear and hydro electric generation. Assessments of the potential for refinery and offshore oil development and the implications for Maine are the subjects of exhaustive policy studies and will be discussed fully in separate papers.

At present, the best that can be said of petroleum is that it will continue to be available throughout this decade at higher and higher prices, to meet those demands which cannot be satisfied more economically by other fuels.

### COAL

Coal was formerly (until well into the 1960's) a major, though declining, constituent of Maine's total energy consumption. Coal was withdrawn almost totally from the Maine energy market due to the availability of cheaper, cleaner and more convenient fuel oil. The implementation of strict environmental standards hastened the demise of coal in Maine. Rising coal prices, increased transportation costs, and supply curtailments by mine workers and railroad strikes assisted in this demise.

However, coal remains this country's most abundant energy resource. Coal is the nationally recognized transitional energy source. Environmental and technological problems associated with coal mining, transportation, and consumption are being addressed. Resolution of many of the problems appears imminent.

These problems include a shortage of miners and capital equipment needed to accelerate output, environmental constraints on production such as acid mine drainage and required reclamation of strip mined land; and environmental constraints on use, such as $SO_2$ and $CO_2$ limits in the atmosphere. The problems currently confronting revitalization of the coal industry - in the U.S., New England, and Maine - are not insurmountable. But, they must be resolved to avoid future adverse impacts on land use, the environment, and the global atmosphere.

Two major electric generating stations in New England are currently burning coal exclusively. Of these two, the Merrimac Station in New Hampshire receives its coal by unit train and is the most economical fossil fueled station in New England. The favorable economics are due in part to a long term coal delivery contract and probably could not be duplicated by a new plant entering into a new contract for coal delivery. However, analysis of the operation, environmental impact, and economics of this plant could serve as a model for extrapolation of expanded coal use in Maine.

There appears to be no shortage of rail capacity to move coal in Maine, but significant overhaul of existing railroads may be required.* A major shift to coal could help finance needed rail reconstruction, and water transport is available to coastal power plants. But our "end of the line" position, particularly for low sulfur western coal, would put us at a relative price disadvantage.

In this report, coal is projected to maintain a constant absolute contribution to Maine's total energy consumption of 1.25 trillion BTU through 1985. It is not anticipated to be higher due to the transportation problems associated with obtaining coal in Maine and the high costs of delivered coal that result from these transportation problems. Any expansion of coal consumption in Maine, primarily for industrial and electric generation end uses, will depend on a solution of the transportation problems and the economic penalties derived therefrom, as well as the environmental problems that accompany large-scal coal consumption.

Several new reports have been recently received by the Office of Energy Resources that deal with anticipated coal production and consumption, both regionally and nationally. These are being studied. In addition, Central Maine Power Company has announced that it is evaluating the potential for construction of a coal-fired generating station in Maine, possibly at Sears Island should the geological features currently delaying progress on the proposed nuclear station not be satisfactorily resolved.

Should a coal-fired unit be built in Maine, either at Sears Island or elsewhere, it could be in the 600-800 MW range, could probably be brought into service by 1982-1984, and, at a 70% plant factor and assumed 9,500 BTU/KWH heat rate, consume about 1.5 to 2.0 million tons of coal per year.

The development of a large coal fired generating station in Maine could also act as a catalyst in the development of other industrial coal-burning facilities.**

The primary source of coal for Maine would probably be Appalachia, although coal deposits of as yet uncertain magnitude and quality have recently been found in Massachusetts and Rhode Island.

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*In addition, a portion of the coal's volume will remain as ash and have to be disposed of or sold. Some additional volume of waste for disposal will be generated if scrubbers are used for $SO_2$ removal.

**It may be difficult for other industries in the 30-80 MW range to incur the costs of environmental controls at this scale plant.

## NATURAL GAS

Natural gas has never made a significant contribution to Maine's total energy consumption, having only been introduced into the State in the 1960's with the completion of a gas transmission pipeline to Portland and Lewiston-Auburn. Prior to the introduction of natural gas, energy needs for gas users was supplied by manufactured gas, which was produced from coal and heavy residual fuel oil. Manufactured gas was phased out after the introduction of natural gas. In 1974, gas consumption was relatively evenly divided between the residential, commercial and industrial sectors and accounted for only 0.5% of Maine's total energy use.

The projected decline and eventual disappearance of natural gas as an energy source for Maine is based on dwindling national reserves and the economic disadvantage that gas has in the Maine energy market.

The reasons for the historically low input of natural gas into Maine are geographic and economic. Maine's location at the end of the gas pipeline from the South-Central gasfields puts us at a disadvantage, as a low priority delivery. The cost of transmitting the gas to Maine prices the fuel at an uncompetitively high level.

Development of Gulf Coast methane from geopressurized fault zones, discovery of Outer Continental Shelf gas, importation of LNG through a terminal at Everett, Massachusetts, and/or implementation of a Federal Gas Allocation Policy that would assure Maine a share of the national gas supplies at competitive prices, would all have an impact on these projections. However, none of these is expected to occur within the time frame of these projections, that is, prior to 1985.

The Tenneco Company is in the negotiations stage of a pipeline to traverse Maine (see map in appendix to this chapter). At the time of this writing it appears doubtful, however, that Maine will receive any of this gas due to FPC regulations preventing the addition of new gas customers. However, the pipeline would put Maine in the position of being in the middle of the supply line, and in a more favorable economic position to acquire natural gas for consumption.

## NUCLEAR POWER

Another exogenous resource available for meeting Maine's demands is nuclear power (including possibly the breeder and fusion reactors in the long term future). As with offshore oil refinery development, the subject of nuclear power is undergoing exhaustive policy studies within Maine and nationally. Large nuclear electric generating stations share constraints of a similar magnitude to those confronted by coal-fired plants. Resolution of the issues surrounding nuclear power is a top national priority. the outcome of which will have an overwhelming impact on the availability for Maine of this energy source.

## CANADIAN HYDROELECTRIC POWER

Considerable undeveloped hydroelectric power potential exists in Canada, and Maine utilities have close ties with Canadian utilities.* There is also considerable tidal power potential in the upper reaches of the Bay of Fundy which is undergoing serious study by Canadian federal and provincial authorities. Under some system designs, excess power would be available for export to and through Maine.

Efforts are now underway to explore possible cooperative relationships, which would permit the early development of Canadian tidal and river hydroelectric power and its sale to the U.S. However, these international agreements take some time to be drafted in a form acceptable to both countries, and, thus, this source of energy is not expected to be a major contributor to Maine's energy supply during the decade under consideration. (For example, it has recently been reported* that there will be a possible five-year delay in the huge James Bay hydroelectric project in Quebec due to a realignment of that province's energy priorities.) In addition, a recent contract negotiated between Hydro Quebec and PASNY for 20 years was modified by the Canadian National Energy Board to be a five year contract. Also, the price charged for Canadian power under new contracts has been very near the level that would have resulted if the new plants had been built by private utilities here in New England.**

A summary of the exogenous energy resources available to Maine is found in Table 27.

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*Energy User News, Monday, November 25, 1976

**W. D. Shipman, in a report prepared for the meeting of the New England Governors and Eastern Canadian Premiers, May 1976.

TABLE-27

EXOGENOUS RESOURCES (IMPORTED FROM OUTSIDE MAINE)

| RESOURCE | QUANTITY AVAILABLE | | | PRICE | FORECAST OF TECHNOLOGY AVAILABILITY | ADVANTAGES | DISADVANTAGES |
|---|---|---|---|---|---|---|---|
| | CAPACITY | ENERGY | YEARS SUPPLY | | | | |
| Petroleum | 50-75 Million Barrels in 1985; Future Availability Limited By Capital Available For Development, Environmental Constraints, Public Pressure, and Reserve Depletion Rates. | | 20-40 | $10-$30 Per Barrel of Crude | Now | 1. Existing power plants and other facilities in Maine designed to use oil.<br>2. Fairly clean burning<br>3. Easy to store, handle, and use. | 1. Must be imported to Maine (Mostly from foreign sources)<br>2. Getting more expensive<br>3. Nonrenewable resource<br>4. Reserves are running out |
| Coal | Limited Only By Capital Availability For Development, Construction of Conversion Facilities, Adequate Transportation Facilities, Expansion of National Mining Capability and Environmental Considerations. | | 100-300 | $2.03 (1985) - $4.16 (1995) Per Million BTU (Source- A.D. Little) | Now, but transportation system and environmental constraints precluding expanded use. | 1. Abundant and readily available to U.S.<br>2. Primary source of electrical energy generation in U.S.<br>3. Technology well proven due to scope and extent of current and historical use. | 1. Not readily available in Maine.<br>2. Pollutes at point of use<br>3. Burning accounts for 75% of sulfur dioxide pollutants causing destruction of tracts of timber especially pine, birch, elm, and poplar.<br>4. Non-renewable resource<br>5. Mining disrupts land and can pollute streams<br>6. Expensive to transport to Maine |
| Natural Gas | Limited by relative lack of gas burning equipment in Maine, which are not likely to be built due to pessimistic supply outlook. | | 10-40 (?) | $2.03/ Per 1000 cubic feet (1985) | Now | 1. Clean burning<br>2. Easy to store, handle, and use | 1. Not readily available in Maine<br>2. Expensive when transported to Maine<br>3. Nonrenewable resource<br>4. Reserves dwindling rapidly<br>5. Most facilities in Maine not equipped to burn gas. |
| LNG | Potentially up to 240 billion cubic feet per year, if/when St. John-Albany Pipeline built, and depending on amount allowed by FPC. | | ? | $2.14-$3.00 Per 1000 Cubic Feet | 5-10 years | 1. Clean burning<br>2. Easy to store, handle, and use<br>3. If St. John-Albany pipeline built Maine will be in the middle. | 1. Not available in Maine<br>2. Must be imported from Foreign Countries.<br>3. Expensive<br>4. Nonrenewable resource<br>5. Most facilities in Maine not equipped to burn gas. |
| Methane | Dependent on Extent and Development of Methane reserve in the Gulf of Mexico, which may exceed energy value of entire U.S. Coal Reserves | | Potentially 100-300 | $2.00-$3.00 Per Million BTU | 10-15 years ? | 1. Clean Burning<br>2. Easy to store, handle, and use.<br>3. Potentially enormous reserves associated with Gulf of Mexico oil fields. | 1. Not currently available<br>2. Maine facilities not equipped to burn gas.<br>3. Extraction technology needs improvements.<br>4. Most facilities in Maine not equipped to burn gas. |
| Nuclear | If Sears Island Built, 2000 MW by 1986 (?) (850 MW at Maine Yankee plus 1150 MW at Sears Island) | 12 Billion KWH per year (Not all for Maine. Maybe 6 Billion) | 30-50 w/o Breeder ? | 3 - 6c/KWH | 850 MW Now, 1150 MW More by 1986 -(?) | 1. No air pollution or odors<br>2. "Clean" resource<br>3. Potentially enormous energy yield<br>4. Good safety record<br>5. Possible source in Maine | 1. Known uranium reserves limited<br>2. Safeguards elaborate<br>3. Breeder reactors not yet developed to consume present fission waste.<br>4. Nonrenewable resource<br>5. Large thermal emissions |
| Breeder | Limited only by capital expenditures on generating plants, when built. | | If successful virtually infinite. | 2c - 10c/KWH (?) | 15-25 years? | 1. Potentially infinite resource<br>2. Means to consume fission waste products | 1. Extremely complex problems in technology.<br>2. Large thermal emissions |
| Fusion | Potentially unbounded energy yield, limited by physical plant. | | When successful, virtually infinite. | (?) | 25-50 Years ? | 1. Potentially infinite resource<br>2. clean resource | 1. Extremely complex problems of technology<br>2. Potentially radioactive plant components when dismantled. |

## CHAPTER IV - PART 2

## INDIGENOUS RESOURCES

Faced with growing uncertainties in the future of global and national energy supplies, it seems to make intuitive common sense for Maine to develop its own resources when it is environmentally and economically feasible to do so. The discussion below evaluates the potential of each of these native resources.

### WOOD

Fuelwood is projected to supply between 6.9 trillion and 8.7 trillion BTU to Maine's total energy demand in 1980, and between 7.1 trillion and 9.8 trillion BTU in 1985. These numbers are the equivalent of between 365,000 and 460,000 cords in 1980, and 376,000 and 514,000 in 1985. Virtually all of this demand will be utilized for residential and commercial space heating and for industrial process heat. The Maine Bureau of Forestry has estimated that annual consumption in 1975 was 356,000 cords, and increasing by about 7,500 cords per year. This consumption growth rate would result in fuelwood consumption of 394,000 cords in 1980 and 431,500 cords in 1985, both of these estimates falling within the projected range.

It must be recalled, however, that all of the historical fuelwood consumption figures represent little more than educated guesses because it is difficult to determine with any degree of accuracy how many homes utilize wood as the primary fuel and how much wood is burned by each housing unit. Contributing to the inaccuracy of the data is the inability to determine how many consumers cut and haul their own fuelwood and, among those who can be determined, the apparent inconsistencies of estimates as to just how much wood they do cut from their own woodlots, and for their own consumption. The Office of Energy Resources is attempting to obtain more accurate fuelwood consumption data.

In spite of this, it can be said that there is the potential for a greater utilization of fuelwood than is currently consumed or projected for consumption in the preceding scenarios, and that this potential exists in the residential, commercial and industrial sectors.

In the evolution from conventional through transitional to ultimate energies, the direct burning of wood must play a significant role in Maine.

Doubling the projections for 1980 and 1985 fuelwood consumption (which were derived above from the Bureau of Forestry growth estimates) might be a realistic possibility. This would mean consumption of 788,000 cords in 1980 and 863,000 cords in 1985, or the equivalent of about 15 trillion BTU in 1980 and 16.4 trillion BTU in 1985. If all of this additional fuelwood consumption were utilized for residential space heating, it could conserve 1.3 million barrels of distillate oil in 1980, and 1.4 million barrels in 1985, or about 10% of the projected total distillate oil consumption for the "Business As Usual" scenario.

As long as heat is the desired result of the conversion process, direct burning should probably be used; any intermediate operation such as gasification or the manufacture of methanol is more expensive and less efficient overall, but may become economically attractive in the future as the cost of natural gas rises. The firing of existing boilers and engines with wood may also require the use of gasification and liquification.

The use of wood for electric generation is limited, because efficient turbine-generator systems require large sizes (heat rates rise rapidly as unit sizes fall much below 35MW). But, the larger the unit is the greater the hauling distance for wood.* Nevertheless, development of community-sized wood-fueled generating stations (25-50 MW) shows some promising potential. (Costs are around $50,000,000 to supply a population of 50,000-100,000.)

The first target for increasing the use of wood fuel is the wood using industry where much waste is now generated. With improved techniques and massive capital investments, much of Maine's wood converting industry could become independent of fuel oil and operate on their own waste. Some generate waste far beyond their own energy needs. With appropriate technical and institutional arrangements, they could sell electricity to the utility grid. A stud mill, for example: needs low pressure steam for kiln energy; has much wood waste on hand; uses a modest amount of energy to operate saws, planers, etc.; and should be able to generate excess electrical capacity for sale to the grid. But like hydroelectric power, this may not be reliable energy and alternate back-up systems may be required. Maine Wood Fuel Corporation has proposed a compound cycle (gas turbine - waste heat boiler - steam turbine - process steam) which has promise. Hague International and the Northern Maine Regional Planning Commission have received an EDA grant for this project. A pilot operation at Masardis should be underway soon and will be watched as a model.

In addition to wood-using industries themselves, institutions (schools, etc.) located near sources of wood waste could be converted.

The amount of wood available for fuel is a much debated topic and all evidence is not yet in. Studies are continuing into the more extensive use of wood as an energy source. An early Office of Energy Resources paper ("Maine and Methanol") speculates that as much as 132.75 million tons of wood are available per year; others indicate that little will be available as pressure for other uses dominates the fiber market. The ecological impact of removing all fiber during harvest (bole to wood products; stump, roots, branches and tops to energy) has not been assessed. An immediate and major research effort in this area is being given high priority by the Office of Energy Resources.

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* For example: a station the size of Wiscasset (800 megawatts electric) will demand heat at the rate of 800 x 1000 x 10,000 = 8 x $10^9$ BTU/Hr. Coal at 10,000 BTU/lb. would require 400 tons per hour. A coal car carries about 100 tons; so 4 cars an hour would be needed. If wood chips were used (one-half the energy per pound and one-fifth the density) 40 cars per hour would be required. The 6,000 gallon tank truck hauling #6 oil to Maine industry is a familiar sight. Ten wood chip vans (10' x 10' x 40') would be required to replace each one. Of course, the materials handling problem argues for use of wood at plants smaller than 800 MW; preferably integrated with use of waste heat.

Certainly the technology of the conversion of wood to useful energy is better understood than the availability of the wood itself. Here, however, are some round numbers: (1) The present timber harvest for all uses is about six million dry tons per year. The harvest operation leaves about this much behind in the form of tops and branches. Considerable additional wood could be available from thinning, diseased trees, etc. (2) If we assume ten million dry tones are available as fuel per year and that wood is 5,000 BTU per pound, then: ($10 \times 10^6 \times 2 \times 10^3 \times 5 \times 10^3 = 10^{14}$ BTU/Year) This is about 1/3 the total energy used in Maine.

## MUNICIPAL AND INDUSTRIAL SOLID WASTE

The energy contained in trash is significant -- some two to five percent of all the energy in the United States could be recovered by proper conversion of waste. So far the major efforts in this area have been confined to large scale operations such as those in Montreal; Saugus, Massachusetts; and St. Louis, Missouri. Although the economies of scale are obvious, some thought should be given to small units where high quality trash is available. Shopping centers would be a good candidate. Their trash is mostly cardboard boxes, and although recycling would be a better use, this material should not be taken to dumps but could be used on the site for heat generation. If the 2-5% potential energy recovery figure applicable to the U.S. were applicable to Maine, the total BTU availability must be approximately 3 to 15 trillion BTU. The lower estimate is probably much more realistic due to the dispersed character of our settlements.

Several Maine communities and industries are currently investigating the feasibility and economics of using solid waste for energy.

## METHANE

Primitive and experimental methane generators have been developed for on-farm use in other parts of the country and some work along these lines has been done at the University of Maine at Orono, but without much success to date due to difficulties in sludge disposal in winter. Recently, a cattle feedlot in Oklahoma has undertaken an experiment to produce 820 million cubic feet of gas per year at an estimated cost of $1.77/1000 cubic ft. This price compares very favorably with synthetic gas made from coal or imported LNG. The Federal Power Commission has permitted inter-state shipments of this gas.*

## SOLAR ENERGY

One of the most popular and plentiful of the alternative sources of energy is solar energy. It is obvious by increased expenditures that the Federal Government has committed itself to the development of solar energy and, despite a relatively low amount of incident sun, the potential for solar energy in Maine may be significant due to the large need for heating energy because of Maine's cold climate. A number of studies are currently in progress to assess the potential for utilizing solar energy for space and water heating in Maine. Three Maine companies currently distribute solar components.

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*New York Times, 5/26/76, p. 47

Several structures, from private homes to the new Audubon Society headquarters in Falmouth and the new sewage treatment plant in Wilton, have been and are being constructed, and will provide very useful tests of the potential for active solar heating.* There is wide diversity of "expert" opinion as to the economic viability of solar heating in Maine. The results up to this time are inconclusive, although several points seem clear:

(1) To the extent that solar heat can be developed and utilized, it will conserve non-renewable resources. (For this reason, solar heat development is classed as "conservation" in some scenarios previously developed by others.) At present it would not conserve scarce capital, however.

(2) While solar heat is currently most economically competitive vis-a-vis electric space heating, wide-spread development of solar heat with electric back-up systems could have unfortunate consequences to the electric utility systems who would need to have the back-up capability available for the extended sun-less periods. Unless the electric back-up system were designed so that it could be used during off-peak hours to "charge" the solar storage unit, the resulting higher costs of peaking electric power could render any potential economic fuel savings highly questionable. Oil and wood fuels for space heating would appear to be sensible alternatives for back-up systems to solar heating.

(3) Optimistic statements about the future of solar energy for the nation when applied to Maine become clouded by the fact that the insolation in Maine, on average, is much less than that for most of the rest of the country.

A sample statement about solar energy is the following:

> "Use of solar energy for heating water and building and for low-temperature industrial processes is feasible, and at today's high fuel prices, these uses should grow rapidly, especially in new structures specifically designed for them. In much of the United States, each square foot of solar collector could collect 150,000 BTU's per heating season, thus saving 1.5 gallons of fuel oil burned at 70% efficiency. With fuel oil at 40 cents per gallon, and a capital charge rate of 15% per year, this fuel savings justifies investment of $4 per square foot of solar collector and associated pump, piping, and heat storage. Installed costs today are around $15 per square foot, and the total cost for a typical house is around $3,000. Nevertheless, improved technology, mass production, increased fuel prices, and government subsidies to encourage fuel conservation should lead to extensive use of solar heating. As it isn't economic to provide all heat needed during coldest weather, perhaps 70% of a building's annual fuel could be saved by solar heating." **

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*"Active" solar heating utilizes a circulating fluid and a storage tank. "Passive" solar heating refers to a building construction method that takes maximum advantage of the sun by providing most windows with a southern exposure. The windows are blocked off at night to prevent the escape of heat.

**From the May 1976 Technology Review -- "U.S. Energy: The Plan that Can Work" by Manson Benedict.

However, in Maine 150,000 BTU/ft. represents all the solar energy (diffused and direct) available during the heating season. Collectors can capture only a small fraction of this. But more important is the high cost of a storage system big enough to be useful in Maine during the long, cold, dark winter nights (sometimes weeks!) in Maine. The $3,000 figure for 70% of the heating needs for a modest home would probably be more like $30,000 in Maine. Perhaps in Maine the percentage of heating needs that could be economically met by solar would be more like 50%.

(4) While these figures make solar energy appear economically unattractive today, it could become attractive in the future. We are now putting buildings in place with life expectancies greater than the transitional energy projections: a building now under construction may eventually be heated with solar energy and close attention to siting and thermal integrity is essential.

## WIND ENERGY

Like wood, wind energy is not a new concept. Although its contribution to Maine's total energy consumption is currently nil, it has previously made significant contributions, particularly in pumping water up from wells for elevated storage and infrequent consumption. In the 1930's and 1940's, a wind-powered 1250 KW electrical generating station was installed by New England utilities on Grandpa's knob in Vermont. The unit ran somewhat successfully for several years before being disabled by mechanical failure of one of the blades. ERDA is currently researching the potential for wind generation as central generating stations operated by utilities. A number of firms, including several in Maine, are marketing smaller systems for individual use by households and smaller businesses. Several homes have installed wind generators for supplemental power or in lieu of electric utility connections. One wind energy system was recently installed on Block Island in Rhode Island to provide electricity for the telephone system there.

Wind generation of electricity will probably remain as an experimental venture over the near (10 year) term. As with active solar, capital costs per unit of output are simply too high for most people to be able to afford both the conversion of the energy and the needed storage system. For larger installations, costs of around $2400 per installed kilowatt are estimated even at favorable (approx. 20 mph) wind velocities. Figure 35 illustrates the problem of wind energy availability versus demand for an offshore island in Maine.* Improved energy storage mechanisms could make an important difference in the practicality of wind systems. Maine is in an excellent location for windmill experimentationm as wind velocities are generally high.

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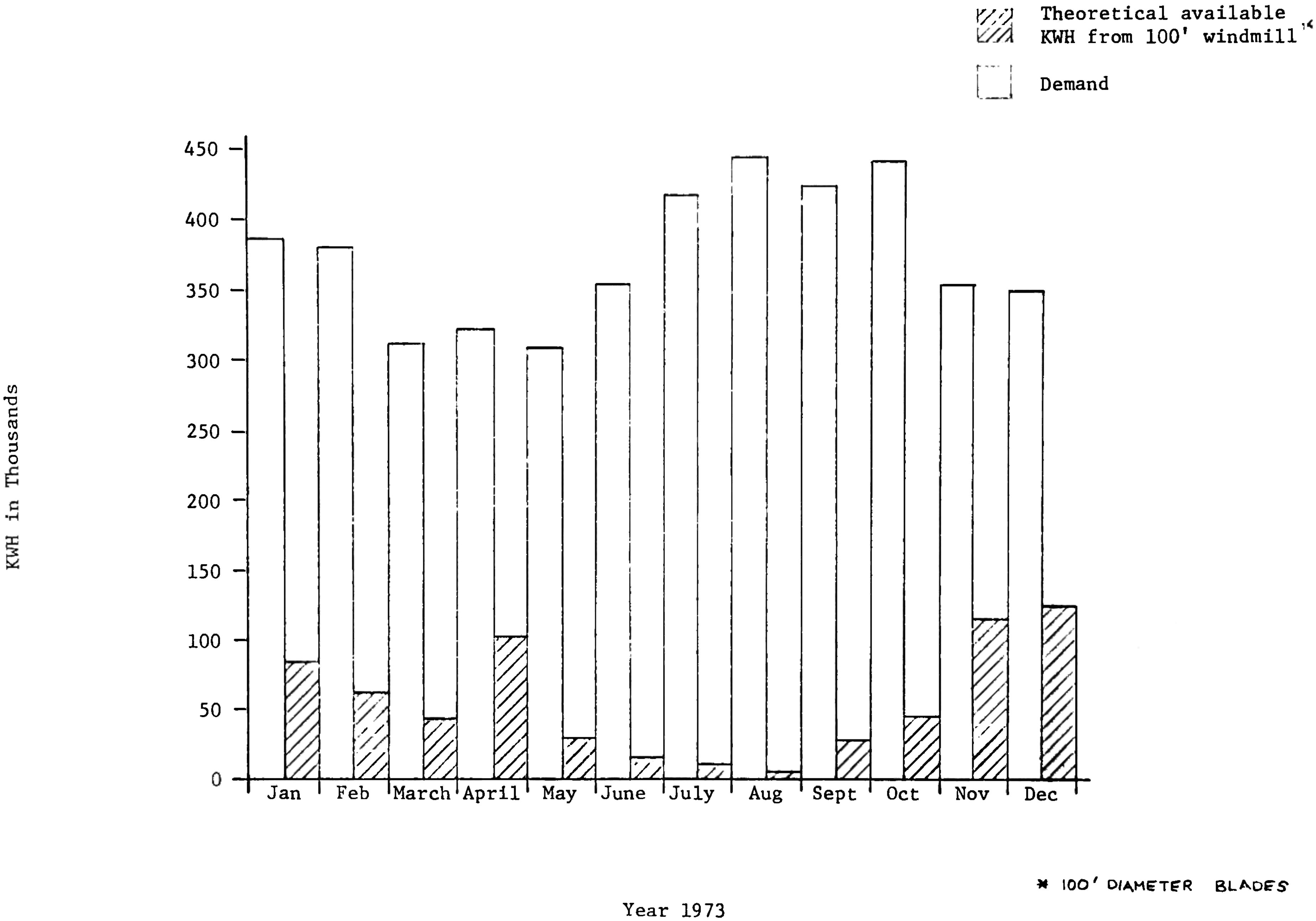
* Richard Hill, University of Maine, Orono: From a report by Glen Perry on wind generation of electricity for offshore islands. Others have criticized this information as misleadingly pessemistic toward wind power. Unlike the State as a whole, islands have a peak demand for electricity in the summer. Compare the possible December or April contribution of the windmill to the situation in August!

FIGURE 35

Windmill Energy Potential and Energy Demand in Vinalhaven



* 100' DIAMETER BLADES

## TIDAL POWER

Early efforts for tidal development in Maine date back to the 1930's when Dexter Cooper and the Roosevelt administration began development of tidal power at Passamaquoddy Bay as a WPA project to boost recovery from the Great Depression. Several small dikes were completed before the project was abandoned. But tidal power for Maine has been an issue ever since those first preliminary steps and generally has been proposed in conjunction with a hydro plant development to balance out the unavailability of tidal energy four times daily during the tidal cycle.

Interest in the Passamaquoddy tidal project has been considerably renewed by the exhaustive studies in progress by the firm of Stone and Webster under a contract from the Energy Research and Development Administration. The amount of capacity and energy delivered from the project are highly dependent on the engineering design. Capital costs are high, but life cycle costs when compared with the rising costs of other energy fuels may make a tidal project feasible, although it would not be expected to deliver energy to Maine within the decade under consideration. The studies are due to be completed early in 1977 and at that time the possibilities for tidal power will be updated.

Most recently, the Passamaquoddy Indians at Perry and Peter Dana Point have proposed a small (2000-6000 KW) tidal and marine research project at Back Cove in Eastport. Uncertainty exists as to any tidal development in the Passamaquoddy Bay area due to potential conflicts with the proposed Pittston oil refinery there.

## HYDRO POWER

Maine has long been a strong user of hydro power both for direct mechanical drive and for hydroelectric generation. Maine's initial industrial development in the textile and shoe manufacturing industries was due to the availability of cheap and abundant hydro power. Many of Maine's communities - such as Biddeford-Saco, Lewiston-Auburn, Rumford, Livermore, Brunswick, Augusta, Waterville-Winslow, and Bangor - were developed at points where falls in a waterway made hydro power readily available without massive daming. The communities grew around the industries that were attracted by the available waterpower. As recently as 1955, Maine still relied on hydro power for 17% of its total energy consumption. However, the fraction of total energy use provided by hydro power has dropped to 10% in 1974 and will probably continue to decline before any new major hydro facilities are developed. Hydro power has declined in this manner because all of the economically attractive available sites had been developed, and the remaining sites to be developed were not competitive with alternative energy sources, such as coal, oil and nuclear power. However, the energy situation and prices created by the 1973 Arab Oil Embargo and subsequent "new economics" of energy have stimulated renewed interest in development of remaining hydroelectric sites in Maine.

In a recent report, the Army Corps of Engineers identified ten sites in Maine for potential hydroelectric development, all of which have benefit/cost ratios in excess of .8, and five of which have B/C ratios greater than one.* Table 28 identifies these ten sites and their potential capacity and energy contributions. The map in Figure 36 locates the sites in the State, along with the Brunswick-Topsham site being redeveloped by Central Maine Power Company. It is interesting to note that Maine contains 10 of the 18 New England sites identified by the Corps with B/C ratios greater than .8, and 1,500 MW of the total 1,800 MW potential in New England. More study of these hydro sites is necessary to assess their environmental impacts, land use patterns, contribution to total energy supply, the relationship to existing and planned generation facilities, in addition to resource management and energy cost implications.

Maine is blessed with an abundance of streams and rivers, most of which have a potential for doing work as they flow to the sea. In addition to the potential major hydroelectric developments discussed above, there exists within the State a possibly greater potential for hydro development on a smaller scale, either for electric generation or direct mechanical work.

The development and growth of centralized generation and extensive transmission and distribution systems in Maine tended to deter consideration of less economical smaller scale individual hydro development. Recent trends, however, have renewed interest in small scale hydro projects, and such interest should be encouraged and vigorously pursued.

The reader should not infer from the above discussions, however, that there are no problems associated with hydroelectric development or redevelopment.

Additional hydro sites in Maine are expensive to develop, low in capacity and uncertain in energy. High water in the spring, low water in August and anchor ice in winter tend to limit the reliability of river hydro. To supply back-up capacity for hydro can be very expensive. And there are significant environmental questions to be resolved on a case by case basis.

The most famous of the undeveloped Maine hydroelectric sites, Dickey-Lincoln is designed as a peaking station and would have small impact on the cost of energy in Maine. Canada has indicated a willingness to share some of the down-stream energy benefits in the form of donating about 150 million KWH per year to the U.S. operator of Dickey-Lincoln (probably the Department of the Interior). Our annual total electrical energy use is around ten billion KWH, so this will not make a big contribution (less than 0.2% of total current KWH demand) even if it were all reserved for Maine use.

Table 29 summarizes the indigenous energy resources available in Maine.

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* These cost estimates should be verified by an independent source.

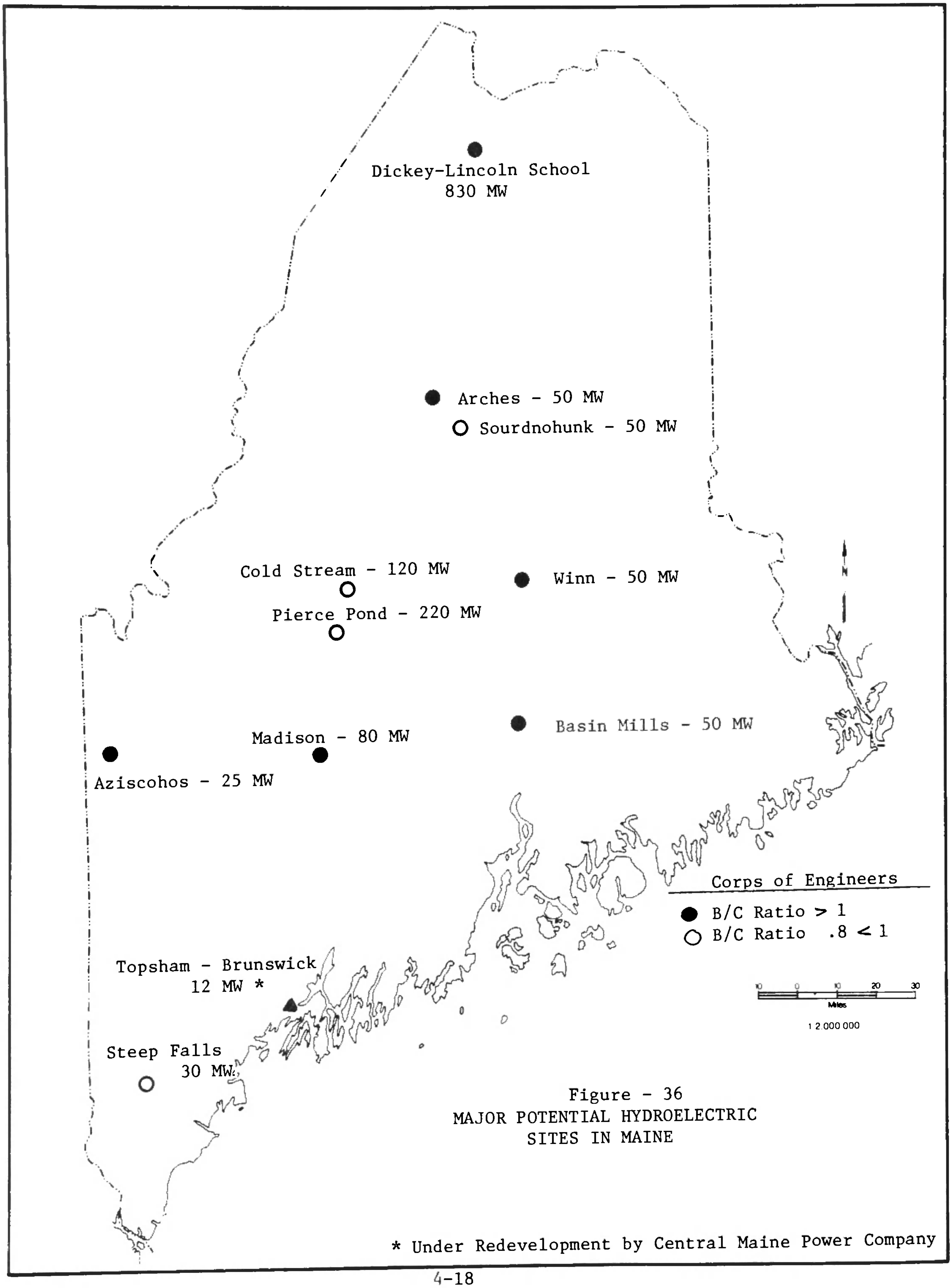

Figure - 36
MAJOR POTENTIAL HYDROELECTRIC
SITES IN MAINE

* Under Redevelopment by Central Maine Power Company

# TABLE 28
## POTENTIAL MAINE HYDROELECTRIC PROJECTS
(Source: U.S. Army Corps of Engineers Draft Report, Spring 1976, Unpublished)

| River | Project | Installed Capacity KW | Capacity Factor | Average Annual Output (1000 KWH) | Initial Cost (1000) | Annual Cost ($1000) | Total Benefit $1000) | B/C Ratio |
|---|---|---|---|---|---|---|---|---|
| St. John | (1) Dickey-Lincoln | 760,000 | .11 | 849,000 | | | | |
| | School | 70,000 | .37 | 305,000 | | | | |
| Combined | Dickey-Lincoln | 830,000 | .16 | 1,154,000 | $463,000 | $22,850 | $58,949 | 2.61 |
| Penobscot (W. Branch) | (2) Arches | 50,000 | .21 | 94,250 | 34,207 | 2,854 | 3,747 | 1.22 |
| | (3) Sourdnahunk | 50,000 | .23 | 109,450 | 54,588 | 4,283 | 3,992 | 0.93 |
| Penobscot | (4) Basin Mills | 50,000 | .21 | 93,150 | 46,993 | 3,600 | 4,196 | 1.17 |
| | (5) Winn | 50,000 | .20 | 89,170 | 54,749 | 4,155 | 3,562 | 0.86 |
| Kennebec | (6) Madison | 80,000 | .21 | 146,800 | 48,871 | 3,855 | 5,756 | 1.49 |
| | (7) Cold Stream | 120,000 | .25 | 259,350 | 125,597 | 10,098 | 9,315 | 0.92 |
| Magalloway | (8) Aziscohos | 25,000 | .22 | 49,080 | 11,875 | 1,100 | 1,780 | 1.62 |
| Pierce Pond Stream | (9) Pierce Pond | 220,000 | .23 | 459,000 | 217,154 | 17,764 | 15,730 | 0.88 |
| Saco | (10) Steep Falls | 30,000 | .18 | 47,690 | 32,652 | 2,650 | 2,135 | 0.81 |
| TOTALS | | 1,505,000 | | 2,501,940 | $1,089,686 | $73,209 | $109,162 | 1.49 |

NOTES: If all identified projects are build: $\frac{\$1,089,686,000}{1,505,000\text{ KW}}$ = $742/KW average installed cost

$\frac{\$73,209,000}{2,501,940,000\text{ KWH}}$ = 2.93¢/KWH average energy cost

| RESOURCE | QUANTITY AVAILABLE | | | PRICE | FORECAST OF TECHNOLOGY AVAILABILITY | ADVANTAGES | DISADVANTAGES |
|---|---|---|---|---|---|---|---|
| | CAPACITY | ENERGY | YEARS SUPPLY | | | | |
| Wood | Dependent on facilities built for wood utilization | 64 million dry tons, or 1 x $10^{15}$ BTU Per Year;<br>350,000 Tons of Waste bark and shavings per year | Virtually Limitless | $35 to $60 Per Cord<br>$1.47 to $2.52 Per Million BTU;<br>Approximately 5.6c/KWH | Now - but expansion of technology required | 1. Renewable resource<br>2. Can be used in conjunction with coal, municipal solid waste, and other solid fuels. | 1. High cost of harvesting and transportation<br>2. Accurate assessments of the actual amounts and types of forest residue generated are difficult to obtain.<br>3. Competes with other wood end uses (e.g. lumber abd paper) and may drive up resource price.<br>4. Due to low density and BTU content, large bulk for energy delivered. |
| Hydro-<br>Developed | 543 MW | 2.8 Billion KWH/Year | Virtually Unlimited | Average Current Costs $724/KW<br>$2.93c/KWH | Now - But 10 to 30 Years to construct additional capacity | 1. Abundant and available in Maine<br>2. Clean<br>3. Renewable Resource | 1. Consumes large tracts of land that may be timber producing.<br>2. May destroy fish and wildlife habitat such as deer yards and spawning grounds.<br>3. Fluctuating shoreline is not aesthetically pleasing and damaging to fishery.<br>4. Most available for peaking capacity only, very little for base load energy delivery. |
| Undeveloped | 1715 MW | 4.3 Billion KWH/Year | | | | | |
| Total | 2258 MW | 7.1 billion KWH/Year | -------- | | | | |
| Wind | 80-100 KW/unit built with 100' Diameter blades. | 200,000-500,000 KWH/Year/Unit For 100 KW Unit Operating 2000-5000 Hours/year. | Unlimited | 10¢ - 40¢/KWH<br>Without Storage | 5-15 years | 1. Abundant and available in Maine<br>2. Clean<br>3. Renewable Resource | 1. Very expensive to develop.<br>2. Intermittent; backup system or extensive storage required for windless periods. |
| Solar | Dependent on extent of facilities built. | | Unlimited | | Space and Water Heating 5-15 years<br>Photovoltaics 10-25 Years ? | 1. Abundant and available in Maine<br>2. Clean<br>3. Renewable Resource | 1. Very expensive to develop.<br>2. Intermittent; backup system or extensive storage required for sunless periods. |
| Tidal | 1,000 MW at Passamaquoddy | 1.2 billion KWH/Year | Unlimited | (1964 Estimate) with 3% Money.<br>$500 Million in combination with Dickey-Lincoln | 10-20 years | 1. Readily available in Maine<br>2. Clean<br>3. Renewable Resource | 1. May supplant other industries such as refineries and free ship passage.<br>2. May degrade environment by alterations of tidal flows. |
| Municipal Solid Waste | Dependent on extent of facilities built. | 7 Trillion BTU/Year | Unlimited | | 5-20 years | 1. Relatively abundant in Maine<br>2. Helps solve solid waste disposal problems<br>3. Renewable resource | 1. Technology and handling problems, including transportation.<br>2. Needs population concentration to be economically attractive. |

# CHAPTER IV

## SUMMARY

There is little doubt that the global stock of nonrenewable energy resources is being depleted and will eventually be exhausted. As reserves diminish and the resources become more and more difficult and expensive to extract, prices will rise in relation to other goods and services and consumers will turn to alternative renewable or "ultimate" energy resources which cannot be depleted. The question is, Has the transition begun in time and can the new technologies be implemented at a rate adequate to satisfy growing energy demands?

Globally and nationally, searches are underway for transitional energy resources (coal, nuclear, hydro) that will fuel expanding economies until the ultimate energy resources (fusion, breeders, solar ocean thermal, etc.) can be brought into production. These transitional energy resources are essential to replace the almost certain shortfall of petroleum that is anticipated prior to the year 2000.

In Maine, exogenous resources will continue to furnish the majority of the State's energy requirements through 1985. Petroleum will supply more than two-thirds of the energy needs, while increasing use could be made of coal, imported electricity from Canada, and, possibly, additional nuclear generating plants by 1990 or 1995. Barring unforeseen developments, natural gas use in Maine will decline and possibly disappear by 1985 or 1990 due to rapidly dwindling national and global reserves.

Maine is fortunate to have available at least some indigenous resources to satisfy energy demands and reduce dependence on uncertain and expensive global and national energy markets.

Wood is Maine's most abundant native energy resource, and could furnish 5% or more of the State's total energy requirements by 1985. Most of the wood consumption would be direct burning for residential, commercial, and industrial heating requirements, although conversion to liquid or gaseous fuels, or to electricity, are also possible.

Municipal and industrial solid wastes represent another potential energy resource for Maine, and could furnish 1 or 2% of total energy requirements. Much of this energy recovery could come from industrial and commercial incineration of waste packaging materials and the like for space heat and process heating requirements.

Methane gas from organic waste matter is another potential energy source whose possible contribution has not yet been quantified. The process of methane gas generation is especially suitable for chicken and cattle raising farms.

Solar energy, regarded by some as <u>the</u> ultimate energy resource, has <u>some</u> potential for application in Maine. However, solar energy can never satisfy all of our energy demands, nor all of our heating requirements. Several installations have been built in Maine to take advantage of the available energy from the sun, and these will be monitored to evaluate the potential for expanded solar development in Maine. However, most systems presently available are not economically competitive with the traditional fuels under current conditions.

Wind energy, like solar, is also available in Maine, but not at economically competitive prices. More developmental work needs to be done, with technological improvements and mass production techniques, so that prices can be lowered to competitive levels. Currently, wind energy systems are suitable only for very specialized applications and for demonstration purposes. Future development could yield significant benefits by the year 2000.

Tidal power, currently considered feasible only at Passamaquoddy Bay in Maine, is still in the quite distant future before it will make any contribution to Maine's energy supply. Development is not foreseen before 1990, but final evaluation must await the results of the study currently in progress by Stone and Webster Engineering for the Energy Research and Development Administration.

Hydropower, long a mainstay on the Maine energy scene, appears due for a resurgence of development in the near future. Renewed studies of the Dickey-Lincoln site, recent proposals and evaluation of hydroelectric potential in Maine by the Army Corps of Engineers, renewed interest in small hydro developments by a number of individuals and agencies, and an apparent new interest by Maine's electric utilities, all indicate that significant development of hydro power could occur in Maine on many levels within the next decade.

# CHAPTER V

## ENERGY POLICY OPTIONS FOR MAINE

### INTRODUCTION

We have presented in the past four chapters, a rather detailed description of historical and present energy use in Maine. We have also presented a preliminary accounting of those energy resources likely to be available for the foreseeable future. In a private energy company or government energy authority which had control over those available energy resources, the planning process would next extend logically into a resource allocation strategy, with target dates for completion of specific construction projects.

However, the Office of Energy Resources is an advisory agency and not an energy development authority. The Office of Energy Resources is charged with the responsibility of preparing a "State Energy Policy". [1] Our role is, therefore, the role of policy analysts. The task before us is to set forth to the public the full ramifications of the energy choices now facing the State. It will be the job of Maine's people and the State Legislature acting on their behalf, to set the final energy policy for Maine.

This chapter is devoted to the delineation of some preliminary policy alternatives. We also describe, in some detail, the process through which these alternatives are being developed. The major portion of the chapter contains policy analysis for Maine alone. The policy recommendations in those sections can be adopted and implemented within the State by and for Maine's people. We have also included a brief synopsis of regional and national energy policies, as they now exist, and a description of the current world energy situation. Although we can do little to alter these policies directly, we feel that, since they obviously affect the citizens of the State, some discussion of them should be included in this document.

We believe that energy is a "means" rather than an "end". It must be viewed as an integral and fundamental element of our economy but not as the ultimate driving force in our society. Consequently recommendations for energy policy must include the interrelationships between energy use, land development, economic growth, taxation, and environmental quality. To develop an energy policy for Maine that is specific, exacting, well-founded, and complete is thus not easy to say the least! It is the responsibility of this agency to gather and to provide to the public the most complete and correct information which we are capable of assembling. To make ad hoc judgements for the sake of political expediency would not be living up to standards of professionalism and would not be in the best interest of the people of Maine.

In a democracy, it is the responsibility of the public to be the final decision maker. Political scientist have said that to leave all of the critical energy decisions up to the "experts" is to abdicate the public's role in favor of an elitist technocracy. In truth, energy systems are complex and so are the ramifications of the choices to be made. Perhaps this complexity will, in the final analysis, overwhelm the public's ability to participate. We hope that this situation does not come to pass.

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1. Maine Revised Statutes Annotated, Title 5, Section 5005 (E).

# CHAPTER V - PART 1

## STATE ENERGY POLICY ANALYSIS

### ORGANIZATION AND METHODS

Because the broad subject of energy policy is inherently complex, there are many ways of designing the task of energy policy analysis. We have chosen to organize the development of Maine's energy policy into a set of policy topics which fall somewhat logically into the four broad groupings shown in Table 30.

We are fully aware of the potential for overlap among these policy topics. We recognize also that the list is not exhaustive but only indicates the areas identified to date which lend themselves readily to research and quantification, and from which reasonable recommendations can be derived.

The Office of Energy Resources will, in the near future, analyse thoroughly each of the above policy topics in a discussion paper to be issued separately from this plan. These discussion papers will take the standard "white paper" format (background, issues, alternatives and recommendations) and will address such relevant questions as taxation, availability of capital, environmental effects, social effects, technological demands, and institutional constraints.* The policy recommendations outlined here and further developed in each of these discussion papers will, in sum, constitute the recommended energy policy for Maine which our office is obliged by statue to develop.

The bulk of this chapter is an annotation to the above list of policy topics, and indicates major issues to be addressed in more depth in the forthcoming discussion papers. Some preliminary recommendations are also made herein.

It must be stressed that these are to be viewed as preliminary recommendations only. They are our professional judgements based on the very brief analysis we have been able to perform up to this point in time. Much more work needs to be done before the Office of Energy Resources will feel completely confident that our preliminary recommendations are sound and reasonable. We welcome at all times the information and advice of others with a personal or professional interest in Maine's energy policy development as this work proceeds.

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* Obviously, the Office of Energy Resources will be obliged to rely upon the considerable bank of knowledge in these areas which exists in other State Agencies and various outside experts. Committees are being set up to work with the Office of Energy Resources on these topics.

## TABLE - 30

## MAINE ENERGY POLICY TOPICS

1. Topics of Immediate Concern due to the State's Current Heavy Reliance on Petroleum.

   1-1 State Energy Emergency Plan

   1-2 Petroleum Storage Reserve

   1-3 Strategies for Energy Conservation

   1-4 Mitigating the Impacts of Energy Prices Increases

2. Topics Surrounding Major Energy Facilities and Their Impact on the State.

   2-1 Energy Facility Siting

   2-2 Oil Refineries

   2-3 Major Electrical Generating Facilities (Nuclear, Coal)

   2-4 Maine's Role as an Intermediary Supplier of Energy

3. Topics Concerning Diversification of the State's Energy Supply and Increased Use of Native Energy Resources.

   3-1 Natural Gas

   3-2 Coal

   3-3 Canadian Electric Power

   3-4 Wood

   3-5 Solar

   3-6 Wind

   3-7 Hydropower

   3-8 Solid Waste

   3-9 Tidal Power

4. Topics Concerning the Changing Nature of Electrification

   4-1 Cogeneration of Electricity and Process Steam in Maine

   4-2 Current Operations of the Electric Utility Industry

   4-3 Public Power

# POLICY TOPICS OF IMMEDIATE CONCERN DUE TO THE STATE'S RELIANCE ON PETROLEUM

## 1-1 State Energy Emergency Plan

### Background:

In 1973 the United States depended upon Arab nations for 15% of our petroleum needs. Energy experts generally agree that a 15% shortage can be weathered with discomfort but not disaster. A combination of factors helped us through the embargo period relatively unscathed. A mild winter, conservation efforts, allocation of resources and the "leakage" of Mid-East Petroleum via other exporters, all helped to cushion the embargo impact. Now, imports of oil from Arab nations have increased to approximately 45% of our total petroleum supply, with little assurance that the next embargo will have as much "leakage" as the last. While the likelihood of a second embargo seems thankfully remote to most of us, the chance of it occurring is nevertheless very real. Some experts are predicting another Mid-East war in 1978 to 1980, at which time they also predict that our continuing support of Israel will cause the U.S. to be embargoed.

Whether or not this theory is correct, the consequences of another embargo would be extremely disruptive of the State's economy, and some curtailments of energy use would be inevitable.

### Issues:

What type of curtailments are both feasible and "fair"? Which are the energy consuming activities that are essential to life and must not be curtailed? What are the steps which we could expect to follow in the implementation? Just how much of what type of fuel could we expect to save? These are questions which to date have not been addressed systematically.

### Alternatives:

The draft emergency plan outlines a set of alternative ways to meet a future embargo, short of a Federally mandated rationing program, although this is also a consideration of the Plan. The Emergency Plan is designed as a handbook for use by the Governor of Maine. It focuses attention on curtailable elements of energy use to determine feasible reductions in petroleum use within Maine. Elements of curtailable energy use include, but are not limited to, reduced driving, reduced thermostat settings in homes, commercial buildings and industry, and reductions in lighting levels for commercial and industrial applications. Included also in the plan are the Governor's statutory powers, the procedures for maintaining, activating and managing the Standby Fuel Allocation Office, and the NEPOOL plans for rotating electricity curtailments. The NEPOOL plan is also of use in any electrical outage situation, such as forced shutdown of a number of regional power plants.

The Emergency Plan is currently undergoing review and comment by appropriate State and local officials. Following modifications undertaken as a result of suggestions received by these authorities, the Emergency Plan will be sent to the Governor for his review.

### Preliminary Recommendations:

1. The Office of Energy Resources feels that maintenance of a complete and up-to-date energy emergency plan is vital to the security and welfare of the citizens of Maine. The Legislature and the Governor should require that the Office of Energy Resources update the Energy Emergency Plan annually until such time as petroleum embargo or energy shortages no longer pose potential threats.

2. To ensure that fuel oil supplies continue to be equitably distributed throughout Maine and that any complaints of supply curtailments can be handled rapidly, the Office of Energy Resources recommends the continuation of the fuel allocation program on a standby basis.

## 1-2 Petroleum Storage Reserve

### Background:

The United States has been preparing for another embargo by undertaking to create a Federally owned and operated National Strategic Petroleum Reserve Program. This program calls for the stockpiling of up to one billion barrels of crude oil which would be shipped to domestic and Carribean refineries in the event of an embargo.

### Issues:

The Federal Energy Administration and European Petroleum Storage Program indicate that a 90-day inventory of each petroleum product should be on hand to weather an embargo. The Federal Energy Administration argues that crude oil storage in the Gulf Coast states would provide a sufficient reserve against supply interruptions despite recognized limitations in domestic refining and transportation capacity. (For example, the U.S. has limited capacity to produce No. 6 residual oil). Transportation limitations include the provisions of the Jones Act (the Merchant Marine Act of 1920 as amended) which state that all U.S. Coastal shipping must be done under U.S. flags. Should an embargo occur, U.S. flag shipping may not be available in sufficient quantity to insure adequate and timely distribution of petroleum product to all areas of the country.

### Alternatives:

One method of preparing for a short term interruption of petroleum supplies would be to maintain high inventories of product in petroleum storage facilities in Maine,(this would include a sensible suggestion to homeowners that they increase the storage capacity of their fuel oil storage tanks to permit them to get through the winter without a "refill".) In our discussion paper on petroleum storage reserves, the Office of Energy Resources explores the amount of storage currently available for each product compared to the amount of consumption of that product in Maine. Although we do not receive adequate information on actual inventory level, adequate storage facilities are available for all fuel types except industrial residual fuel. This type of fuel is essential to the economic vatality of the State and Region. Alternative ways of meeting this potential storage deficiency are evaluated and include:

(1) The federal crude oil storage program as it currently exists;

(2) Creation of a regionally financed, regionally allocated reserve of #4 fuel oil;

(3) Creation of a federally financed reserve of No. 4 in the region;

(4) Creation of a state reserve with state funds.

### Preliminary Recommendations:

(1) The Office of Energy Resources should improve its ability to monitor the inventories of petroleum products held in storage facilities maintained by the private sector in Maine.

(2) The Office of Energy Resources concurs with the recommendation of the Federal Regional Council that the Federal Government establish a regional industrial fuel reserve within or near New England.

## 1-3 Strategies for Energy Conservation

Background:

It is estimated that up to 1/2 of the energy we consume in the U.S. is not converted to work but is wasted. Because of the thermodynamic laws governing energy and work, some of this waste cannot be avoided. We can, however, using more efficient machines and processes, substantially reduce the amount of energy wasted, without impairing economic growth or imposing hardships on any energy consuming sector.

On a national level, energy conservation, as a substitute for supply, may be as important as nuclear power, or our domestic oil and gas reserves.

(1) It can reduce the rate at which we are depleting our nonrenewable energy resources, thus prolonging the availability of their supply.

(2) It can free up capital currently devoted to exploration for, or purchase of, nonrenewable energy resources. This capital can be redirected somewhat toward development of the "ultimate" energy resources which mankind will need to sustain itself in the 21st century.

(3) It can soften the impacts of inflation and rising energy prices on consumers.

(4) It can reduce pollution levels and other environmental impacts by reducing the rate of fuel consumption.

In Maine, we have estimated that a sustained commitment to conservation programs could reduce our projected energy consumption level 16% by 1985. The programs discussed in the "conservation strategies" paper could significantly reduce the amount of energy wasted in Maine.

Issues:

(1) What is Energy Conservation? Energy Conservation as used in this document means the reduction of waste by improving end use efficiencies. Because there are many emotionally charged uses of the word "conservation" today, the term is in need of such a uniform definition.

(2) Why should people conserve energy? There are a variety of energy sources to supply our energy demands but without conservation those sources may not be adequate.

(3) What are the economic, political and social implications of an energy conservation program? It should be possible to undertake cost/benefit analyses of any particular conservation strategy as a beginning point in this assessment.

(4) What are our conservation goals, and how can they be attained? What can remain voluntary and what must be mandatory in order to be effective?

(5) How much energy can we save?

## Alternatives:

There are several categories of energy conservation programs which could be implemented in Maine. Within each category are a number of specific projects which can and should be undertaken by the Office of Energy Resources or other appropriate agencies.

(1) Educational Programs

  (a) A program for school systems to fit into existing science curricula.

  (b) An energy conservation awareness program for the general public.

  (c) General instruction programs (home winterization, auto maintenance etc.).

  (d) Instruction programs for specific clients, such as building managers.

(2) Technical Assistance Programs

  (a) An "energy extension service" program which would provide technical assistance on an individual or group basis. Such a program could be implemented using Maine's existing outreach agencies and could serve homeowners and business.

  (b) Development of systems (such as individual gas or electric meters) which would make individual tenants in apartments responsible for their own energy use.

  (c) Assistance in evaluation and rewriting of land-use plans so that residential and other development can proceed in a more energy conservative manner.

  (d) Promotion of "Retrofit" or energy conservation consulting companies.

  (e) Car-pool-Vanpool and Mass Transit programs to allow commuters an alternative to the private auto.

(3) Financial Assistance Programs

  (a) Tax incentives for conservation projects, including sales, income and property tax exemptions.

  (b) Low interest loans or grants for major conservation investments.

  (c) A winterization program for low income and elderly homeowners (presently in operation).

  (d) Improvement of the railway system by such means as subsidizing improvements in track and rolling stock, or by state or federal management of right-of-way.

(4) Regulatory Programs

- (a) Implementation of energy conservation building standards.
- (b) Changes in traffic codes and regulations such as:
  - (1) Right-Turn-On-Red-After-Stop,
  - (2) Permission of tandem trailers on limited access Highways,
  - (3) Better synchronization of traffic lights in some cases,
  - (4) Vehicle performance efficiency checks as part of the semiannual auto inspection,
  - (5) Vehicle registration fee system-based on vehicular weight, weight/engine displacement ratio, or other relative fuel economy indicator.
  - (6) Stricter enforcement of the 55 M.P.H. Speed Limit at least until such a time as the average fuel efficiency of vehicles improves at higher speeds.
- (c) Changes in electric power price structures to promote electricity conservation, such as "peak load"pricing, flat or inverted rate structure, marginal cost pricing either by pricing on the margin of production or by longterm incremental cost pricing, interruptable loads in all sectors.

Preliminary Recommendations:

(1) The Office of Energy Resources should continue its programs to promote opportunities for, and awareness of, voluntary energy conservation.

(2) The state should participate fully in the federal energy conservation programs under the Energy Policy and Conservation Act (PL 94-163) and the Energy Conservation and Production Act (PL 94-385).

(3) The state should institute an Energy Extension Service program to give technical assistance to all sectors. Such a program should be a combined effort of State Government, the University of Maine and the Community Action Agencies.

(4) The state should develop and enact energy efficiency standards for new buildings.

(5) Lighting standards should be developed and enacted for public buildings.

(6) The state should enact Right-Turn-On-Red traffic regulations.

(7) Energy efficiency standards should be established for purchases made by government at all levels. The concept of life cycle costing should be considered and implemented wherever feasible.

(8) The state and various transportation planning groups should establish programs to promote carpools and vanpools and the use of public transportation.

(9) The state, working with regional planning commissions, local planning boards and conservation commissions, should develop and provide information on techniques for including energy efficiency considerations in land use planning.

(10) The Office of Energy Resources should evaluate all potential energy conservation ideas and seek implementation of those which will bring about the greatest reduction of energy waste.

(11) OER and Bureau of Taxation should consider the possibilities for a small tax on energy consumption (above a certain minimum amount) to create a fund to be used for energy conservation assistance.

## 1-4 Mitigating the Impact of Energy Price Increases

Background:

As we have seen elsewhere in this report, energy prices have taken tremendous leaps in recent years. Consumption has not markedly dropped, however.

Unless a major, cheap new energy source is discovered, energy prices will continue to rise. For example, Alaskan oil costs $13.25/bbl. versus $8.03/bbl. for oil coming from older U.S. wells. New electricity from nuclear, coal or wood-fired power plants will probably cost from 4 to 10¢/KWH as compared with old hydroelectric power from completely amortized dams at 0.5¢/KWH or the nuclear power from Maine Yankee at approximately 1.2¢/KWH.

Since energy is fundamental to the production and distribution of goods, there will be a ripple of inflation through the economy each time energy prices rise. The Office of Energy Resources has calculated the following costs to the Maine economy of a 5% OPEC price increase:

TABLE - 31

THE COST TO MAINE OF 5% OPEC PRICE INCREASE

| | Distillate Oil | Residual Oil | Electricity |
|---|---|---|---|
| Commercial | $1,198,674 | $1,104,552 | $ 311,540 |
| Industrial | $ 107,201 | $2,170,152 | $ 560,714 |
| Residential | $2,041,426 | $ - 0 - | $ 582,040 |
| Total | $3,347,301 | $3,274,704 | $ 1,454,174 |
| Transport | $4,289,772 | | |
| Total | $12,365,951 | | |

Issues:

Some experts feel that without an allowed rise in energy prices, energy companies will not be able to raise the estimated $900 billion in capital needed for development of new energy sources.[*] Others feel that large energy corporations should not be allowed "windfall" profits[**] that the major oil companies should be "horizontally divested" of their interests in other energy sources and that the Government, through taxation, should develop a variety of new energy sources. Virtually all energy experts agree that the more expensive "alternative" energy sources will not be widely utilized until the price of "conventional" energy sources is allowed to rise. But where does this leave the individual citizens of our State, where sufficient home heat is essential for survival, and where the per capita income has historically been, and remains one of the lowest in the U.S.? What can be done for our hospitals, schools, theaters, churches, etc. which are having a hard time meeting fuel bills?

Alternatives:

One suggested means of assuring that rising prices are distributing equitably around the country is the pricing "trigger" system wherein price controls would be reactivated if price data gathered from the market place shows that a region of the country is experiencing undue price rises.[***] There is currently a "trigger" system in effect for the next 3 months on distillates. Price data from New England and mid-Atlantic states as a region is gathered and analysed by FEA.

However, trigger systems can only be viewed as short term solutions. Conservation and some fuel shifting is probably the best means available for businesses and institutions to cope with the rising costs of conventional fuels.

Several suggestions for programs to benefit individual citizens exist. These include lifeline electricity rates for residential consumers and small business, a "BTU Tax", or development of an energy stamp program similar in concept to our present food stamp program. A few areas have instituted lifeline and energy stamp programs; little data has been collected thus far, however, on the effect of such proposals, both in the consumption of energy and in alleviating the energy price burden. Efforts are now underway within the Office of Energy Resources and the Division of Community Services to evaluate the impact of energy price increases on Maine's low-income citizens and to specify areas where action needs to be taken.

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[*] An excellent discussion of this point is found in Raymond L. Golden's "Financing Tomorrow's Energy System", a paper delivered at the Third Energy Technology Conference, Washington, D.C., March, 1976.

[**] One of the perhaps unanticipated affects of decontrol and an increase in the price of other fuels could be the further penetration of U.S. Markets by foreign oil, leading to worsening import statistics and possible tarriff restrictions on imports. Such tarriff restrictions would once again disfavor the New England area, if we were still more heavily dependent on foreign oil than the rest of the U.S.

[***] There is also an allocation "trigger" to insure adequate distribution of available supplies.

### Preliminary Recommendations:

(1) Maine should continue to pursue a vigorous program of home winterization for the benefit of the low income and elderly citizens of the State.

(2) At this time, Maine should not oppose the decontrol of oil prices, but the State should recommend a "trigger" system for New England to assure that petroleum prices in Maine do not rise disproportionately as compared with national price increases. We would further recommend that the "Trigger" region exclude the Mid-Atlantic states which may tend to screen higher prices in New England.

(3) At this time, the Office of Energy Resources does not recommend immediate adoption of either lifeline rates or energy stamp programs. Instead, social assistance programs of all types should reflect realistic appriasal of current energy costs.

(4) The soon-to-be-completed experimental lifeline project for the elderly citizens of six communities should be evaluated to determine:

  (1) What effect the program has had on decreasing the electricity bills of the low income elderly.

  (2) What effect have lower electricity bills had on energy conservation.

  (3) Have these programs incurred any detrimental effect to other classes of customers, whether they be of the residential, commercial or industrial classes, and to what extent these other customers approve of the lifeline concept.

  (4) Whether such a lifeline program ought to be expanded, and in what way.

(5) The energy stamps programs in operation in the other parts of the country, as well as other programs with the aim of alleviating the energy price burden on the poor, should be examined by the Office of Energy Resources in cooperation with Community Services Administration, and evaluated with regards to their applicability to the State of Maine.

## 2. POLICY TOPICS SURROUNDING MAJOR ENERGY FACILITIES AND THEIR IMPACTS ON THE STATE.

General Comments:

Most of the controversy surrounding the establishment of large-scale energy facilities arises, we believe, from the following:

(1) Concern about the safety hazards and environmental damages associated with these facilities;

(2) An opinion that Maine should not undertake to supply significant quantities of energy for out-of-state users, since our environment would be "somewhat" damaged for "relatively little" economic gain;

(3) A desire on the part of some citizens to lead a more self-sufficient lifestyle.

It is beyond the scope of the Office of Energy Resources to make recommendations on the third point. Our chosen lifestyle may be fundamental to the eventual demands we place upon our energy supplies, but such deliberations are an appropriate effort for the Commission on Maine's Future and not the Office of Energy Resources. On the second point, we have little to say except that Maine's current position as a net importer of about 88% of its energy is frequently overlooked! However, working with other agencies, the Office of Energy Resources should be able to shed some light on the first point, namely on the risks and benefits associated with large scale energy facilities.

Most present day legislation, regulation and standard setting is based on intuitive balancing of risks and benefits. Analytical methods of quantifying risks and benefits are still in the development stages.*

The Office of Energy Resources feels that there are seven distinguishable questions which ideally should be answered separately before a decision is reached on the adviseability of any large-scale energy project in Maine.

(1) What are the scientific, technological and economic bases for assessment of the level of risks or beneifts?

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* A very good "State of the Art" review is the unpublished manuscript Status of Risk Benefit Analysis by Andrew J. Van Horn and Richard Wilson, Energy and Environmental Policy Center, Harvard University, November, 1976. This discussion owes much to that source.

While risk-benefit analysis borrows heavily from the economic techniques of cost benefit analysis, it has been slower to develop partly because of its multi-disciplinary nature and partly because its objective and subjective components can never be wholly separated. Latent and cumulative effects pose severe problems. For example, comparing coal and nuclear fuels for an additional power plant in Maine cannot be readily extended to a choice between energy systems on a larger scale; yet the national debate on these two fuels will have a marked impact on the decisions before us in Maine.

(2) What are the risks and benefits thus quantified?

(3) What are the relative probabilities of particular consequences?

(4) Can the risks be reduced (or benefits enhanced) and what will it cost?

(5) What is the distribution of risks and benefits (i.e. who will bear the risks and who will receive the benefits)?

(6) Is the distribution of risks and benefits fair?

(7) Is the risk acceptable?

The last two questions are outside the scope of risk benefit analysis, which cannot be viewed as a substitute for moral and political judgement, but merely a clarifying aid to those judgements.

### Preliminary Recommendations:

(1) The Office of Energy Resources feels that it is essential for the hearing proceedures of both the Public Utilities Commission and the Bureau of Environmental Protection to include cost-and-risk-benefit analyses of proposed major energy projects and their possible alternatives. The Office of Energy Resources should assist in the preparation and presentation of these analyses.

(2) Tax revenues from major energy facilities should be shared regionally or statewide. It is normal for a town in which a major industry is located to reap the tax benefits, but the liabilities and governmental service costs generated by the industry are often spread over a wider region. Tax benefits should be distributed to reflect the risks and service costs borne by surrounding communities and the State as a whole.

## 2-1 Energy Facility Siting

### Background:

A strong correlation exists between cost increases for energy facilities and time delays due to the regulatory processes involved in energy facility siting. For example, the next major power plant in Maine will have to obtain up to 25 permits from about 5 separate state and federal authorities, some of which have overlapping areas of regulatory jurisdiction. It is estimated that if all goes well, these procedures will take about 4 years to complete.

### Issues:

Are the States capable of assuming a greater share of the responsibility for regulation? If joint procedures are adopted, which level of government has supremacy? Should acceptable energy facility sites be pre-determined by the government, or should ad-hoc procedures continue? Should intervenors be allowed to obstruct the regulatory process by presentation of irrevelent testimony? What is irrelevant? Should generic hearings be held nationally on some issues? What are the best ways to expedite proceedures without sacrificing safeguards?

### Alternatives:

Many statements have been published recently about regulatory lags and regulatory delay, but specific proposals for improvement have been less easy to obtain.

In support of Maine's Coastal Planning effort, the Office of Energy Resources is evaluating the existing review mechanisms for major energy facility siting. The purpose of this study is to develop recommendations for improving and expediting the energy facility siting process in the coastal areas, without sacrificing the necessary protection of the coast which the existing review procedures afford. Much of the same information should be applicable to any geographic area of the State.

As part of the study, legislation passed by other states to resolve similar problems is being studied. In some cases, an institution such as a "facility siting council" which had been created to expedite precedures has actually caused difficulties of its own in the need for increased coordination with other elements of the State and Federal Governments. In other cases, new institutions seem to be working better.

### Preliminary Recommendations:

(1) The Office of Energy Resources feels that the State, by law or regulation, should establish a major facility siting process whereby the applicant would confer in advance with those agencies of State and local government who would have a direct or indirect interest in the proposal * for the purpose of ensuring that the final proposal submitted to the Board of Environmental Protection and the Public Utilities Commission would, to the maximum extent possible, be consistent with the goals and objectives of all parties. Care should be exercised in this process that the full rights of outside intervenors are not abrogated.

(2) Consideration should be given to the concept of eliminating the requirement for "title, right or interest" before review of major energy sites by the Board of Environmental Protection.

(3) In the review process for major energy facilities, the Office of Energy Resources recommends that approval of sites be separated from approval of specific plant design.

(4) Maine should advocate the passage of Federal legislation which would separate and clearly define the scope of authority vested in the various federal agencies involved in approval of major energy facilities. Further, clearer definition of responsibility between the State and Federal governments should be achieved, with a preference for state autonomy wherever possible.

(5) A major facility should be located only in a town or region in which the citizens have voted to accept it. The State bears some responsibility under law for seeing that a refinery or other major energy facility is well situated so as not to harm the environment. But the citizens of a town or region in which a facility is located must bear the immediate consequences of its development. Particularly in smaller Maine towns these effects on property values and ways of life can be quite substantial. The Citizens should, therefore, have the opportunity to vote either in a referendum or through their elected and appointed representatives on whether to accept major energy developments. **

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* Including, but not limited to: Office of Energy Resources, Department of Environmental Protection, Department of Marine Resources, Public Utilities Commission, State Planning Office.

** The Office of Energy Resources has not made a determination on whether such a referendum should be advisory or binding. We suggest that all these issues receive public discussion and debate.

## 2-2 Oil Refinery

### Background:

Some experts within the oil industry project a need for up to six new refineries on the East Coast, a projection substantiated by the Federal Energy Administration. Maine is an attractive location for these developments, and has of course been the location of several unsuccessful proposals in the past. In their November 1975 report, the Governor's Economic Advisory Committee recommended that oil refineries be included in the State's economic development plans.

This paper is intended to be a study of the characteristics of oil refining, including economic benefits and institutional constraints on development of a refinery in Maine. This paper is being developed jointly by the Office of Energy Resources and the Economic Planning Division of the State Planning Office as background information on potential costs, risks and benefits of an oil refinery.

### Issues:

Economic benefits of refineries include the direct employment aspects of construction, multiplier effects of that employment, long term employment and multipliers, potential petroleum product supply and potential tax revenue. Economic costs includes the requirement for "social overhead capital" including schools, road repair, and other governmental services. While it is difficult to quantify these costs and benefits without a specific refinery proposal in hand, the Office of Energy Resources feels that it should be possible to make some estimates based on the substantial and growing body of literature available.

### Alternatives:

There is a wide spectrum of positions which Maine could take with regard to oil refineries. Maine's position seems to be viewed by companies outside Maine as being somewhat ambiguous owing to the fate of refinery proposals received to date, although public opinion polls in Maine have indicated citizens support for refineries. * Very good thought and effort went into the 1972 Report of the Governor's Task Force on Energy, Heavy Industry and the Maine Coast. The major recommendations regarding oil refineries in that report were that oil development be confined to the Portland area; that a Maine Coast Industrial Development Corporation be established; and that the tax benefits of such heavy industrial development be distributed statewide.

### Recommendations:

The Office of Energy Resources recommends that an oil refinery policy be developed for Maine to assist State and Local officials in their efforts to attract such facilities. Elements of such a refinery policy might include the following as criteria for Siting and Operation (offered here for discussion purposes:)

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* For example, see"Citizen Evaluation of Public Policy in the Coastal Zone", Kenneth Hayes, Social Science Research Institute, University of Maine, Orono, 1975.

(a) Refineries should not be located directly [1] on the coast. The possible economic advantages of locating a refinery on the coast must be weighted against the jeopardy to this unique and valuable resource. One company weighed the economic pros and cons and proposed an inland site over a coastal site. An inland site appears to be preferable for social and environmental reasons.

(b) Any refinery applicant should have a clear plan for the training and hiring of Maine workers. In order to be of maximum benefit to the Maine workforce, provisions will have to be made to train local labor for jobs in both the construction and operation of the refinery. Measures will also have to be taken to offset the temporary dislocations that accompany any large construction project such as a refinery.

(c) Any refinery built in Maine should meet without exception current environmental standards. Through the efforts of the State Development Office, Maine should actively assist a refinery applicant whose proposal meets high standards to comply with the procedural requirements of our environmental laws. Maine has some of the most complete environmental laws in the nation. These laws provide a necessary public safeguard. Our clean environment and uncluttered landscape are attractive to many businesses and industries. Our environmental laws ensure that we will have only high quality energy development in Maine.

(d) Maine should encourage location of a refinery in the State only by those refiners who have (or have assurance of developing) wholesale or retail markets for petroleum products in Maine and New England. One of the benefits of a refinery, aside from the jobs it would create, could be a nearby supply of petroleum products. Maine theoretically could use about half the annual output of a 250,000 barrel per day refinery. In reality it would use a great deal less because of the presence of competing suppliers and the existence of delivery systems and contracts of long standing. The excess production could help meet the energy needs of the rest of New England. Meanwhile the refinery's in-state competitors might have further incentive to maintain a steady supply of oil products at reasonable prices in order to protect their markets.

(e) Petroleum transportation to and from a refinery should minimize risk to the environment. A safe transportation plan must be an integral part of any adequate refinery proposal.

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1. "Located directly on the Coast" means in a way that it would be readily visible from the shore line thus causing visual pollution. "Those activities that can only function through use of waterfront property or access to it must have first priority for inclusion in shoreland development." Maine Coastal Plan-Application for Financial Assistance from Federal Coastal Zone Management Act of 1972. Coastal Planning Group, State Planning Office, January 15, 1974.

## 2-3 Bulk Power Plants

### Background:

The Office of Energy Resources does not question the eventual need for additional electric generation facilities. At a minimum, replacements will be needed for old, inefficient, oil fired units. We predict, however, the need for more than just replacement facilities. A new Base Load Thermal Power Plant will not actually start operating until sometime after 1985. Resolution of debate on the type and scale of needed facilities must occur now so that electrical energy planning can proceed with some reasonable degree of certainty that such plans can be carried out.

### Issues:

For purposes of this discussion paper, we will consider that an additional bulk (approximately 1000 MWE) power plant will be needed in about 10 years. (Whether or not this assumption is correct will be treated in separate discussion papers). The foreseeable choice at this time for Base Load Elect Generation is between two fuel types, coal or nuclear. This paper will study the economics of existing coal and nuclear electric generating facilities and evaluate the constraints on projected coal and nuclear energy development in Maine. Physical, institutional, and financial constraints will be identified and, where possible recommendations will be made for alleviating these constraints.

Physical constraints to the future development of nuclear energy include uranium resource limitations, capacity limitations of the domestic fuel cycle industry, spent fuel reprocessing constraints and nuclear waste disposal limitations. Institutional constraints include the interrelationships of state and federal agencies and time delays which result from multiple regulatory proceedings. Financial constraints include the large capital costs of these facilities and the availability of this capital from traditional sources.

The institutional and financial constraints to future large coal fired power plants are very similar to those experienced by nuclear plants. ( The cost of electricity produced by coal has been much higher than the cost of nuclear electricity, although recent studies have seemed to indicate a convergence of these estimates.) Physical constraints include availability of coal in Maine (including transportation system limitations), limitations on disposal of waste products, and air-pollution hazards.

### Alternatives:

To have electricity available for the future, Maine must either develop new sources of generation, purchase surplus electricity from other sources, or use existing generation capacity more wisely. The use of wood for generating electricity at scattered locations in Maine, the possible importation of Canadian electric power if such power is available, and the use of load management to induce more complete use of existing generation capacity will be evaluated in separate studies.

Preliminary Recommendations:

(1) The Office of Energy Resources feels that all energy options should remain open and does not support legislation that would forclose the nuclear option.

(2) The Office of Energy Resources recommends that top priority be placed at the federal level on finding solutions to the current uncertainties of the nuclear fuel cycle, including fuel reprocessing and permanent waste disposal.

(3) The Office of Energy Resources should intervene to present testimony at Certificate of Public Convenience and Necessity Hearings for New Electric Generating Capacity Additions. Intervention should address generation plant options from the standpoint of optimal plant size to meet projected demands, lifestyle costs of the alternative facilities, and availability of fuel for the economic life of the plant, among other factors including risks and benefits.

## 2-4 Maine's Role as an Intermediary Supplier of Energy

### Background:

Maine is currently traversed by the Portland/Montreal crude oil pipeline. An application is pending before the FPC on a natural gas pipeline. There is much discussion about the possibilities of "wheeling" increased amounts of Canadian power through the State on its way to the more populous Northeastern areas. A large oil refinery in Maine would have a daily throughput approximately twice the aggregate daily consumption of petroleum product used by Maine. There has been speculation (although largely set aside by this time) that the Federal Government is eyeing Maine as a nuclear energy center site.

In all these cases, Maine would serve as a geographical intermediate between the source of energy and its destination.

### Issues:

This study, in the developmental stages, explores the probability of Maine as an intermediary for energy processed or stored in Maine or transmitted through the State. This type of energy development has widely varying degrees of potential as a source of energy for Maine depending on the particular project.

Several questions concerning such energy projects need to be explored. Since Maine's economy is highly dependent on the health of the U.S. economy, what is Maine's responsibility for the energy supply of the rest of the U.S. and how can we best fulfill that responsibility? If the State's air, land, and water resources are to be used for the transportation or storage of energy, should the necessary governmental expense to protect the public health, safety and welfare from potential adverse impact of these facilities come from general fund revenues or from revenue derived from these facilities? What avenues of taxation are open to the state?

### Alternatives:

Maine has several options for dealing with intermediary energy supply status. Maine can officially rule out certain types of development or can officially take no position and thus allow any type of development which can meet environmental laws. Other options include acceptance of development under state-specified conditions of location, and possibly obtaining added (dedicated or general) revenues through taxation. Some of these alternatives were studied prior to the institution of the Oil Conveyance Act, but laws passed in other states (such as severance and pipeline taxes) should be evaluated for their applicability to Maine.

Preliminary Recommendations:

(1) The Office of Energy Resources, in conjunction with State Development Office and Bureau of Taxation, should study the possibilities for taxation of energy products shipped through the state. The level of taxation should be high enough so that the net risks and costs of such development to Maine are equitably compensated, but low enough and stable enough so that Maine does not discourage such development.

## 3. TOPICS CONCERNING DIVERSIFICATION OF THE STATE'S ENERGY SUPPLY AND INCREASED USE OF NATIVE ENERGY RESOURCES.

General Comments:

Both goals implicit in this subject heading, diversification of energy resources and increased reliance on indigenous energy resources, make sense for the security and safety of Maine's energy supply. However, what is feasible to accomplish from the standpoint of economics does not begin to approach what is possible to accomplish from a technical standpoint. In this series of papers, strategies will be developed for increased use of indigenous resources or underutilized exogenous resources to enhance Maine's energy resource base. The reader should refer to Chapter 4 for background information on each fuel type.

In the appendix to this chapter is an interesting article which reports on a recent study of the current energy Research and Development activities of private companies. Among other things, the study shows that America is looking to government for leadership in the research and development of more costly and unconventional energy resources.

Preliminary Recommendations:

(1) Working with the University of Maine, the Office of Energy Resources should take a more active role in organizing Maine's colleges and Universities to pursue dilligently research projects which will lead to economic and environmentally acceptable ways to develop and utilize Maine's energy resources.

(2) The Office of Energy Resources should continue to pursue sources of federal and private funds and incentives for energy R, D & D projects and should continue to provide this information to all interested persons in Maine.

(3) The Office of Energy Resources should continue to provide public information on ways to utilize native energy resources.

## 3-1 Natural Gas

### Issues:

Will significant quantities of natural gas be available in Maine at competitive prices in the future? How long will remaining world gas reserves last at projected consumption rates? What would be the implications of a large Outer Continental Shelf gas find? What are the implications of relying on imported energy from a North African country? Is it feasible to gear up for gas consumption in Maine in the face of possible early depletion of remaining gas reserves?

### Alternatives:

Maine can obtain natural gas in the near future from at least three sources: (1) increased delivery of domestic gas through the existing pipeline to Southern Maine, and possible extension of that pipeline to other areas of Maine; (2) importation of gas from Algerian LNG through the St. John-Albany pipeline, and (3) potential gas finds from OCS exploration off of the Maine coast. The first alternative is unlikely in view of rapidly depleting domestic gas reserves, unless Gulf Coast methane deposits are tapped. The second alternative would place Maine in the position of again relying on uncertain energy supplies from a potentially unfriendly nation, a situation which we are attempting to correct now with respect to our petroleum imports. The third alternative is uncertain until potential resource deposits are found and quantified. The remaining alternative is to not rely on gas supply to Maine in the near future and to plan to meet our needs without it, utilizing more dependable energy resources while leaving open the option of using gas when adequate secure supplies at competitive prices become available. To the extent that natural gas may be utilized, it would assist in diversifying Maine's energy resources and reducing air pollution levels.

### Preliminary Recommendations:

(1) Natural gas should be retained as an option to satisfy limited energy needs for special applications (such as feedstocks for chemical manufacture, or to maintain air quality in urban areas) where other energy resources are less suitable or entirely unsuitable.

At this time it looks like Maine should not plan on relying heavily on natural gas.

## 3-2 Coal

Issues:

Should coal utilization be expanded in Maine? To what extent and for what purposes? What is the long term outlook for coal availability and delivery to New England and to Maine? How should the environmental issues be resolved? What are the economic, social, and environmental trade-offs with coal as opposed to alternative fuels?

Alternatives:

No thought is being given in Maine, or anywhere else to our knowledge, to increased coal use for residential or commercial consumption, and certainly not for transportation (except as converted through a costly liquefaction or gasification process. See appendix to this chapter for tables on costs of various ways to use coal.) The only logical end uses for coal are in relatively large industrial boilers, where it could supplant or complement heavy residual fuel oils, and in Central electric generating plants, where it could supplant or complement the heavy residual fuel oils or nuclear fuel. For Maine, this means potential use of coal in our limited heavy industry, primarily by the paper mills, and to fuel future growth in base load electrical generation as an alternative to nuclear generation. There is no question that there would be environmental penalties associated with increased use of coal and possibly economic penalties as well, but these penalties must be weighed against potential benefits, including the following: (1) On the consumption end of the fuel cycle, coal burning may be more labor intensive than either petroleum or nuclear energy and therefore, could provide more permanent jobs. Overall economic benefits to the state via increased tax revenues from the railraods and personal income taxes as well as perhaps a small reduction in unemployment and welfare costs, could partially offset the higher energy costs. (2) Increased use of coal would help to diversify the state's energy resource base, and reduce our dependence on imported foreign petroleum. (3) Increased use of coal would help to further the nation's goal of independence from foreign energy sources. (4) Increased use of coal in the near term would "buy time" for the development of cleaner and more abundant ultimate energy resources. (5) Coal burning is relatively compatible with the burning of other solid fuels, such as waste wood, municipal solid waste, and sewage sludge, and could thus aid in the solution of problems associated with their disposal. (6) With proper environmental controls, coal burning plants can be located close to urban centers, thus reducing transmission losses. Coal burning plants can be better integrated with the cogeneration concept, or with district heating to improve the overall efficiency of fuel utilization, reducing the environmental impacts and inherent energy waste of large scale heat rejection.

Preliminary Recommendations:

(1) Coal use should be expanded in Maine for heavy industrial and electric generation end uses, with proper and adequate enviromental safeguards. If the economics prove feasible, for the next large, base load thermal electric generating station to be built in Maine, serious consideration should be given to a coal fired unit between 600-800 MW capacity.*

(2) Studies should be made and technology developed to integrate coal burning for industrial and electric generation uses with the burning of waste wood, municipal solid waste, and sewage solids. The state should support and encourage pilot facilities using these fuels.

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* Note that the economics of the coal option might be enhanced by building on twin units and exporting some of the power. This would result in roughly the same amount of exported electricity as from a large nuclear plant. Obviously, a great deal of analysis needs to be done to compare the coal and nuclear options in Maine.

## 3-3 Canadian Electric Power

### Issues:

Is it in the mutual interest of both the U.S. and Canada for the latter to develop its hydroelectric power resources for export? How much should be developed, and for which U.S. customers? (Maine would probably make a small contribution to the demand). Who should pay the cost of development? What would be the allowed time-frame of a purchase contract? Would such a contract be honored even if Canadian demand for the power grew unexpectedly fast?

What would be the cost of the power? Would it be a real "bargain," or would it be priced at the cost of alternative U.S. sources? How about the objections voiced by U.S. workers concerned with loss of potential job opportunities? Will there be objections to an outflow of U.S. dollars? Is it better to have dollars go to Canada or to OPEC? Will there by an increase of Canadian environmental objections to large scale energy projects?

### Alternatives:

Since Maine's demands could not be expected to be sufficient within this decade to cause, by themselves, the construction of a major Canadian energy facility, it makes sense to explore the possibilities of Canadian power in concert with other New England States and possibly with States beyond this region, such as New York. There are a number of alternative sites for consideration; Tidal Power from the Bay of Fundy, James Bay, Churchill Falls.

There is also the possibility of purchases from existing Canadian facilities (as we saw in Chapter 3, some of these purchases are already planned).

Alternatively, Maine could choose to discourage imports of energy from Canada and choose to concentrate instead on development of its own resources.

One fact is seldom mentioned in the discussions about Canadian power is that the Canadian utilities are by and large public power authorities and thus more or less under the control of the Provincial Governments. In Maine and most of New England, power is generated by private companies. Thus, undertaking meaningful planning and negotiation between Maine and Canadian Provincial power authorities requires the close cooperation of the Maine utilities and State government, as well as NEPOOL, the Northeast Power Coordinating Council, and the other New England States. Of course, it is also adviseable to undertake any such discussions with the cooperation and understanding of the federal authorities as well.

Preliminary Recommendations:

(1) A continuing dialogue should be established between Maine state government and the Maine private power companies to explore opportunities for further importation of Canadian electric power.

(2) Maine should continue to be an active participant in the deliberation of the New England Governors/Eastern Canadian Premiers Energy Committee.

## 3-4 Wood

Issues:

Wood is a plentiful, renewable, and relatively inexpensive energy resource in Maine.

There is a popular opinion that the use of wood for an energy resource puts energy into competition with other potential end uses, such as lumber, furniture and other wood products, and pulp for the paper industry. Such competition should be avoidable however, as different grades and species of trees are most useful for different applications, and waste products from all other end uses can be utilized as fuel.

Large quantities of waste wood products (bark, sawdust, slabs, chips, shavings, limbs, branches, leaves, needles, etc.) are available from other wood consuming processes. How much more wood can Maine consume for fuel than is being used currently? How much impact, if any, will increased wood consumption for fuel have on wood prices for other end uses? What types of trees should be used for each purpose? How much wood is available for energy as raw wood? As wastewood? What are the best systems for using wood for energy? Direct use? Intermediate conversion to electricity? To gas? To methanol? To charcoal? What will be the impact of wood production for energy on Maine's forest resources? On Maine's enviroment? On Maine's economy?

Alternatives:

There is little doubt that wood can and should contribute more to Maine's total energy use than it currently does. Wood is an attractive alternative to oil, coal or nuclear electricity generation; to direct use of oil or coal for home heating, cooking, etc.; and even, when converted to methanol, to gasoline and diesel fuel for transportation. The energy value of wood lost from production due to flooding of 88,000 acres of forest land has been presented as one argument against the proposed Dickey-Lincoln hydroelectric project. Wood is also a viable alternative as a backup fuel to solar space heating systems, as in being demonstrated by the new Maine Audubon Society building in Falmouth.

The most energy efficient method of using wood is by direct burning for residential and commercial space and water heating, cooking, and industrial steam production. Intermediate conversion to electricity, gas, or liquid fuels entails some losses and lower overall energy efficiency. However, some end uses, such as transportation, are not suitable for direct use and intermediate conversion is required, even with an efficiency penalty.

Recommendations:

(1) Thorough analysis should be undertaken to evaluate the overall availability and enviromental impact of greatly increased use of wood for energy. Such analysis should include determination of the production capability of Maine's forest with proper management, and any potential

price impacts on the wood resource that may result.

(2) The concept of "energy farming", or "energy plantations" (growing trees in designated areas solely for use an an energy resource) should be explored further to determine the economic viability in Maine for such systems on a small scale.

(3) Efforts should be increased to improve woodlot management practices, particularly by small woodlot owners. Successful pilot programs for coordinating fuelwood buyers with fuelwood sellers should be expanded statewide.

(4) High priority should be placed on the development of efficient, safe, and inexpensive wood combustion equipment for home and institutions.

(5) Consideration should be given to allowing a higher rate of return (or exemption entirely from public utility status) for an experimental (up to 60 MW) wood-fired electric generating station whose electricity is to be distributed through an existing utility.

## 3-5 Solar Space and Water Heating

Issues:

Solar energy is presently not attractive to most Maine citizens for the following reasons.

(1) Solar energy systems initially cost more than conventional energy systems. Because of our cold weather the storage component of the system can be even more costly here than in other parts of the U.S.

(2) Maine lacks sufficient personnel trained in solar installation and maintenance.

(3) There exists buyer uncertainty associated with solar systems and the solar industry.

(4) Solar considerations are absent from conventional construction projects, regulations and zoning laws.

(5) Because solar energy systems in Maine cannot supply 100% of a buildings hot water or space heating needs, a conventional backup system such as wood, oil, or electricity is necessary.

Alternatives:

There are numerous methods of dealing with the emergence of solar energy utilization in Maine. The State can take no part at all in this endeavor or can assist it by providing tax incentives, research monies, low interest loans, and educational programs, among other things. Some of the alterations available are actions which could be taken by the Office of Energy Resources, such as dissemination of information on solar energy and investigation of the consequences of various backup systems.

Other actions could be taken by the Office of Energy Resources in cooperation with other agencies or organizations (including local units of government). These would include organization of housing design competitions and demonstrations, improvement of solar education in institutions and among the general public; adoption of building codes and zoning ordinances which provide protection and encouragement for solar energy; and additional changes in Federal research priorities.

Still other actions would require legislation such as tax incentives favoring solar energy systems; provision of loan guarantees and subsidies for use of solar energy systems; requirements that government consider use of solar equipment to conserve fossil fuels and provide an example for the private sector; certification of solar equipment manufactured in Maine; and a guarantee of "solar rights."

Preliminary Recommendations:

(1) Office of Energy Resources should continue to evaluate the cost effectiveness of solar energy systems in Maine and should develop a plan to encourage institution of solar energy as it becomes economic.

(2) The federal government should legislate tax credits for the purchase of solar energy equipment until the technology becomes widely accepted.

(3) Consideration should be given to the exemption of solar devices from Maine property and sales taxes.

(4) Buildings should be designed and constructed to accommodate solar heating equipment as it becomes economical in the future.

## 3-6 Wind

### Issues:

There is potential for wind energy in Maine although it is not economically competitive with existing technology and available systems. Technology improvements and expanded production facilities should improve the economics in the future. However, adequate storage and/or back-up systems are needed to deliver energy when the wind is not blowing. Should development of wind systems concentrate on large scale facilities for utility-type systems to use, or should smaller scale systems for individual use be developed? How can the unreliability of wind energy availability be best resolved? What type(s) of storage and/or back-up systems should be used? How can the economics of wind systems be improved, and when will they become competitive?

### Alternatives:

As a nonpolluting, renewable, free, and universally available energy resource, wind has much appeal. The unreliability of delivery is the biggest disadvantage as it adversely effects the economics of the system and the back-up/storage requirements. Wind is an attractive supplement for fossil fuels, nuclear energy, hydro development, and wood utilization, especially for certain remote locations. It is even being considered (albeit perhaps light-heartedly) as an alternative energy resource for transportation via sail powered automobiles and the revival of the "golden age of sail", with venerable clipper ships updated to utilize modern technologies.

### Recommendations:

(1) Continue to work with inventors, private entrepreneurs, and utilities to encourage the design and testing of experimental wind systems.

(2) Consideration should be given to the exemption of small scale wind generation equipment from sales and property taxes at least for a period of time while wind energy is still in the experimental stages.

## 3-7 HYDRO POWER

### Issues:

Many uncertainties exist over the further development of hydro power in Maine. The economies of hydro power as opposed to alternative energy sources is uncertain because future trends in cost for alternative sources are uncertain. Projected costs of oil, coal, and gas, as well as nuclear construction cover a wide range of possibilities, depending upon who is generating the cost estimates and for what purpose(s). If costs of these alternatives continue to rise as they have in the recent past and are expected to continue to do for the near future, then hydro development will again become economically attractive. But a limitation will still exist as to the amount of hydro capacity that can be developed and the energy that can be provided by hydro power.

When hydro power is economically attractive, the next issue to be resolved is its environmental impact, and particularly its impact relative to available alternatives. Environmentally, although hydro development may inundate extensive tracts of productive forest land, it would still seem generally preferable to oil, coal, or nuclear as an energy source, because it is cleaner, renewable, and the "fuel" is not generally subject to escalating costs.

Another issue in the development of hydro power is the question of whether it should be developed for use in Maine, or for export to other New England states and other NEPOOL member companies than those located in Maine. The plans for development of the Dickey-Lincoln hydroelectric complex by the Army Corps of Engineers, and the transmission and marketing studies by the Department of the Interior, provide for exporting the majority of the power generated to southern New England. Much of the controversy that arises in discussion of the Dickey-Lincoln project centers on the question of perceived despoilation of Maine's precious natural beauty and resources to satisfy southern New England power demands.

### Alternatives:

There are a number of options available in Maine's energy future that include hydro power as one alternative. The first option is to slow the rate of growth of energy consumption, and particularly electrical energy consumption, so that no major new generating facilities are needed before 1985. This result may be attainable via load factor improvement (meaning greater growth in off-peak electrical consumption than in on-peak consumption), strict conservation measures, and efficiency improvements in end use (such as by use of more efficient appliances, lower lighting levels, etc.). All of the available options for reduced electrical consumption growth rates involve a conscientious and cooperative effort on the part of utilities, residential, commercial, and industrial users. To date, a slower rate of electricity growth has not been observed in Maine.

In spite of the best efforts to conserve energy and slow growth, new capacity additions will eventually be needed. When they are, hydroelectric facilities for use by Maine consumers would be preferable to most of the other available alternatives.

Recommendations:

(1) If economically feasible, hydroelectric development for energy supply to Maine consumers should be given priority consideration over other available alternatives. Maine electric utilities should be encouraged to develop some of the available hydro sites lying within their service areas. A good candidate for early consideration might be the 120 MW Cold Stream site by Central Maine Power Company.

(2) The potential for increased storage of spring runoff waters should be evaluated by the Water Resources Planning Program. Such storage increase could yield at least three major benefits to Maine:

    (a) Increased availability of fresh water supply to Maine communities;

    (b) Reduced exposure to flood dangers in low lying areas and river valleys; and

    (c) Increased energy output from existing and future hydroelectric facilities, possibly improving load factors to the point where facilities now regarded peaking could become intermediate or base load generating facilities.

(3) A pilot project should be undertaken to revitalize one or more of Maine's existing very small hydroelectric dams. Studies leading up to such a project should define construction work needed to maximize efficiency, describe ways to minimize costs, suggest realistic methods for overcoming constraints such as "ratchet" charges*, define appropriate means for integrating with the grid for reliability purposes, and accurately define the market for the power as well as the management authority for the project.

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* See discussion of cogeneration, page 47 - Chapter 5

## 3-8 MUNICIPAL AND INDUSTRIAL SOLID WASTE

Issues:

(1) Lack of concentrated waste volumes

The generation of waste within the State is very diffuse. Only five areas of the State (Greater Portland, Lewiston-Auburn, Augusta-Waterville, Greater Bangor, and Northern York County) have sufficient waste volumes to make energy recovery a viable possibility from the standpoint of an efficiently scaled operation.

(2) Economic problems

The "opportunity cost" of the available alternatives for solid waste disposal is generally much lower in Maine than the cost of the energy recovery option.

(3) Technological problems

Although the technology for burning municipal solid waste is known, there are some problems with applying that technology to supply existing energy demands. Examples of these problems may be drawn from the experiences of some paper companies in Maine, burning waste wood in so-called "Hogged Fuel" boilers. Violation of air standards, inability to operate in winter, and lower than anticipated BTU output have been some of the obstacles they have encountered. New types of waste inceneration systems may provide answers to these problems.

Alternatives:

There are essentially two ways waste materials can be used to supply energy, by direct combustion or by being processed into "refuse derived fuel" which can be burned like coal. The fuel value of the waste is currently being used elsewhere in three basic processes:

(1) To supply steam for electric generation in either public utility power plants or for private industrial electric generation facilities.

(2) To provide process steam for industry, or

(3) To provide steam for space heating in closely developed urban areas.

An alternative to the direct use of waste materials as a combustible fuel is its use as a feedstock for the chemical industry. Through a process called "pyrolysis" the waste can be broken down and the different chemicals contained in the waste can be extracted. This process is as yet very expensive and untested on a full scale operation.

There are several alternatives for utilizing municipal solid waste or a combination of solid waste and wood waste.

(1) Wastes could be collected at central receiving points within the State and processed for direct heat recovery (incenerated) or processed to allow later utilization as fuel (as RDF or as the gaseous and liquid products of pyrolosis).

(2) Small incenerator/boiler units could be set up, perhaps at the sites of local or regional industrial parks. Such units could provide all or part of the energy needed by the industries in those parks. Shopping centers offer an attractive opportunity for institution of such systems.

(3) Existing industries and electric utilities could be encouraged, through tax incentives or subsidies, to install equipment which would allow the use of raw refuse or refuse derived fuels for a primary or secondary fuel source.

Recommendations:

The Office of Energy Resources and the Department of Environmental Protection should encourage the construction and operation of municipal solid waste energy recovery facilities in those areas of the State where this option appears to be economically viable. Such a project should be sited close to an existing industry or industries which could use steam for industrial processes. A State program in this area could include:

(a) Technical assistance to municipalities and/or industries in setting up an energy recovery system.

(b) Financial assistance to municipalities to set up such systems (possibly through the Federal Solid Waste Recovery Act).

## 3-9 TIDAL POWER

### Issues:

The technical feasibility of tidal power has not been demonstrated to everyone's satisfaction and problems may still remain. Not the least of these is the development of suitable materials that will withstand permanent immersion in corrosive salt water and resist biofouling.

The economic competitiveness of tidal with other forms of power has also yet to be clearly demonstrated. Most proposals for tidal development involve the construction of massive dikes to create tidal pools. Controlling flows into and out of those pools during tidal cycles is the basis for tidal power development. However, the dikes must reach up from the ocean floor to harness comparatively modest tidal heads, and they must span long distances to enclose whole tidal basins. The construction of such dikes involves huge amounts of fill and may, in addition to their expense, have harmful effects on marine species, particularly bottom dwellers such as lobsters, crabs and scallops; intertidal species such as clams, and migratory species such as Atlantic salmon.

The cyclical nature of the tides means that power may be available for relatively short durations (perhaps 3-4 hours during each of the four daily incoming and outgoing tides). Also, the energy is not frequently coincidental with the periods of highest demand, owing to the difference between solar and lunar cycles of about one hour each day. Filling in the periods when tidal power is not available may mean the construction of auxiliary generating facilities (perhaps hydro or thermal).

How much tidal power is available at Passamaquoddy Bay? Can it be economically developed? Is it technically feasible? What are the potential environmental impacts? Can potential conflicts between tidal power and refinery development be resolved? Will the future costs of other ways of generating electricity make a tidal project competitive on a life-cycle cost basis?

### Alternatives:

There are many alternative ways of designing a tidal power project. Studies are soon to be completed by the Stone and Webster Engineering Company under contract to ERDA. Several alternative designs are being evaluated. There is also the possibility of building a small tidal project as a demonstration to test the characteristics of low-head turbines. The originally proposed Passamaquoddy project is probably on too large a scale and too unique to be considered as a demonstration project.

Preliminary Recommendations:

(1) Further consideration of tidal development as an energy alternative for Maine should await release of the ERDA study of tidal power.

(2) If eventual (within 30 years) technical and economic feasibility can be demonstrated for tidal power by life cycle cost calculations being undertaken in the Stone and Webster study at Maine's request, then the Passamaquoddy Tidal Power site should be retained intact as an option for future energy supply to Maine.

(3) ERDA should plan to sponsor a Worldwide Tidal Power Conference jointly with the Atlantic Provinces Tidal Power Review Roard in the Spring of 1977 when the tidal studies of both countries are completed.

# TOPICS CONCERNING THE CHANGING
# NATURE OF ELECTRIFICATION

## 4-1 Co-Generation and Co-Location, New Applications of Old Institutions

### Background:

Co-generation of electricity and Co-location of generating and consuming facilities are not new ideas. There are new applications of these ideas which are of value due to the need to achieve higher efficiencies of energy use.

Co-generation of electricity means that a commercial or industrial facility generates electricity for itself at the same time it provides heat for process use or space heat. For any single user of electricity, co-generation allows higher levels of efficiency to be derived from the energy source. In Maine, a number of firms generate their own electricity and provide process steam or space heat from the "waste" energy.

Co-location means the generation of electricity or steam in one building for sale to other users in close proximity to the point of generation. For example, West Germany and Sweden are developing central district heating utilizing electric or steam generation and steam distribution to locations in proximity to the plant. Maine potentially could also provide for co-location of electric generation plants near municipalities, fired by municipal solid waste and wood or coal, and providing steam or hot water to other facilities located in an industrial development district. Developing the concept and bringing that energy source into reality will take time, planning, and foresight.

### Issues:

Co-generation and Co-location of facilities are technically feasible, but several constraints limit application of these techniques. The constraints include energy prices, institutional limitations, and inertia.

Electricity prices have been declining for years and pricing techniques used by utility companies have encouraged both increasing use of electricity and increasing concentration of electric generation. Because of economics of scale from larger generating plants, electricity could be offered at relative declining prices in the 1950's and 1960's. However, with today's rising electric energy prices, it is becoming increasingly economic for industry to generate its own electricity.

Institutional limitations upon development of co-generation and co-location exist but are not insurmountable. One impetus to the development of co-generation might be development of "peak load" or "time of day" pricing although data collected recently by CMP indicates that at least in Maine, the opportunities for shifting off-peak may not be very great. A second impetus would come from the elimination or modification of "ratchet" charges. The ratchet charge is a surchange on customers who buy power only occasionally. Assume that a manufacturing plant satifies all its power requirements from co-generation during 11 months of the year but must buy power during the 12th month from a utility. The utility will then charge the plant not only the cost of one month's power but will for the next 11 months charge the plant the equivalent of 80% of the cost of the power used during that one month. There is an understandable reason for the ratchet charge, in that the utility must plan expensive capacity to satisfy its peak load, whatever the origin of that peak. Third, the utility purchases excess electricity from industrial firms in Maine at "dump rates." Assuming the same manufacturer would sell, from time to time, power generated by his facility in excess of his actual needs, the utility would buy such excess power at a rate of $0.0036/kwh. Were excess power sold to the utility on a constant basis, the utility would pay $0.006/kwh. These low prices reflect, to some extent, the general unreliability of the source. A fourth problem which might hinder efforts to increase the extent of co-generation in Maine is the fact that an electric generating facility with power to sell to the public (or wholesale to an electric utility) usually is considered a public utility itself and is thus subject to control by the PUC. The reason for this is obviously that true control of retail prices is impossible without control of wholesale rates. If the power produced in a co-generation facility were available more cheaply than power produced by centralstation generation, it would appear intuitively correct, that the PUC would not pose a serious obstacle to the operations of such a facility. Nevertheless the fact ramains that companies who are not experienced in the utility business are reluctant to undertake an additional, unfamiliar regulatory procedure.* The best opportunities for a co-generation situation which would avoid this regulation would probably be a cooperative activity among a small number of customers, but each situation must be decided on its own and generalization is difficult.

## Alternatives:

Co-generation and Co-location of facilities are two possible elements of a necessary trend toward higher efficiency of electric generation. The alternative to instituting either of these two methods is to retain the present trend toward central station generation with the hope that greater efficiencies can be realized. Co-generation and co-location are probably not of themselves sufficient to permit the elimination of central stations altogether.

## Preliminary Recommendations:

(1) The Office of Energy Resources should evaluate the opportunities and constraints for co-generation in Maine.

(2) The Office of Energy Resources should work with the State Development Office and State Planning Office to provide information to industrial parks and regional planning commissions on co-location of facilities for electric generation and provision of heat.

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*Worthy of note is the fact that if the wholesale power is sold to a utility which engages in interstate commerce, the wholesaler might also fall under FPC jurisdiction.

(3) Consideration should be given to increasing the rates which utilities pay to industries for power fed into the utility grid.

(4) Consideration should also be given to modifications in the "ratchet" charges now levied on infrequent utility customers who generate their own electricity or electricity for sale through the grid.

## 4-2 Current Operations of the Electric Utility Industry

### Background:

Several interrelated characteristics of present utility structure bear evaluation for their impacts upon Maine. Electric rate structures, the proportion of reserve margins to total capacity, the method used to forecast growth rates and techniques available to manage growth all need to be addressed as methods to conserve energy resources for the future. At present, the protagonists of different viewpoints engage in an adversary process requiring quasi-judicial proceedings. Clearly, improved communications between governmental decisionmakers and utility planners needs to occur to allow a dialogue on energy issues, particularly selection of energy facility sites, load forecasting and rate structure.

### Issues:

At issue are the interrelated characteristics of electric energy pricing, returns on invested capital and need for capacity investment. These three characteristics constitute a cycle which crudely describes the present electrical energy marketing situation. The question which must be raised is whether any of several alternative approaches will leave Maine in a better or worse porition to face an energy future. Alternate electric rate structures need to be evaluated for effect upon company revenues, energy conservation and load growth. Rate structures which reduce KWH energy sales while not reducing system peak or the growth rate in system peak will not serve to limit long run cost increases, even though temporary reductions in total costs to consumers may occur.

The institution of load management techniques in Maine is essential but must be based upon evaluation of costs and benefits in both the short and long run. A necessary predecessor for the proper evaluation of load management is an understanding of system load characteristics; (in short, a load study).

The relationship of reserve margins to total demand must be analyzed. Reserve margins are extra capacity held in case of emergency to ensure system reliability. The higher the reserve margins (about 22% of capacity is considered adequate) the more it costs consumers to maintain reliability. If reserve margins are lowered, less expense occurs but presumably reliability is also lower.

Adequate forecasting of electric load growth is essential to project needs for capacity additions in a timely manner. It is important to maintain accurate forecasting of electric energy demand because the electrical industry is extremely capital intensive. Too high a forecast results in overcapitalization and over investment and, consequently higher rates than necessary. Forecasts too low would mean insufficient capacity on line to meet demands and could mean potential brownouts or blackouts.

### Alternatives:

Presently, utility rates follows the general format of the declining block rate schedule. Alternative rate structures include flat rates, peak load pricing on either a time of day or seasonal basis, marginal cost pricing, and lifeline type of rates.

Presently, utilities have instituted almost no techniques to try to manage system loads. The theory developed over the previous 50 years to describe an electric utilities function is that electricity must be provided upon demand and in the quantities demanded for each and every user. The alternative to this theory and practice is to institute physical controls upon the quantity of electrical energy used or to provide means for the utility company to control selected uses of energy. For example, one load management technique involves the use of a control device on electric hot water heaters to allow the utility company to turn off the heaters for short periods of time and reduce system peak load.

Electric reserve margins are a response to the 1965 blackout in the Northeast. Presently, reserve margins for New England are about 45% rather than the suggested 22%. More importantly, some fundamental questions have to be asked about what causes a requirement for reserve capacity, and whether there are alternative means of providing for electric system reliability.

Electric load forecasts are presently based upon extrapotation of historic trend. These techniques are adequate for short term forecasts of 2 to 3 years but are not extremely accurate for intermediate (5-10 year) forecasting. Alternative forecasting techniques are available and should be evaluated for applicability to Maine. Growth in electricity consumption has received a strong impetus from recent price increases for competitive fuels. Consequently, the need to accurately forecast electrical energy growth and to develop a process to guide that growth towards the most effective use of generating capacity is important.

Recommendations:

(1) The Office of Energy Resources should develop more adequate forecasting tools to evaluate future demand for electric energy and for new generating capacity.

(2) The Office of Energy Resources should evaluate the effectiveness of potentially institutable load management techniques.

(3) The Office of Energy Resources should evaluate the effects on energy demand and capacity demand of alternative rate structures.

(4) The Office of Energy Resources should evaluate the effects of accounting provisions such as the investment tax credit and construction works in progress (CWIP) upon the long run customer costs.

(5) The Office of Energy Resources shall provide expert testimony to the Public Utilities Commission on matters affecting the electric and gas utility industry.

(6) Maine should take part in a regional effort to adequately evaluate NEPOOL forecasts, forecasting methology, cost effectiveness and impacts for utility pricing alternatives, and load management techniques.

(7) The Office of Energy Resources should maintain a dialogue with electric and gas utilities to ensure periodic review of industry plans, forecasts and forecasting techniques. This dialogue should possibly take the form of a regular public informal review session.

## 4-3 Public Power

### Background:

Maine dealt with one type of a public power proposal in a referendum on the Power Authority of Maine. In fact, there are numerous forms in which publically owned utilities may function, ranging from public condemnation of investor owned utilities as occurred in New Brunswick to institution of small municipal electric or steam generation units using municipal solid waste. This study will evaluate the benefits and costs to Maine of instituting any particular mode of publically owned or funded energy projects.

### Issues:

Development of sufficient financial support to provide for needed expansion of electric generation facilities in Maine is an important element of Maine's Energy future. An important financial advantage of government ownership and operation of electric power systems is their exemption from income taxes and their ability to sell bonds, either general obligation or revenue bonds, the interest on which is tax exempt to the recipient. Government owned utilities also are exempt from local property and sales taxes; but in many cases they make payments to the local taxing jurisdiction in lieu of taxes. As a consequence, government power systems have the financial advantage of (1) no federal income taxes on income (2) lower cost debt capital through the issuance of tax exempt bonds, and (3) lower property taxes to the extent that offsetting payments are not made to local jurisdictions. All of these "savings" constitute a portion of total revenue requirements of investor-owned utilities and other private corporations.

These "savings" are not real economic savings for society as a whole, but merely a transfer of tax burdens from one group of taxpayers to another. For what state and municipal power systems do not pay in taxes to the federal government and other taxing jurisdictions must be paid by individuals, property owners, and other corporations. In this sense, the tax exemption accorded public power systems is a subsidy of one form of ownership by others.

### Alternatives:

A substantial range of public ownership methods are potentially available to provide energy facilities in Maine. Each alternative method has implications for employment, taxation, land and water use, utility regulation, and energy prices. The opposite ends of the public power question are investor ownership and operation versus government ownership and operation. In between these extremes are a number of alternatives which may bear investigation.

### Recommendations:

(1) That the Office of Energy Resources evaluate the economic, social and legal aspects of instituting publically funded energy facilities in Maine.

# CHAPTER V - PART 2

## REGIONAL POLICY

The State of Maine is inextribly bound in its energy use to dependence upon other states and nations. Maine, as a part of the New England region, is subject to the same price impacts of OPEC, the same benefits and costs of electrification policies, the same impacts of the vagaries of Federal policy. Recognizing that a community of interest exists in the Energy field Governor Longley signed the New England Regional Energy Policy in November 1975.

The New England Regional Commission * finalized a policy setting priorities for future energy use in New England. The region of New England is prepared to commit itself to the development of a more nearly balanced mix of energy production capabilities, including nuclear power facilities hydroelectric and other indigenous resources, domestic oil and gas resources, and the use of coal and laternative fuels. To that end (the region) has established fuel use goals to be achieved during the next decade to reflect that balance and to reduce the regions dependence on oil by one fifth.

The regional policy deals with six areas (1) Energy Conservation (2) Nuclear energy (3) Outer Continental Shelf Development (4) Coal conversion (5) Hydroelectric and other indigenous resource development and (6) Alternative energy sources -- research and development. Excepts from each of these policy areas follow: **

(1) Conservation

The regional is committed to a continued effort of conservation in a systematic and concerted manner. The establishment of strong quantitative goals and a comprehensive implementation plan commonsurate with respective state capabilities will have the highest immediate priorities within our region.

(2) Nuclear Energy

The region recognizes the role of additional nuclear capacity in meeting future requirements, mindful of the continuing need for the pursuit of plans for disposition of nuclear wastes. The region will work as an equal partner with the Nuclear Regulatory Commission in regulatory and licensing proceedures to ensure expeditions and safe handling of radioactive materials and wastes and mutually satisfactory construction and operation practices.

(3) Outer Continental Shelf

The New England region stands ready to participate fully with the Federal Government in the OCS endeavor and in the pursuit of regulations and guidelines to protect the coastal shore line.

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* The New England Regional Commission consists of the six Governors of the New England States and a Commissioner appointed by the President.

** A complete text of the New England Energy Policy appears in the Appendix.

(4) Coal Conversion

The region affirms its position to review and aggressively pursue the economic viability of new fossil fuel energy production facilities with the private sector.

(5) Hydroelectric, Solid Waste and other indigenous Resources Development

The region affirms its position to support the expeditions implementation of feasible hydroelectric including tidal projects, support the use of wood for power generation, continue negotiations concerning the purchase of surplus energy from the Eastern Canadian Provinces and undertake to develop facilities for solid waste recovery.

(6) Alternative Energy Sources - Research and Development

New England will provide tax and financial incentives for utilizing solar and other alternative forms of energy.

## NATIONAL POLICY

Many energy policies have developed on the national level since the embargo of 1973-1974. Project Independence of Presidents Nixon and Ford, the Energy Policy and Conservation Act (PL 94-163) and more recently the Energy Conservation and Production Act (PL 94-385) constitute the amalgam of Federal Policies developed by the Executive and the Legislative branches of government.

Project Independence focused attention upon the development of new energy resources. The goals were immediate, specific, and unattainable. The three major goals of the program were (1) to reduce oil imports by 1 million barrels per day in 1976 and 2 million barrels per day in 1977 through immediate action to reduce energy demand and increase domestic supply, (2) to eliminate U.S. vulnerability to foreign supply decisions by achieving full energy independence by 1985 and (3) to develop technology (e.g. synthetics coal fuels, oil shale, solar and geothermal energy) to enable the U.S. to supply an increasing share over time of the World's energy needs.

To reduce oil imports, the President undertook to increase taxes on oil imports and decontrol the price of domestic crude oil. Further, steps to educate the public on energy conservation were to be undertaken by the Energy Resources Council. Finally, proposals were made to Congress to allow production of petroleum from the Naval Petroleum Reserve at Elk Hills and to amend the Energy Supply and Environmental Co-ordination Act of 1974 to allow E.P.A. to extend compliance dates and eliminate restrictive regional environmental limitations.

To eliminate vulnerability to foreign supply decisions the Project Independence Program focused upon three elements (1) Supply actions (2) Energy Conservation Actions and (3) Emergency Preparedness Actions. The supply actions consisted of increasing petroleum supply, stabilizing the price of domestic energy to provide a price floor to stimulate investment in energy supply, and encourage increased use of coal through amendments to the Clean Air Act, increased surface mining, and increased coal leases on Federal lands in the west. Finally, economic incentives to Electric Utilities would expand production and legislation would require all states to have a comprehensive, coordinated process for expeditiously reviewing and approving energy facility siting applications.

Energy Conservation actions would include improved automobile gasoline mileage, the development of national mandatory thermal efficiency standards for new homes and commercial buildings, tax credits for energy conservation, subsidies for low-income energy conservation and development of appliance energy efficiency and labeling standards.

Emergency Preparedness Actions include development of a Strategic Petroleum Reserve and standby authority to deal with any future embargos. The standby authority includes "implementation of energy conservation plans, allocation of petroleum products, fuel rationing, allocation of energy production materials, increased domestic oil production and petroleum inventory regulations."

Project Independence focused attention upon the development of new energy resources but that effort foundered upon resource limitations, financial limitations, technology limitations, and public opposition. The fundamental direction of Federal initiatives has been and remains to supply more energy by facilitating the technological, financial, and institutional development of more energy.

## ERDA

The implementation of Project Independence changed the nature of President Nixons original recommendations. Congress authorized the Energy Research and Development Administration (ERDA) to undertake the research development and demonstration aspects of Project Independence. ERDA's National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future lays out the goals for energy technology development in the United States.

The latest identifies eight energy technology goals for the United States. These goals include (1) Expand the domestic supply and economically recoverable energy producing raw materials, (2) Increase the use of essentially inexhaustible domestic energy resources, (3) Efficiently transform fuel resources into more desirable forms, (4) Increase the efficiency and reliability of the processes used in energy conversion and delivery systems, (5) Transform consumption patterns to improve energy use, (6) Increased end use efficiency, (7) Protect and enhance the general health, safety, welfare, and environment related to energy, and (8) Perform basic and supporting research and technical services related to energy.

Congress took the Project Independence recommendations and developed two pieces of legislation which incorporated some elements of the Presidents recommendations and added other features. The two acts, PL 94-165 and PL 94-385, now represent the bulk of the United States legislated energy policy.

The Energy Policy and Conservation Act (PL 94-163) is designed to implement a comprehensive national energy policy by a series of short term and long term measures to be administered by the President and various executive agencies. The act is divided into five Title or Parts; (1) Domestic Supply Availability, (2) Standby Energy Authorities, (3) Improving Energy Efficiency (4) Petroleum Pricing Policy and Amendments to the Allocation Act, and (5) General Provisions for Congressional Review.

Domestic supply availability is divided into two areas of emphasis. The first area provides a set of tools to encourage the development of domestic energy resources. These tools include authority for FEA to order the use of coal rather than petroleum or natural gas and provide funds to encourage development of new underground coal mines. This Title of the Act also authorizes provisions for emergency production of petroleum and natural gas during a severe energy disruption. Part B of Title I provides for the creation of a Petroleum Storage Reserve Program to store up to one billion barrels of crude oil.

Title II of the EPCA Program focuses on the need for standby authority to deal with another embargo situation. Part A of this Title focuses upon the development of contingency or rationing plans in case of an emergency. Part B of this Title focuses upon American's part in the development of an international energy program and authorizes the President to require implementation of U.S. obligations.

Title III develops elements of an energy conservation plan to implement improved energy efficiency. The five parts of this title focus upon five separate elements where energy efficiency can be higher. Part A establishes mandatory fuel economy standards for passenger automobiles manufactured or imported into the United States after the 1977 model year. Part B mandates that the Federal Energy Administration issue energy efficiency testing and labeling regulations for major home appliances and establish energy efficiency improvement targets for each of the consumer product groups. Part C authorizes Federal expenditures of $150 million in the next three years to assist the States in developing and implementing energy conservation plans. The states must develop five mandatory elements of this plan. These elements include mandatory lighting standards for public buildings, programs to promote carpooling and mass transportation energy efficiency standards for State procurement practices, mandatory thermal and insulation standards for new and renovated buildings and changes in the traffic laws to allow right turns at red lights. Part D provides for the establishment of industrial energy efficiency targets for each of ten most energy consumptive industries in the United States. Part E specifies several other conservation programs which the Federal Energy Administration will participate in.

Title IV of EPCA provides for a policy on petroleum pricing which extends the authority of the Emergency Petroleum Allocation Act to 1981, temporarily rolls back the price of crude oil and allows the price of domestic crude oil to rise gradually over a 40 month period. Title V is a proceedural statement relating to accounting practices, Federal audits, enforcements, conflicts of interest, judicial review, transfer of authority, and Congressional review.

<u>The Energy Conservation and Production Act (PL 94-385)</u> extends the Life of the Federal Energy Administration (FEA) to December 1977, amends previously enacted energy-related statutes, and establishes several new programs involving energy conservation and renewable resources energy production. The act contains four Titles: (1) Federal Energy Administration Act amendments and related matters (2) Electric Utility rate design initiatives, (3) Energy Conservation Standards for New Buildings (4) Energy Conservation and Renewable Resource Assistance for Existing Buildings.

Title I Part A of ECPA deals with extending the FEA to December 1977 and reducing to a certain extent some inequities in application of the regulations. Part B provides for incentives to induce increased production of domestic petroleum. Part C authorizes the creation of an Office of Energy Information and Analysis to establish a central National Energy Information System that will contain all the energy information required to carry out FEA's statistical and forecasting activities. Part D of Title I amends the Energy Reorganization Act of 1974 to extend the responsibilities of the Energy Resources Council. The Council is now required to report annually on the progress of national energy conservation activities. The council also has the responsibility to prepare a plan from the reorganization of the Federal Governments' activities in energy and natural resources.

Title II of ECPA focuses the efforts of FEA upon the development of proposals for the improvement of electric utility rate design. FEA is also authorized to make grants to states to establish offices to assist consumers in presenting their views before utility regulatory commissions.

Title III of ECPA specifies that within three years, the Housing and Urban Development Department must develop energy consumption performance standards for new commercial and residential buildings. If each House of Congress approves, no Federal financial assistance will generally be made available for the construction of new commercial or residential buildings unless the applicable State or Local government has adopted a building code that meets the performance standards, and the new building conforms to that standard.

Title IV consists of five parts. Part A specifies that FEA is required to develop and implement a weatherization program to improve the thermal efficiency of dwellings occupied by low income households. Part B requires that FEA develop guidelines for a supplemental State Energy Conservation Program. Part C of Title IV amends Title V of the Housing and Urban Development Act of 1970 to authorize a demonstration program. The program will evaluate various types of assistance that may be used to promote a comprehensive national energy conservation and renewable resource energy program. Part D of Title IV authorizes FEA to guarantee the payment of loans entered into by private or public entities for the purpose of financing energy conservation measures or renewable-resource energy measures in buildings or industrial plants. Part E provides for review by the Controller of miscellaneous programs developed by FEA or HUD.

There is a degree of confusion implicit in the various elements of Federal Energy Policy because there has been no reconciliation of various elements of energy activity presently divided among several agencies. Federal priority for development of our nations energy future seems now to be locked into a high technology, highly capitol intensive course. There is a need for the Federal Government to reconcile the conflict between governmental organizations and develop a rational set of priorities for effective use of our energy resources.

America is just coming to the realization that we have not dealt with our net energy deficit. The energy problems facing Maine, New England and the nation are systems problems demanding systems solutions. These systems problems are not susceptable to solution solely through the band-aid development of new technology and better hardware. Ultimately, America must address the question of how much effort we must put forth in the development of new sources compared with how much effort should go into more efficient utilization of finite sources.

# CHAPTER V - PART 3

## THE WORLD ENERGY OUTLOOK
(Some Brief Remarks)

In October of 1975 the Institute for Energy Analysis of the Oak Ridge Associated Universities held a conference to discuss future strategies for global energy development. The question to be debated was whether in the future, the world should rely heavily on centralized nuclear and fossil fuel technologies or whether the "soft" technologies of conservations and small-scale energy development would suffice. This "soft" path was eloquently put forth in a paper by British physicist Amory Lovins. This paper, entitled "Energy Strategy: The Road Not Taken"*, provided one of the motivations for the conference and is reprinted in the appendix to this chapter.

In general, Mr. Lovins thesis is that the world stands at a crossroad. He argues that we must develop a more conservative means of providing only essential amounts of energy. Only in this way can we attain a global civilization with a reasonable distribution of freedom and equity. Critical elements of the "soft" path as described in the Lovins paper include greatly increased efforts at conservation, rapid development of renewable resources, and special transitional fossil fuel technologies such as cogeneration.

However, Dr. Alvan Weinberg has calculated that in order to satisfy the energy demands of a growing world population at a standard of living roughly equivalent to that of West Germany**, the "soft" path might require up to one-fifth of the world's land area (for biomass) and up to 60 trillion dollars in capital (for solar electric generation). This is nearly equivalent to the gross world product. Others at the Center for Applied Systems Analysis in Vienna have calculated that the theoretical limits for wind, biomass and hydro power are four "terrawatts"***. The world is consuming seven "terrawatts", two of which are from the Persian Gulf.

On the other hand, the "hard" path seems hardly workable either. Meeting the same demand levels in the year 2010 using breeder reactors would result in a 50 trillion dollar investment for 7000 reactors. These reactors would probably produce three major accidents every 10 years**** and require fifteen square miles for burial of high level radioactive wastes every year. It is also predicted that by the year 2010, the burning of fossil fuels (oil and coal) will have resulted in unacceptable levels of atmospheric carbon dioxide. Another limiting factor in the choice of the "hard" path is the dwindling world supply of those minerals which are essential to the fabrication of energy hardware.

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* <u>Foreign Affairs</u>, October 1976, Council on Foreign Relations, Vol. 55, #1

** Where the per capita energy consumption is 140 x $10^6$ kilojoules as contrasted with a U.S. per capita energy consumption of 350 x $10^6$ kilojoules. Maine's per capita consumption in 1974 was 320 x $10^6$ kilojoules.

*** One terrawatt = $10^{12}$ watts

**** Using estimates based on the current state-of-the-art of breeder technology.

Whether or not Dr. Weinberg's projections are correct, one fact remains clear: the people of the emerging nations (Africa, Asia, and Latin America) will continue to demand more and more of the world's energy resources. They now control much of the raw material resources necessary to our industrial processes. Thus, it would seem that they have us, the industrial nations of the world, over the proverbial barrel.

While the conference did not come to a formal concensus, it is safe to say that many of the attendees realized that neither the "soft" nor the "hard" roads would provide all the answers. The optimal mix of future energy systems will probably include elements of both, taking advantage of geographical and social diversity.

It appears at this point in time that it will be extremely difficult if not impossible to raise the world standard of living as measured by per capita energy consumption up to the level enjoyed by advanced Western countries. The year 2010 is well within our children's lifetime. Some hard decisions are upon us now, so that we can leave the world a reasonable place for those children to live. There are countries which enjoy a high standard of living for less energy.* Perhaps Maine could best prepare itself for the future by studying their methods.

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* Efficient Energy Use and Well-Being: The Swedish Example, Lee Schipper and Allan J. Lichenberg , Science, 3 December 1976, Vol. 194, #4269.

# CHAPTER - V

## SUMMARY

(The Following Pages Summarize Chapter V and List the Preliminary Actions which could be Undertaken).

# PRELIMINARY RECOMMENDED ACTIONS WHICH COULD BE UNDERTAKEN BY THE OFFICE OF ENERGY RESOURCES ALONE

## Concerning Conservation, Emergency Planning and Price Impacts

1. The Office of Energy Resources feels that maintenance of a complete and up-to-date energy emergency plan is vital to the security and welfare of the citizens of Maine. The Legislature and the Governor should require that the Office of Energy Resources update the Energy Emergency Plan annually until such time as petroleum embargo or energy shortages no longer pose potential threats.

2. To ensure that fuel oil supplies continue to be equitably distributed throughout Maine and that any complaints of supply curtailments can be handled rapidly, the Office of Energy Resources recommends the continuation of the fuel allocation program on a standby basis.

3. The Office of Energy Resources should improve its ability to monitor the inventories of petroleum products held in storage facilities maintained by the private sector in Maine.

4. The Office of Energy Resources should continue its programs to promote opportunities for, and awareness of, voluntary energy conservation.

5. The Office of Energy Resources should evaluate all potential energy conservation ideas and seek implementation of those which will bring about the greatest reduction of energy waste.

## Concerning Major Facilities

1. The Office of Energy Resources should intervene to present testimony at Certificate of Public Convenience and Necessity Hearings for New Electric Generating Capacity Additions. Intervention should address generation plant options from the standpoint of optimal plant size to meet projected demands, lifecycle costs of the alternative facilities, and availability of fuel for the economic life of the plant, among other factors including risks and benefits.

## Concerning Resource Development and Diversification

1. The Office of Energy Resources should continue to pursue sources of federal and private funds and incentives for energy R, D & D projects and should continue to provide this information to all interested persons in Maine.

2. The Office of Energy Resources should continue to provide public information on ways to utilize native energy resources.

3. The Office of Energy Resources should continue to evaluate the cost effectiveness of solar energy systems in Maine and should develop a plan to encourage institution of solar energy as it becomes economic.

4. The Office of Energy Resources should continue to work with inventors, private entrepreneurs, and utilities to encourage the design and testing of experimental wind systems.

5. The Office of Energy Resources should evaluate the opportunities and constraints for co-generation in Maine.

### Concerning the Electric Power Industry

1. The Office of Energy Resources should develop more adequate forecasting tools to evaluate future demand for electric energy and for new generating capacity.

2. The Office of Energy Resources should evaluate the cost effectiveness of potentially institutable load management techniques.

3. The Office of Energy Resources should evaluate the effects upon energy demand and capacity demand of alternative rate structures.

4. The Office of Energy Resources should evaluate the effects of accounting provisions such as the investment tax credit and construction works in progress (CWIP) upon the long run customer costs.

5. The Office of Energy Resources should provide expert testimony to the Public Utilities Commission on matters affecting the electric and gas utility industry.

6. The Office of Energy Resources should evaluate the economic, social and legal aspects of instituting publicaly funded energy facilities in Maine.

7. The Office of Energy Resources should maintain a dialogue with electric and gas utilities to ensure periodic review of industry plans, forecasts and forecasting techniques. This dialogue should possibly take the form of a regular public informal review session.

# PRELIMINARY RECOMMENDED
# ACTIONS WHICH COULD BE UNDERTAKEN
# BY THE OFFICE OF ENERGY RESOURCES
# IN COOPERATION WITH OTHER ENTITIES

## Concerning Conservation and Price Impacts

1. The State should participate fully in the federal energy conservation programs under the Energy Policy and Conservation Act (PL 94-163) and the Energy Conservation and Production Act (PL 94-385).

2. The State should institute an Energy Extension Service program to give technical assistance to all sectors. Such a program should be a combined effort of State Government, the University of Maine and the Community Action agency.

3. The State should develop and enact energy efficiency standards for new buildings.

4. Lighting standards should be developed and enacted for public buildings.

The State should enact Right-Turn On Red traffic regulations.

5. Energy efficiency standards should be established for purchases made by government at all levels. The concept of life cycle costing should be considered and implemented wherever feasible.

6. The State and various transportation planning groups should establish programs to promote carpools and vanpools and the use of public transportation.

7. The State, working with regional planning commissions, local planning boards and conservation commissions, should develop and provide information on techniques for including energy efficiency considerations in land use planning.

8. The Office of Energy Resources and Bureau of Taxation should consider the possibilities for a small tax on energy consumption (above a certain minimum amount) to create a fund to be used for energy conservation assistance.

9. The energy stamp programs in operation in other parts of the country, as well as other programs with the aim of alleviating the energy price burden on the poor, should be examined by the Office of Energy Resources in cooperation with Community Services Administration and evaluated with regards to their applicability to the State of Maine.

## Concerning Major Facilities

1. The Office of Energy Resources feels that it is essential for the hearing procedures of both the Public Utilities Commission and the Bureau of Environmental Protection to include cost and risk benefit analyses of proposed major energy projects and their possible alternatives. The Office of Energy Resources should assist in the preparation and presentation of these analyses.

2. The Office of Energy Resources recommends that an oil refinery policy be developed for Maine to assist State and local officials in their efforts to attract such facilities.

3. The Office of Energy Resources, in conjunction with the State Development Office and the Bureau of Taxation, should study the possibilities for taxation of energy products shipped through the State. The level of taxation should be high enough so that the net risks and costs of such development to Maine are equitably compensated, but low enough and stable enough so that Maine does not discourage such development.

## Concerning Resource Development and Diversification

1. Working with the University of Maine, the Office of Energy Resources should take a more active role in organizing Maine's colleges and universities to pursue diligently research projects which will lead to economic and environmentally acceptable ways to develop and utilize Maine's energy resources.

2. Coal use should be expanded in Maine for heavy industrial and electric generation end uses, with proper and adequate environmental safeguards. If the economics prove feasible, for the next large base load thermal electric generating state to be built in Maine, serious consideration should be given to a coal fired unit between 600-800 MW capacity.

3. Studies should be made and technology developed to integrate coal burning for industrial and electric generation uses with the burning of waste wood, municipal solid waste, and sewage solids. The State should support and encourage pilot facilities using these fuels.

4. A continuing dialogue should be established between Maine State Government and Maine electric power companies to explore opportunities for further importation of Canadian electric power.

5. Maine should continue to be an active participant in the deliberations of the New England Governor/Eastern Canadian Premiers Energy Committee.

6. Thorough analysis should be undertaken to evaluate the overall availability and environmental impact of greatly increased use of wood for energy. Such analysis should include determination of the energy production capability of Maine's forest with proper management, and any potential price impacts on the wood resource that may result.

7. The concept of "energy farming", or "energy plantations" (growing trees in designated area solely for use as an energy resource) should be explored further to determine the economic viability in Maine for such systems on a small scale.

8. The Office of Energy Resources and the Department of Enviromental Protection should encourage the construction and operation of municipal solid waste energy recovery facilities in those areas of the State where this option appears to be economically viable. Such a project should be sited close to an existing industry or industries which could use steam for industrial processes. A State program in this area could include:

(a) Technical assistance to municipalities and/or industries in setting up an energy recovery system.

(b) Financial assistance to municipalities to set up such systems (possibly through the Federal Solid Waste Recovery Act).

9. The Office of Energy Resources should work with the State Development Office and State Planning Office to provide information to industrial parks and regional planning commissions on co-location of facilities for electric generation and provision of heat.

### Concerning the Electric Power Industry

1. Maine should take part in a regional effort to adequately evaluate NEPOOL forecasts, forecasting methology, cost effectiveness and impacts for utility pricing alternatives, and load management techniques.

# PRELIMINARY RECOMMENDED
# ACTIONS WHICH COULD BE UNDERTAKEN BY MAINE ENTITIES OTHER THAN THE OFFICE OF ENERGY RESOURCES

## Concerning Conservation and Price Impacts

1. Maine should continue to pursue a vigorous program of home winterization for the benefit of the low income and elderly citizens of the State.

2. At this time, the Office of Energy Resources does not recommend immediate adoption of either lifeline rates or energy stamp programs. Instead, social assistance programs of all types should reflect realistic appraisal of current energy costs.

3. The soon-to-be-completed experimental lifeline project for the elderly citizens of six communities should be evaluated to determine:

    (1) What effect the program has had on decreasing the electricity bills of the low income elderly.

    (2) What effect have lower electricity bills had on energy conservation.

    (3) Have these programs incurred any detrimental effect to other classes of customers, whether they be of the residential, commercial or industrial classes, and to what extent these other customers approve of the lifeline concept.

    (4) Whether such a lifeline program ought to be expanded, and in what way.

## Concerning Major Facilities

1. Tax revenues from major energy facilities should be shared regionally or statewide. It is normal for a town in which a major industry is located to reap the tax benefits, but the liabilities and governmental service costs generated by the industry are often spread over a wider region. Tax benefits should be distributed to reflect the risks and service costs borne by surrounding communities and the State as a whole.

2. The Office of Energy Resources feels that the State, by law or regulation, should establish a major facility siting process. The applicant would confer in advance with those agencies of State and local government who would have a direct or indirect interest in the proposal for the purpose of ensuring that the final proposal submitted to the Board of Environmental Protection or the Public Utilities Commission would, to the maximum extent possible, be consistent with the goals and objectives of all parties. Care should be exercised in this process that the full rights of outside intervenors are not abrogated.

3. Consideration should be given to the concept of eliminating the requirement for "title, right or interest" before review of major energy sites by the Board of Environmental Protection.

4. In the review process for major energy facilities, the Office of Energy Resources recommends that approval of sites be separated from approval of specific plant design.

5. A major energy facility should be located only in a town or region in which the citizens have voted to accept it. The State bears some responsibility under law for seeing that a refinery or other major energy facility is well situated so as not to harm the environment. But the citizens of a town or region in which a facility is located must bear the immediate consequences of its development. Particularly in smaller Maine towns these effects on property values and ways of life can be quite substantial. The citizens should, therefore, have the opportunity to vote either in a referendum or through their elected and appointed representatives on whether to accept major energy developments.

6. The Office of Energy Resources feels that all energy options should remain open and does not support legislation that would foreclose the nuclear option.

### Concerning Resource Development and Diversification

1. Natural gas should be retained as an option to satisfy limited energy needs for special applications (such as feedstocks for chemical manufacture, or to maintain air quality in urban areas) where other energy resources are less suitable or entirely unsuitable. At this time, it looks like Maine should not plan on relying heavily on natural gas.

2. Efforts should be increased to improve woodlot management practices, particularly by small woodlot owners. Successful pilot programs for coordinating fuelwood buyers with fuelwood sellers should be expanded statewide.

3. High priority should be placed on the development of efficient, safe, and inexpensive wood combustion equipment for homes and institutions.

4. Consideration should be given to allowing a higher rate of return (or exemption entirely from public utility status) for an experimental (up to 60 MW) wood-fired electric generating station whose electricity is to be distributed through an existing utility.

5. Consideration should be given to exemption of solar devices from Maine property and sales taxes.

6. Buildings should be designed and constructed to accomodate solar heating equipment as it becomes economical in the future.

7. Consideration should be given to the exemption of small scale wind generation equipment from sales and property taxes at least for a period of time while wind energy is still in the experimental stages.

8. Further consideration of tidal development as an energy alternative for Maine should await release of the ERDA study of tidal power. If eventual (within 30 years) technical and economic feasibility can be demonstrated for tidal power by life cycle cost calculations (being undertaken in the Stone and Webster study at Maine's request), then the Passamaquoddy Tidal Power site should be retained intact as an option for future energy supply to Maine.

9. Consideration should be given to increasing the rates which utilities pay to industries for power fed into the utility grid.

10. The "ratchet" charge now imposed by the utilities for infrequent customers should be investigated and potential modifications proposed. Amendment to this "ratchet" charge provision may be necessary to allow the redevelopment of small hydroelectric projects and the development of wood and other generation alternatives.

11. If economically feasible, hydroelectric development for energy supply to Maine consumers should be given priority consideration over other available alternatives. Maine electric utilities should be encouraged to develop some of the available hydro sites lying within their service areas. A good candidate for early consideration might be the 220 MW Cold Stream site by Central Maine Power Company.

12. The potential for increased storage of spring runoff waters should be evaluated by the Water Resources Planning Program. Such storage increase could yield at least three major benefits to Maine:

(a) Increased availability of fresh water supply to Maine communities;

(b) Reduced exposure to flood dangers in low lying areas and river valleys; and

(c) Increased energy output from existing future hydroelectric facilities, possibly improving load factors to the point where facilities now regarded peaking could become intermediate or base load generating facilities.

13. A pilot project should be undertaken to revitalize one or more of Maine's existing very small hydroelectric dams. Studies leading up to such a project should define construction work needed to maximize efficiency, describe ways to minimize costs, suggest realistic methods for overcoming constraints such as "ratchet" charges, define appropriate means for integrating with the grid for reliability purposes, and accurately define the market for the power as well as management authority for the project.

## PRELIMINARY RECOMMENDED ACTIONS WHICH COULD BE UNDERTAKEN * BY REGIONAL OR FEDERAL ENTITIES

### Concerning Emergency Planning

1. The Office of Energy Resources concurs with the recommendation of the Federal Regional Council that the Federal Government establish a regional industrial fuel reserve within or near New England.

2. At this time, Maine should not oppose the decontrol of oil prices, but the State should recommend a "trigger" system for New England to assure that petroleum prices in Maine do not rise disproportionately as compared with national price increases. We would further recommend that the "trigger" region exclude the Mid-Atlantic states which may tend to screen higher prices in New England.

### Concerning Major Facilities

1. Maine should advocate the passage of Federal legislation which would separate and clearly define the scope of authority vested in the various federal agencies involved in approval of major energy facility siting. Further, clearer definition of responsibility between the State and Federal governments should be achieved, with a preference for State autonomy wherever possible.

2. The Office of Energy Resources recommends that top priority be placed at the federal level on finding solutions to the current uncertainties of the nuclear fuel cycle, including fuel reprocessing and permanent waste disposal.

### Concerning Resource Development and Diversification

1. The Federal government should legislate tax credits for the purchase of solar and wind energy equipment until the technology becomes widely accepted.

2. ERDA should plan to sponsor a Worldwide Tidal Power Conference jointly with the Atlantic Provinces Tidal Power Review Board in the Spring of 1977 when the tidal studies of both countries are completed.

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* This particular list is not, by any means, exhaustive!