OVERVIEW OF MAINE ENERGY DATA

PREPARED BY:

Maine Office of Energy Resources

SUBMITTED TO LEGISLATIVE
COMMITTEE ON ENERGY AND
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CONTENTS

PART I

DISCUSSION OF ENERGY DATA SOURCES AND RELIABILITY

1-15-80

DISCUSSION OF ENERGY DATA SOURCES AND RELIABILITY

Since the OPEC Oil Embargo of 1973-74 Maine, the nation and indeed the world community have attempted to examine our energy resources, supplies and demand. Recently, the Iranian Crisis, supply disruptions, OPEC price increases, spot shortages of gasoline (summer 1979) combined with the world political and economic climate have re-emphasized the necessity to collect and evaluate energy data.

The Office of Energy Resources (OER) is interested in defining, assessing and understanding our states true energy requirements. The ultimate goal of our data gathering effort is to provide accurate information to Maine's policy makers and planners in order to insure adequate energy supplies for the future.

To date the OER has been very active in the utilization of computerized tools for data management and analysis. Participation in regional and national energy data management groups has provided the OER with various mechanisms for storage, retrieval and evaluation of energy data. Also, invaluable experience has been gained in the management and development of a comprehensive energy data base.

In order to meet our goal of providing accurate data for the development of energy policies, the data base must meet three essential requirements:

1. Reliability or integrity -

We must have confidence that the data truely reflects the supply and demand situation and can be used with assurance.

2. Timeliness -

The data must be up-to-date.

3. Adaptability -

The data must be in a format which is easily accessable for a wide range of uses.

With these three essential requirements in mind the following pages of this document will cite various data sources.

Data Source	Reliability Integrity	Timeliness	Adaptability
Federal Energy Data System (FEDS)	When compared to other data sources large differences have been noted.	At least two years behind the times. Latest available data is for 1977.	Available in machine readable form.

The FEDS data is the only truly comprehensive data base available. However, due to the lack of timeliness and integrity this data base is of little value in formulating energy policy for the State of Maine. If this data were available with a lag time of one year, this data could be used as a historical base from which refinements, projections and analyses could be made.

Data Source	Reliability Integrity	Timeliness	Adaptability
EIA-25	Since this data comes from each supplier and correlates well with actual delivery data, OER attributes a high degree of integrity to this data.	Reported monthly, giving projected data one month in advance.	Input on State computer system proprietary data.

This is a report filed monthly by all major suppliers of petroleum products in Maine. A computer generated report is produced from this data for the State Allocations Office. The EIA-25 is a prediction by each major supplier of the amount of product they expect to deliver to the State of Maine. These deliveries do not equate to the amount of fuel which will be consumed (demand) in Maine. Some of this product is later sold to other New England states. There is no mechanism for determining how much of this reported product is sold out-of-state. This data is particularly useful for determining the energy supply outlook in the coming month for products on which data is collected on a timely basis. For instance, gasoline, diesel, aviation gasoline (tax data) and home heating oil reports (Ethyl Corp.) can be used to determine a more accurate picture of product availability and demand.

Data Source	Reliability/Integrity	Timeliness	Adaptability
State of Maine Bureau of Taxation	Considered the best source of gasoline, diesel, and aviation gasoline data since these data are required by law	a lag time of 6 weeks	Input on the New England Energy Management Information System(NEEMIS)

This is the best available demand data for the above mentioned products. Used in conjunction with the EIA-25 a very accurate picture of demand and supply can be obtained.

Data Source	Reliability/Integrity	Timeliness	Adaptability
Ethyl Corp. Home Heating Oil Reports	These data compare well with survey results conducted by the OER and are considered to be within 5% accurate	monthly reports	Input on the NEEMIS facility

This data source is used as a reliable and consistent historical base from which consumption trends can be noted and assumptions developed for projections as necessary.

Data Source	Reliability/Integrity	Timeliness	Adaptability
Form OER070179 Bi-weekly stocks & deliveries Report	Report of actual petroleum stocks by prime supplier	1st & 3rd Mondays of each month	Input on State Honeywell System

This data is required by law and has provided a successful mechanism for tracking primary stocks of home heating oil in Maine.

Data Source	Reliability/Integrity	Timeliness	Adaptability
Form OER080179 Home Heating Oil Supply/ Price Monitoring Report	Actual data collected from a sample of secondary home heating oil dealers	1st & 3rd Monday of each month	Input on NEEMIS facility

A report of current price and stocks is generated during the first and third weeks of each month. This report is compiled from information which is supplied on a voluntary basis from a random sample of home heating oil dealers and allows the OER to track current prices and inventories at the secondary level.

The preceeding data sources do not comprise a comprehensive list of available data but are cited as examples of most often used data and to identify the criteria used in establishing the confidence which can be attributed to each source. For a more comprehensive listing of data sources see New England Energy Balance Data Assessment, NERCOM Energy Program Report: 79-2. February 6, 1979 (available on request).

Over the past four years, at both the regional and national level, a great deal of emphasis has been placed on developing sophisticated data management tools for facile storage and retrieval.

OER involvement in the New England Energy Management Information System (NEEMIS) and more recently the Emergency Energy Management Information System (EEMIS) has led OER to the following conclusions.

1. These efforts produce limited results. Energy policy and analysis is dependent upon the collection and evaluation of reliable timely data.
2. All too often energy data is produced in a "top-down" fashion (aggregate data based on national or regional data is allocated based on assumptions) rather than a "bottom up" method (data collected from the source of distribution).
3. The time has come to place greater emphasis on the collection of data based on "bottom-up" methodologies.
4. Since Federal and Regional groups have indicated they have neither the resources nor inclination to collect "bottom-up" data and since it is to our advantage to have a clear view of supply and consumption patterns on a timely basis, the OER is placing a greater emphasis on "bottom-up" data collection. For example, in order to evaluate the feasibility of realizing and equity of recent voluntary gasoline targets and the standby gasoline rationing program we must have reliable data sources. While the data for this analysis is available from the Bureau of Taxation if targets are set for other products which are not reported to the State on a timely basis, the analysis will have to be based on data which is less reliable.

In summary we would like to re-emphasize our opinion of the necessity to place an emphasis on data collection by the "bottom-up" method. Now that computer tools and resources are available to meet analytic needs, it is necessary to populate our data bases with reliable and timely data. The complexity of deriving data based on "top down" methodologies can obscure the reliability and understanding of this data obviating the need for "bottom up" type collection methods.

PART II

CURRENT ENERGY DATA FOR MAINE

Introcution to Part II

Part II of this report is comprised of five documents produced by OER staff within the last year. The following is a list of these reports and a brief description of the data contained in each.

1. Comprehensive Supply/Demand Data, OER, Dawbin, 1980
   This is an overview of energy supply and demand. Tabulations of supply by fuel type and demand by consuming sector are given. Also, pie charts by fuel type and consuming sector are shown.

2. Heating Oil Supply/Price Monitoring Report, OER, Dow, 1980
   This is a report of historic (8/1/78-7/31/79) average inventory and deliveries of No.2 heating oil and current price trends for No.2 and kerosene at both the retail dealer and rack levels. Also, included are current inventory and deliveries data. Tabulations of the data and selected graphs are included.

3. Heating Oil Use in Maine 1973-1979, OER, Dow, 1979
   This document contains tabulations and graphs of yearly as well as monthly heating oil use patterns in Maine. Typical daily use patterns (by month) as well as weather corrected data is given for Kerosene and No.2 heating oil.

4. Analysis of Motor Fuel, Distillate, Residual Oils and Electricity Consumption Patterns in Maine, OER, Dow, 1979
   This is a compilation of yearly and monthly gasoline, diesel and aviation gasoline consumption patterns. An analysis of

per capita gasoline, electricity, distillate and residual oil consumption is also included.

5. Coal in Maine, OER, Booker, 1979

This paper is a discussion of the current level of coal utilization in Maine and addresses key environmental issues as well as price and distribution considerations.

The reports follow in the order in which they are mentioned above.

Comprehensive Energy Supply/Demand Data

I. Introduction

The following pages show, in tabular form and graphically, a comprehensive overview of energy supply and demand in Maine.

On the supply side, these figures indicate that petroleum is still the dominant energy source in Maine, by a very wide margin, providing nearly 71% of the State's total energy consumption, with nuclear generated electricity being the second largest energy source at 14.3% of the total, followed by hydropower (8.7%), fuelwood (5.4%), natural gas (0.6%), and coal (0.1%).

Among the petroleum fuels, distillate oil (primarily #2 home heating oil) is the largest component, at 21.1% of total energy, followed by residual fuel oils for industrial use and electrical power generation (20.7%) and gasoline for highway, aviation, and marine transportation (20.1%), with jet fuel (3.8%), diesel fuel (2.2%), kerosene (1.7%), and LPG (1.3%) trailing way behind.

On the demand side, the industrial sector is the largest energy consumer at 28.9% of the State's total demand, followed by the residential and transportation sectors at 27.5% each, with the commercial sector consuming but 16.1% of the total energy used in Maine in 1977.

It should be noted that comparisons between this energy information and that published in prior years (1976 and 1978) may not be meaningful due to changes in the data bases. Resolution of discrepancies between these data bases to allow meaningful comparisons has not yet been attempted. Fuel use trends should be taken from the accompanying data reports compiled by R.E. Dow of the OER staff.

II. Discussion of Data Sources

1977 was selected as the year for which to prepare this display because it is the most recent year for which relatively complete and comprehensive data exists for both fuel supplies by type, and final demands by the ultimate consuming sectors. More recent data is presented for the supplies of most fuels. However, this data is not available on a comprehensive basis. Corresponding demand distribution by consuming sector is not currently available for all sectors.

The source for most of the data is "FEDS", the Federal Energy Data System of the U.S. Department of Energy's Energy Information Administration. FEDS data was used as published for petroleum, natural gas, coal, and utility hydro generation in Maine. Fuelwood use is not reported in FEDS, and data on that fuel were added from estimates of residential consumption made in a survey by the Maine Audubon Society for the winter of 1977-78, and estimates of industrial consumption made in a survey in 1978 by the Thayer School of Engineering at Dartmouth College, sponsored by the New England Regional Commission.

The FEDS data also excluded industrial hydroelectric generation, and an estimate of this energy input was derived from published statistics of the Federal Energy Regulatory Commission of the U.S. Department of Energy.

An additional adjustment to the FEDS data was made in the area of nuclear electric generation and consumption. The published data implied that Maine consumed all of the output of the Maine Yankee Atomic Power Comapny plant in Wiscasset, whereas, in reality, one-half of the plant's output goes to other New England States in proportion to the capacity ownership shares of utilities in those States. In addition, Maine utilities, and Central Maine Power Company in particular, own shares of power plants in other states, so that there is a continuing exchange of imported and exported electrical energy, all coordinated and controlled by the New England Power Exchange (NEPEX), the operating agency of the New England Power Pool (NEPOOL). There is also a constant importation of electricity from Canada at several points along the Maine border, with the bulk of this energy being "wheeled" to southern New England on transmission lines owned by the Maine Electric Power Company (MEPCO).

One final adjustment was made to the FEDS data. The conversion of primary energy (oil, coal, nuclear fuel, water power, etc.) to electricity entails some losses in available energy due to inefficiencies in the conversion process. Consumption of electricity at the point of end use is, for all practical purposes, 100% efficient. Conversion inefficiencies can be expressed either as the percentage of primary energy input that it delivered by the electrical generator to the transmission/distribution system, or as an equivalent thermal heat rate, in BTU's per killowatt-hour generated. One kilwatt-hour has an energy value of 3413 BTU's, at its point of use. The FEDS data reports electrical generation in terms of gross primary energy inputs, while consumption in the final demand sectors is at the 3413 BTU/kwh equivalent for end use conversions. To properly allocate electrical generation conversion losses to the consuming sectors creating the demand for the energy, implicit heat rates were calculated from the generation input data, and the consumption data was then re-converted at these implicit heat rates. Hydropower generation was converted at an equivalent thermal heat rate to obtain an oil displacment energy value.

Maine Energy Consumption - 1977

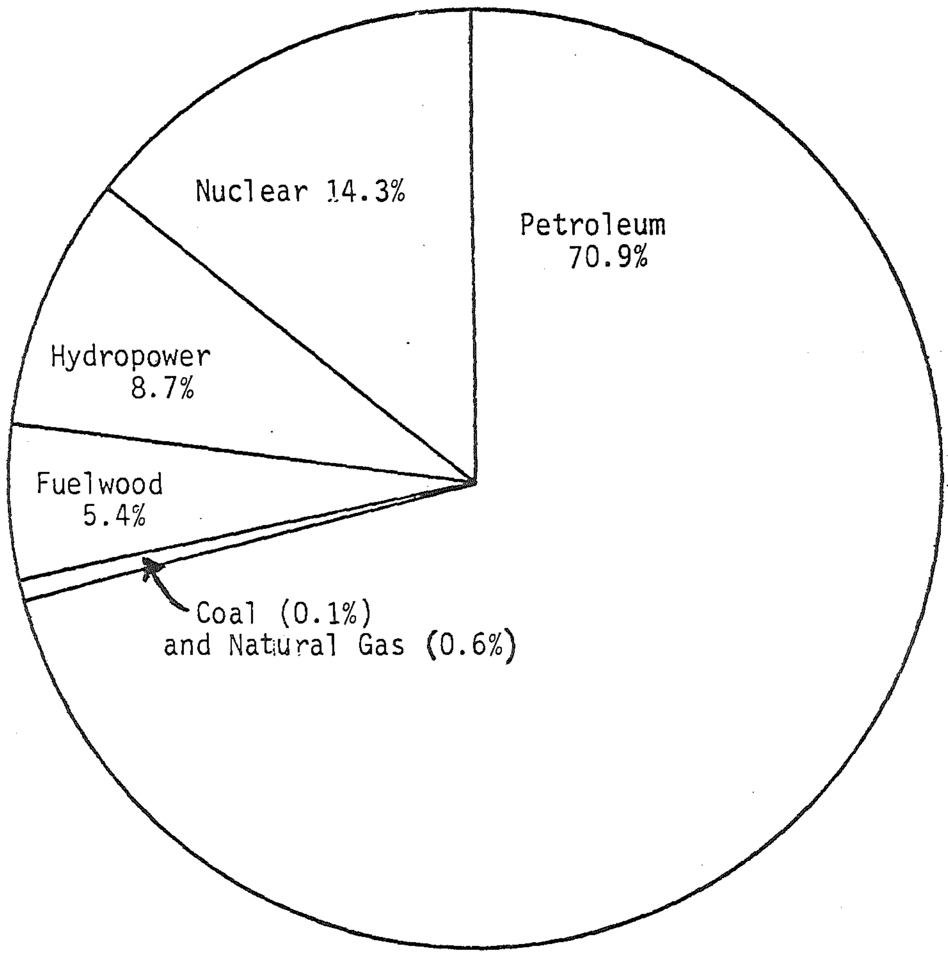
Supply:

Fuel	Physical Units	Trillion BTU's	% of Total
Gasoline	574,360,000 gallons	71.78	20.1
Residual-Non-Utility	10,940,000 barrels	65.79	18.4
Utility	1,730,000 barrels	8.20	2.3
Distillate	13,010,000 barrels	75.56	21.1
Diesel	1,360,000 barrels	7.95	2.2
Jet Fuel	104,120,000 gallons	13.45	3.8
LPG	49,470,000 gallons	4.73	1.3
Kerosene	1,070,000 barrels	6.09	1.7
Sub-total, Petroleum		253.55	70.9
Coal	10,000 tons	0.21	0.1
Natural Gas	2,040,000,000 cu.ft.	2.11	0.6
Fuelwood	985,000 cords (1)	19.25	5.4
Hydro-Utility	1.99 Billion KWH	20.63	5.8
Industrial	1 billion KWH(2)	10.37	2.9
Nuclear	1 billion KWH(3)	51.47	14.3
Totals		357.59	100.0

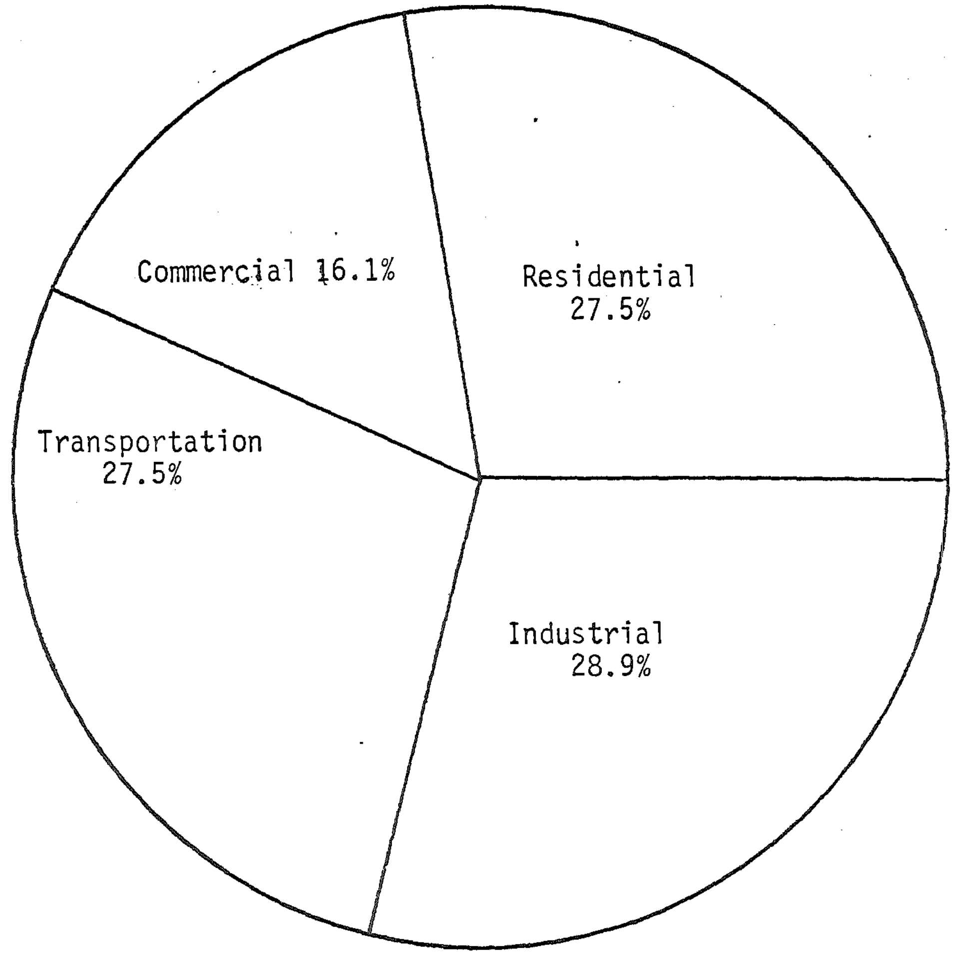
Demand:		Trillion BTU's	% of Total
	Residential	98.40	27.5
	Commercial	57.72	16.1
	Industrial	103.06	28.9
	Transportation	98.41	27.5
		357.59	100.0

Notes: (1) Estimated from Maine Audubon Society's fuel wood survey (485,000 cords burned in residential sector in winter of 1977-78) and Dartmouth College/NERCOM industrial fuelwood survey (500,000 cords equivalent burned by industry in 1977).
(2) Estimated from published DOE electrical generation data
(3) Estimated net nuclear input from Maine Yankee and owned shares of out-of-state nuclear plants, from ECNE statistics

MAINE ENERGY CONSUMPTION DISTRIBUTION - 1977



Supplies
(by fuel type)



Demands
(by sector)

Sources - "FEDS" and OER data, Maine Audubon and NERCOM Fuelwood Surveys, ECNE Statistical Bulletin

Heating Oil Supply/Price Monitoring Report:

Part I - Historic Data - August 1978 to July 1979

Part II - Current Data - August 1979 to January 1980

Maine
Office of
Energy
Resources

January 2, 1980

Contact Person: Richard Dow

State of Maine, Executive Department
Office of Energy Resources
55 Capitol Street
Augusta, ME 04333

Telephone: (207) 289-3811

Table of Contents

Introduction

This data gathering effort is the result of the expansion of the Price Monitoring System (PMS) developed by the Maine Office of Energy Resources (OER) staff during the summer of 1977. During the winters of 1977/78 and 78/79 the Maine OER participated in pilot programs for collecting home heating oil data. Our efforts are meant to complement those of the Department of Energy.

A computerized version of PMS is written in APL resides on the New England Energy Management Information System, (NEEMIS), and is used in this expanded effort to calculate average prices throughout the state. The OER staff is in the process of evaluating the viability of computerizing this expanded home heating oil data collection effort.

The following is an example of the report which will be sent to Regional DOE during the first and third weeks of each month.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: ______________________ Number 2 Kerosene

A.	Average Price Retail(cents)		
	High Price (cents)		
	Low Price (cents)		
B.	Average Price Rack (cents)		
	High Price (cents)		
	Low Price (cents)		
* C.	Current Inventory (gallons)		
* D.	Total Gallons Delivered/Sales		

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

Methodology

Part I (Historic data):

The historic data is based on surveys conducted by the Maine Office of Energy Resourses and the Maine Oil Dealers Assoication (MODA). The storage capacity by location is taken directly from the 1975 Fuel Distribution Survey, FDS), Dow, OER, 1978.

The average on-hand monthly inventory is based on figures obtained from the FDS with updates based on a survey conducted by MODA in July 1979.

The average sales/deliveries of No. 2 heating oil are based on the FDS. This was done since a survey of dealers indicates that they are selling approximately the same amount of oil as they were in 1975 but are serving more customers. Also, a high percentage of dealers have gone out of business or have been absorbed by larger dealers or merged.

The number of residential customers is calculated as 85% of the total number of housing units in Maine. This figure is substantiated by a survey done by the Social Science Research Institute at the University of Maine, Orono, ME.

A total of 300 dealers comprising well over 90% of the secondary sales to end users in Maine were surveyed for the FDS. Every dealer of No. 2 heating oil was surveyed. Only 11 firms refused to participate.

State of Maine Office of Energy Resources
No. 2 Heating Oil Supply/Price Monitoring Report

Part I Data (Historic Data 8/1/78 to 7/31/79):

Volume of Storage Capacity surveyed = 20,101,549 gallons

Number of storage facilities surveyed = 496

Number of residential customers = 291,742

Average on-hand monthly inventory of No. 2 home heating oil (gallons)		Average sales/deliveries of No. 2 heating oil (gallons)	
Aug 78	56,448	Aug 78	28,918
Sep 78	60,480	Sep 78	49,900
Oct 78	80,640	Oct 78	64,856
Nov 78	48,384	Nov 78	86,810
Dec 78	28,224	Dec 78	176,501
Jan 79	36,228	Jan 79	165,884
Feb 79	40,320	Feb 79	155,879
Mar 79	36,992	Mar 79	138,036
Apr 79	33,938	Apr 79	103,149
May 79	31,136	May 79	53,215
Jun 79	28,566	Jun 79	36,127
Jul 79	26,208	Jul 79	24,810

Part II (Bi-Monthly data):

During the 1st and 3rd weeks of each month a sample of 31 dealers, selected from a population of 300, are telephoned to determine the data elements required on Part II of the No. 2 Heating Oil Supply/Price Monitoring Report. The data elements are collected for No. 1 and No. 2 heating oils as described in Part II columns a,b,c and d. Sample point selection is based on population density with at least one selection made from each of 16 counties.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 1st week August 1979

		Number 2	Kerosene
A.	Average Price Retail (cents)	76.2	81.4
	High Price (cents)	79.4	84.9
	Low Price (cents)	71.3	76.1
B.	Average Price Rack (cents)	66.05	69.98
	High Price (cents)	69.25	73.25
	Low Price (cents)	64.05	68.05
* C.	Current Inventory (gallons)	1,500,981	261,482
* D.	Total Gallons Delivered/Sales	832,016	91,985

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 3rd week August 1979		Number 2	Kerosene
A.	Average Price Retail (cents)	78.8	84.0
	High Price (cents)	82.1	87.8
	Low Price (cents)	73.9	78.7
B.	Average Price Rack (cents)	66.67	70.82
	High Price (cents)	70.99	74.90
	Low Price (cents)	64.33	68.20
* C.	Current Inventory (gallons)	1,574,150	280,722
* D.	Total Gallons Delivered/Sales	896,767	104,298

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 1st week September 1979		Number 2	Kerosene
A.	Average Price Retail (cents)	81.5	86.7
	High Price (cents)	84.9	90.9
	Low Price (cents)	76.6	81.4
B.	Average Price Rack (cents)	67.29	71.66
	High Price (cents)	72.78	76.58
	Low Price (cents)	64.6	68.35
* C.	Current Inventory (gallons)	1,650,885	301,377
* D.	Total Gallons Delivered/Sales	966,558	118,259

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 3rd week September 1979		Number 2	Kerosene
A.	Average Price Retail(cents)	82.0	87.3
	High Price (cents)	85.2	91.4
	Low Price (cents)	77.1	82.1
B.	Average Price Rack (cents)	69.92	72.52
	High Price (cents)	74.62	78.30
	Low Price (cents)	64.88	68.50
* C.	Current Inventory (gallons)	1,731,362	323,552
* D.	Total Gallons Delivered/Sales	1,041,780	134,090

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 1st week October 1979

		Number 2	Kerosene
A.	Average Price Retail(cents)	82.4	87.8
	High Price (cents)	85.6	91.9
	Low Price (cents)	77.5	82.7
B.	Average Price Rack (cents)	68.55	73.39
	High Price (cents)	76.50	80.06
	Low Price (cents)	65.17	68.65
* C.	Current Inventory (gallons)	1,815,761	347,359
* D.	Total Gallons Delivered/Sales	1,122,857	152,039

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 3rd week, October 1979

		Number 2	Kerosene
A.	Average Price Retail (cents)	82.9	88.4
	High Price (cents)	85.9	92.4
	Low Price (cents)	78.0	83.4
B.	Average Price Rack (cents)	69.19	74.26
	High Price (cents)	78.42	81.86
	Low Price (cents)	65.45	68.80
* C.	Current Inventory (gallons)	1,904,275	372,917
* D.	Total Gallons Delivered/Sales	1,210,243	172,391

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 1st week November 1979		Number 2	Kerosene
A.	Average Price Retail (cents)	83.3	88.9
	High Price (cents)	86.2	92.9
	Low Price (cents)	78.5	84.1
B.	Average Price Rack (cents)	69.84	75.15
	High Price (cents)	80.40	83.70
	Low Price (cents)	65.73	68.95
* C.	Current Inventory (gallons)	1,997,104	400,356
* D.	Total Gallons Delivered/Sales	1,304,429	195,467

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 3rd week November 1979		Number 2	Kerosene
A.	Average Price Retail (cents)	83.8	89.5
	High Price (cents)	86.6	93.4
	Low Price (cents)	79.0	84.8
B.	Average Price Rack (cents)	70.49	76.05
	High Price (cents)	82.42	85.58
	Low Price (cents)	66.01	69.10
* C.	Current Inventory (gallons)	2,094,458	429,814
* D.	Total Gallons Delivered/Sales	1,405,946	221,633

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 1st week December 1979		Number 2	Kerosene
A.	Average Price Retail (cents)	84.3	90.1
	High Price (cents)	86.9	93.9
	Low Price (cents)	79.5	85.5
B.	Average Price Rack (cents)	71.15	76.96
	High Price (cents)	84.50	87.50
	Low Price (cents)	66.30	69.25
* C.	Current Inventory (gallons)	2,196,557	461,439
* D.	Total Gallons Delivered/Sales	1,515,364	251,300

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 3rd week December 1979

		Number 2	Kerosene
A.	Average Price Retail (cents)	86.7	92.4
	High Price (cents)	89.9	94.9
	Low Price (cents)	83.9	88.5
B.	Average Price Rack (cents)	71.15	76.96
	High Price (cents)	84.50	87.50
	Low Price (cents)	66.50	69.25
* C.	Current Inventory (gallons)	2,112,752.4	366,985.5
* D.	Total Gallons Delivered/Sales	2,075,433.4	251,667.7

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

FORM-OER080179

STATE OF MAINE
OFFICE OF ENERGY RESOURCES
HOME HEATING OIL SUPPLY/PRICE MONITORING REPORT

- PART II DATA -

Reporting Period: 1st week January 1980

		Number 2	Kerosene
A.	Average Price Retail (cents)	88.02	94.02
	High Price (cents)	92.40	99.0
	Low Price (cents)	84.9	89.9
B.	Average Price Rack (cents)	72.04	76.96
	High Price (cents)	84.05	87.5
	Low Price (cents)	66.30	70.1
* C.	Current Inventory (gallons)	2,350,651.7	429,423.2
* D.	Total Gallons Delivered/Sales	2,820,118.7	439,976.6

*This data applies only to those dealers surveyed. These dealers comprise approximately 12% of the total distillate market in Maine.

TABULATION OF DATA

KEROSENE PRICE DATA
(Retail)
Reported in cents

	August		September	
	Week One	Week Three	Week One	Week Three
Average Price	81.40	84.00	86.70	87.30
High Price	84.90	87.80	90.90	91.40
Low Price	76.10	78.70	81.40	82.10

	October		November	
	Week One	Week Three	Week One	Week Three
Average Price	87.80	88.40	88.90	89.50
High Price	91.90	92.40	92.90	93.40
Low Price	82.70	83.40	84.10	84.80

	December		January
	Week One	Week Three	Week One
Average Price	90.10	92.40	94.02
High Price	93.90	94.90	99.00
Low Price	85.50	88.50	89.90

NUMBER TWO PRICE DATA
(Retail)

	August		September	
	Week One	Week Three	Week One	Week Three
Average Price	76.20	78.80	81.50	82.00
High Price	79.40	82.10	84.90	85.20
Low Price	71.30	73.90	76.60	77.10

	October		November	
	Week One	Week Three	Week One	Week Three
Average Price	82.40	82.90	83.30	83.80
High Price	85.60	85.90	86.20	86.60
Low Price	77.50	78.00	78.50	79.00

	December		January
	Week One	Week Three	Week One
Average Price	84.30	86.70	88.02
High Price	86.90	89.90	92.40
Low Price	79.50	83.90	84.90

KEROSENE PRICE DATA
(Rack)
Reported in cents

	August Week One	August Week Three	September Week One	September Week Three
Average Price	69.98	70.82	71.66	72.52
High Price	73.25	74.90	76.58	78.30
Low Price	68.05	68.20	68.35	68.50

	October Week One	October Week Three	November Week One	November Week Three
Average Price	73.39	74.26	75.15	76.05
High Price	80.06	81.86	83.70	85.58
Low Price	68.65	68.80	68.95	69.10

	December Week One	December Week Three	January Week One
Average Price	76.96	76.96	76.96
High Price	87.50	87.50	87.50
Low Price	69.25	69.25	70.10

NUMER TWO PRICE DATA
(Rack)

	August Week One	August Week Three	September Week One	September Week Three
Average Price	66.05	66.67	67.29	69.92
High Price	69.25	70.99	72.78	74.62
Low Price	64.05	64.33	64.60	64.88

	October Week One	October Week Three	November Week One	November Week Three
Average Price	68.55	69.19	69.84	70.49
High Price	76.50	78.42	80.40	82.42
Low Price	65.17	65.45	65.73	66.01

	December Week One	December Week Three	January Week One
Average Price	71.15	71.15	72.04
High Price	84.50	84.50	84.05
Low Price	66.30	66.50	66.30

INVENTORY AND DELIVERY DATA

(Gallons)

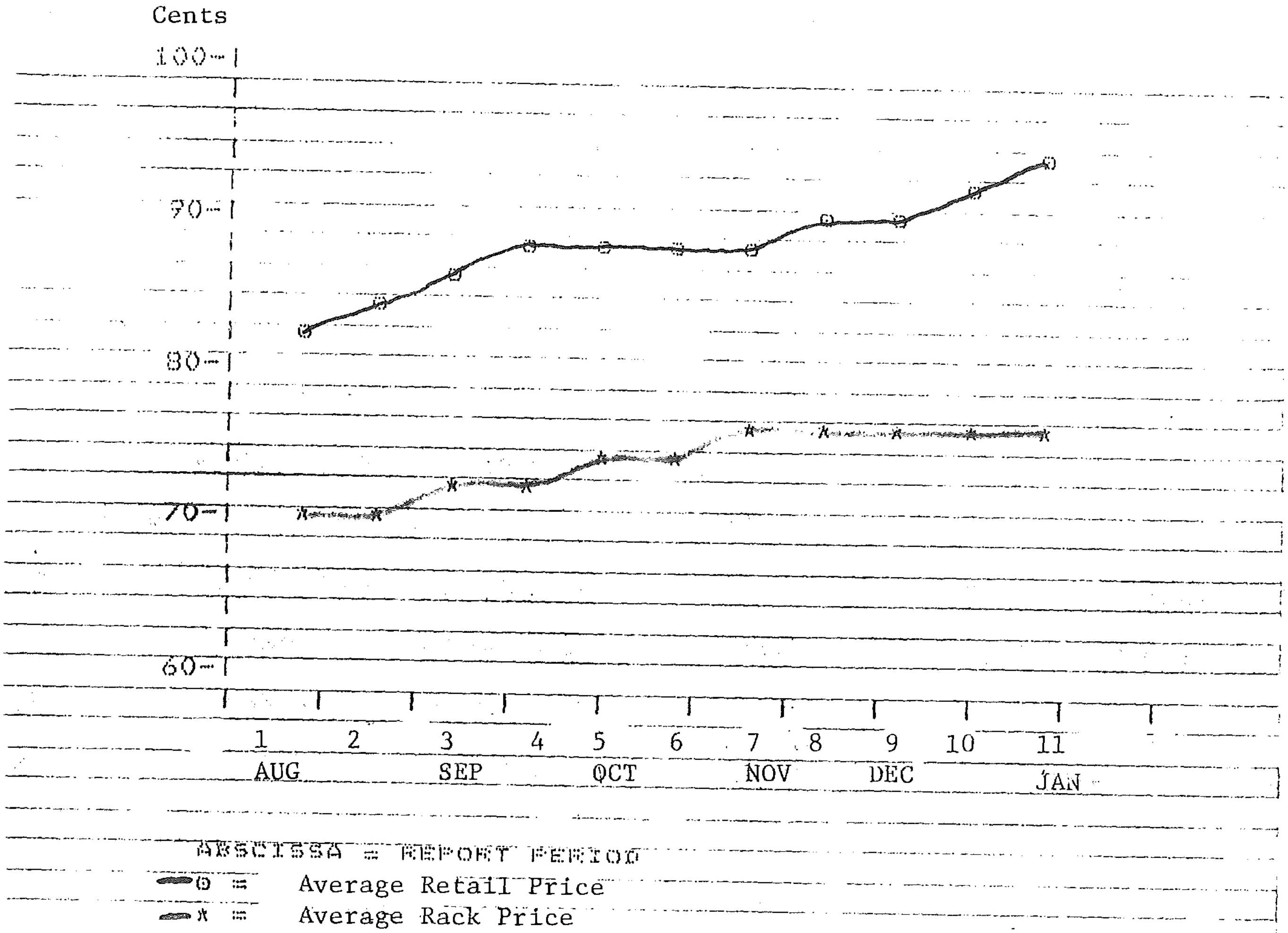
	August		September	
	Week One	Week Three	Week One	Week Three
Inventory-Kero	261482.00	280722.00	301377.00	323552.00
Deliveries-Kero	91985.00	104298.00	118259.00	134090.00
Inventory-#2	1500981.00	1574150.00	1650885.00	1731362.00
Deliveries-#2	832016.00	896767.00	966558.00	1041780.00

	October		November	
	Week One	Week Three	Week One	Week Three
Inventory-Kero	347359.00	372917.00	400356.00	429814.00
Deliveries-Kero	152039.00	172391.00	195467.00	221633.00
Inventory-#2	1815761.00	1904275.00	1997104.00	2094458.00
Deliveries-#2	1122857.00	1210243.00	1304429.00	1405946.00

	December		January
	Week One	Week Three	Week One
Inventory-Kero	461439.00	366985.50	429423.20
Deliveries-Kero	251300.00	251667.70	439976.60
Inventory-#2	2196557.00	2112752.40	2350651.70
Deliveries-#2	1515364.00	2075433.40	2820118.70

SELECTED GRAPHS

KEROSENE



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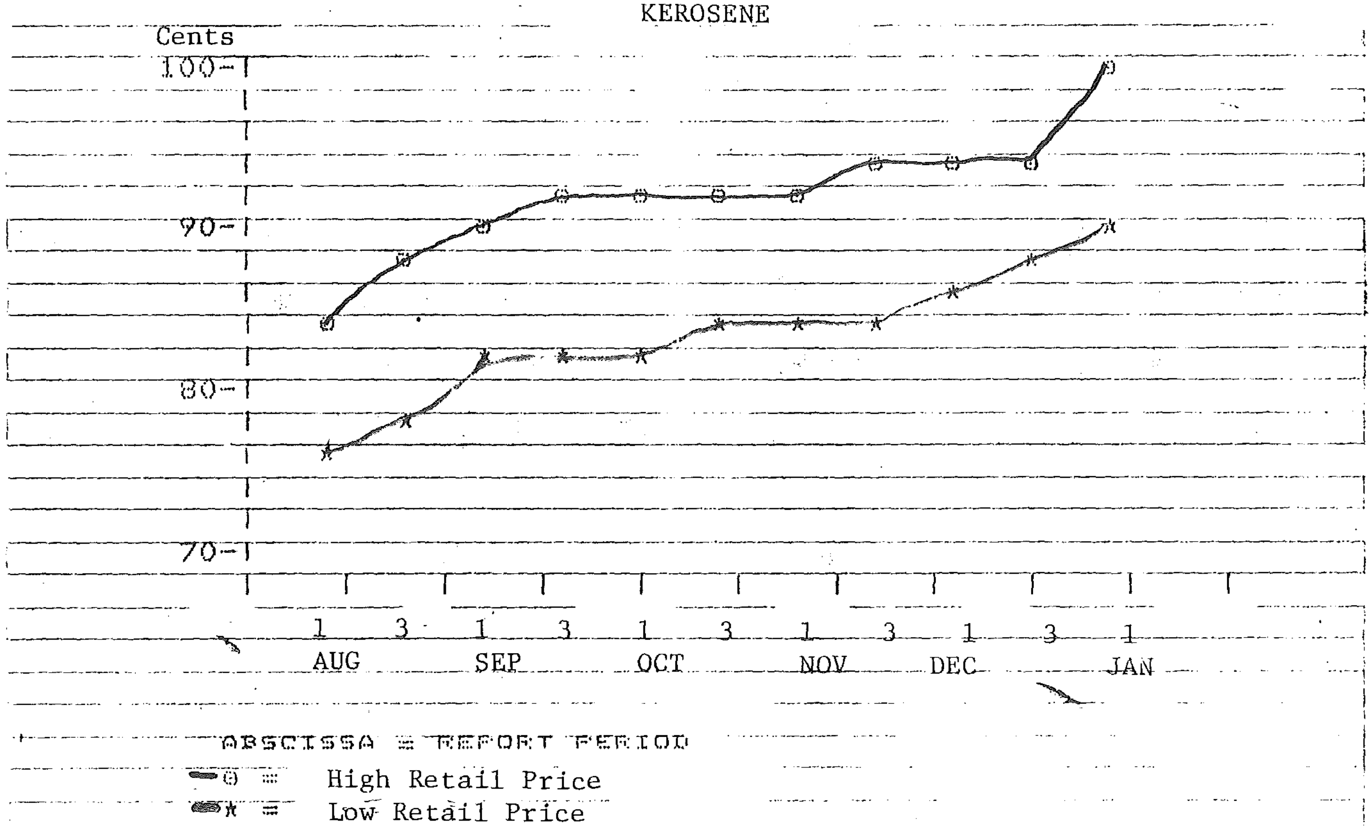

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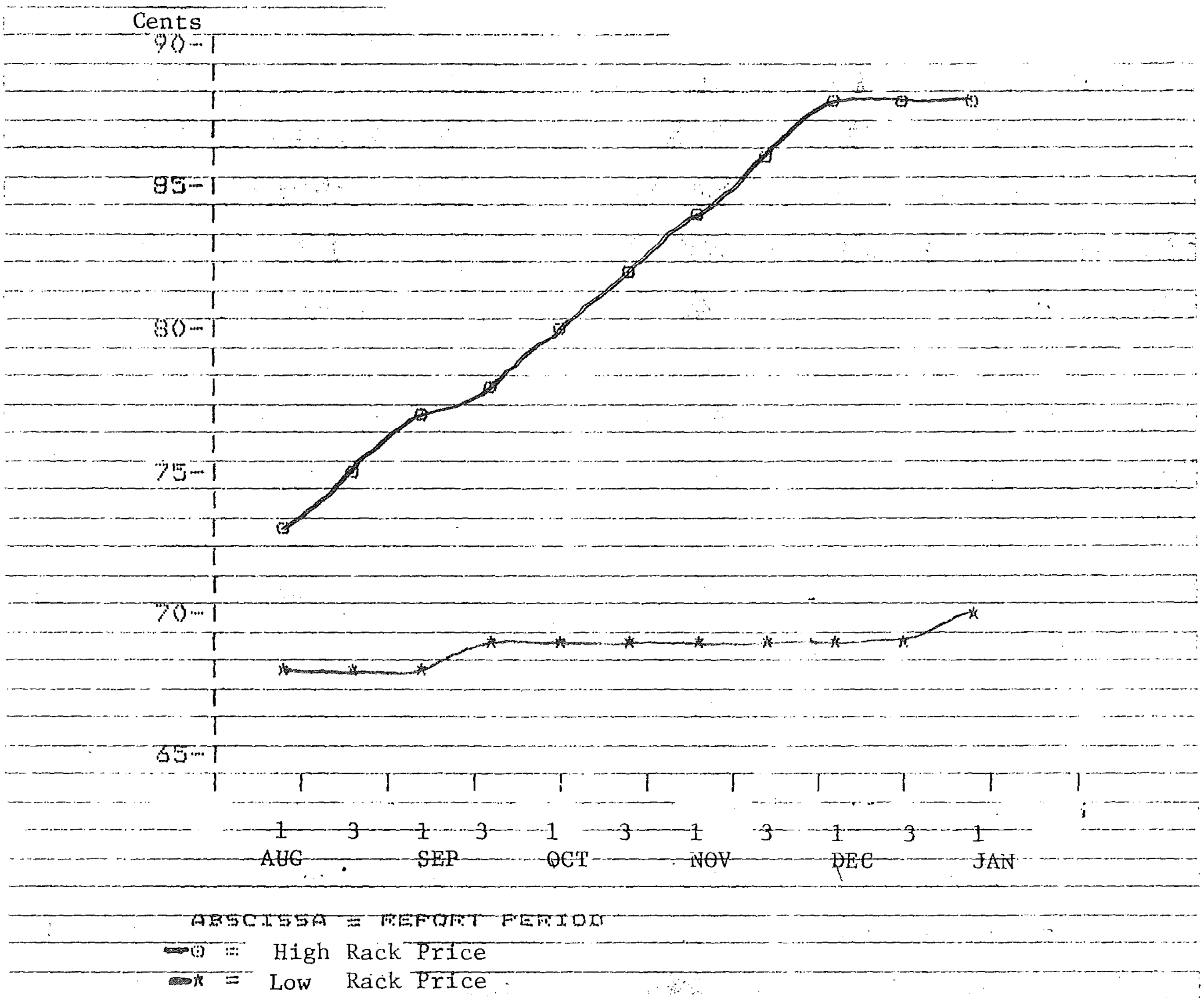
Cents
90-
85-
80-
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70-
65-
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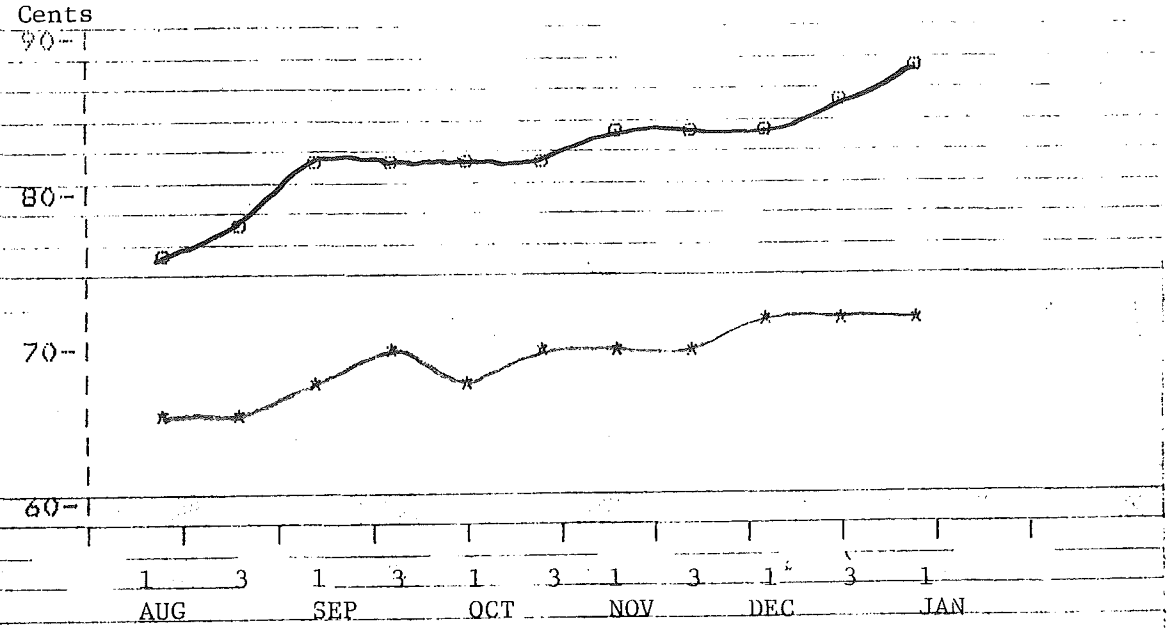
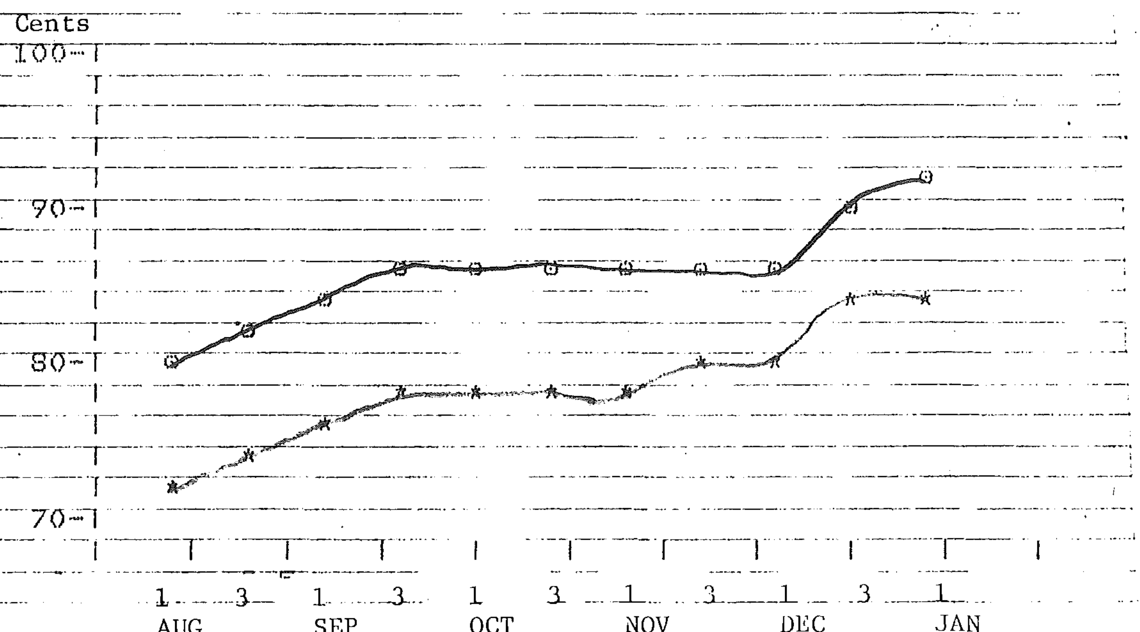
AUG SEP OCT NOV DEC JAN
ABSCISSA = REPORT PERIOD
= High Rack Price
= Low Rack Price

NUMBER TWO



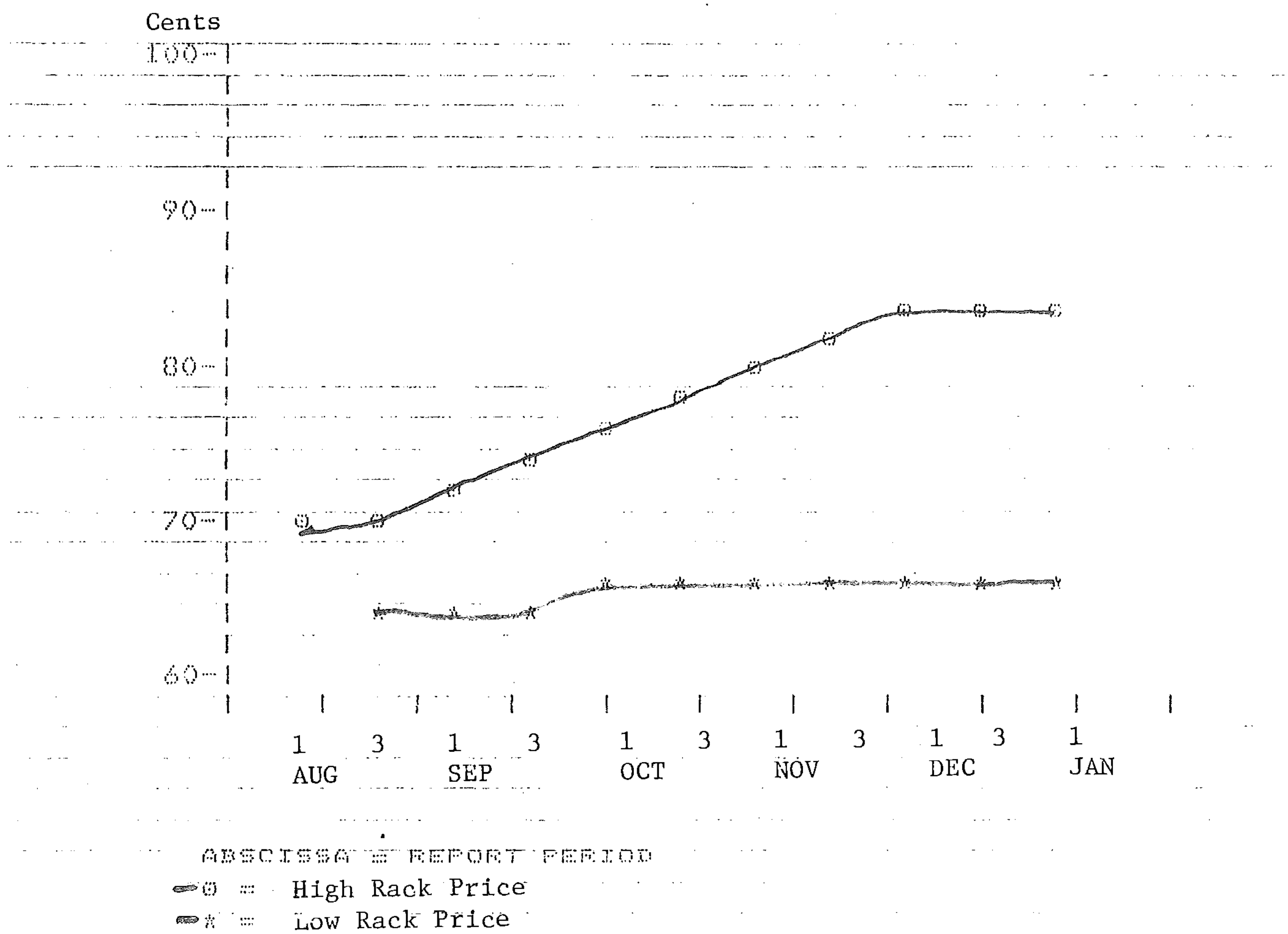
ABSCISSA = REPORT PERIOD
⊙ = Average Retail Price
☆ = Average Rack Price

NUMBER TWO



ABSCISSA = REPORT PERIOD
⊙ = High Retail Price
☆ = Low Retail Price

NUMBER TWO



Cents
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1 OCT
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1 NOV
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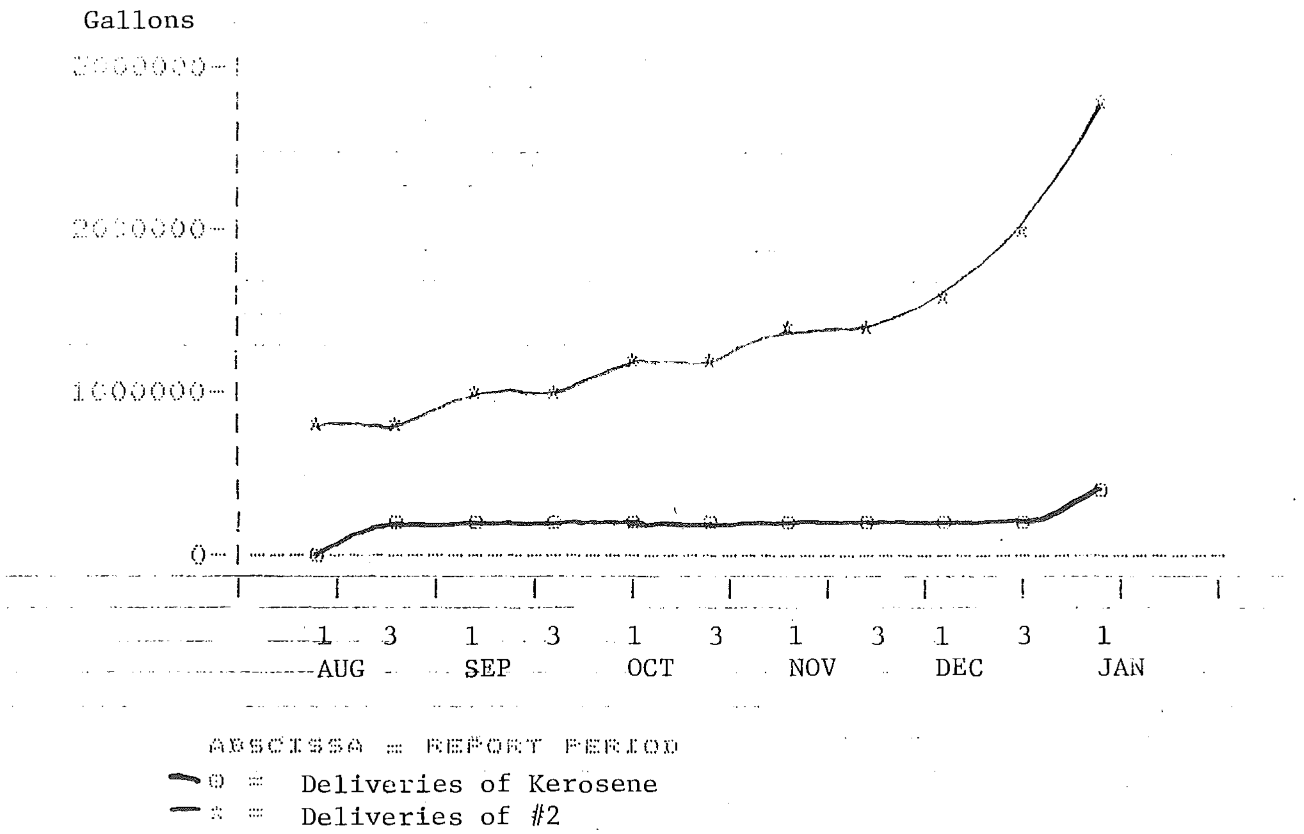
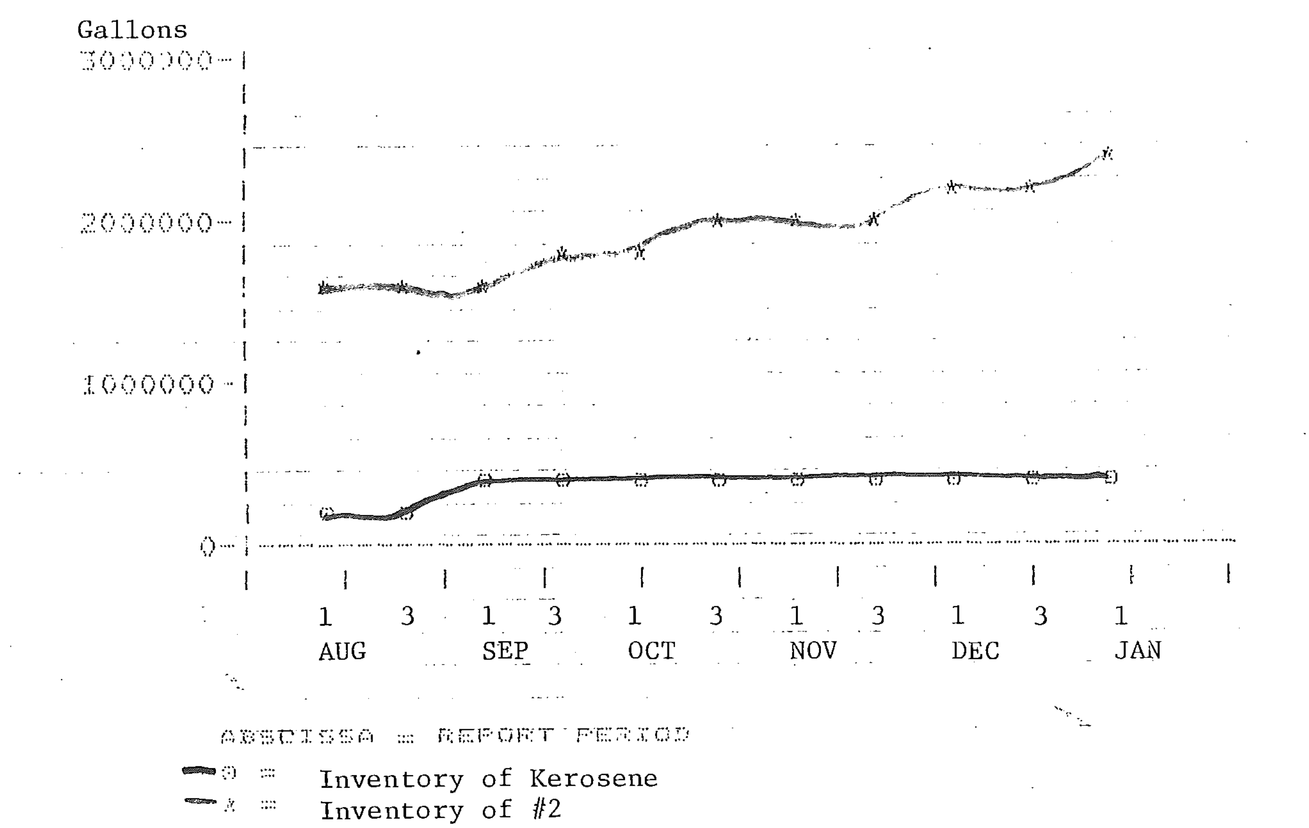
1 DEC
3
1 JAN
ABSCISSA = REPORT PERIOD
⊙ = High Rack Price
☆ = Low Rack Price

DELIVERIES AND INVENTORY





Maine
Office of
Energy
Resources

HEATING OIL USE IN MAINE 1973 - 1979

Compiled by

Richard E. Dow

for the

Maine Office of Energy Resources

September, 1979

TABLE OF CONTENTS

INTRODUCTION

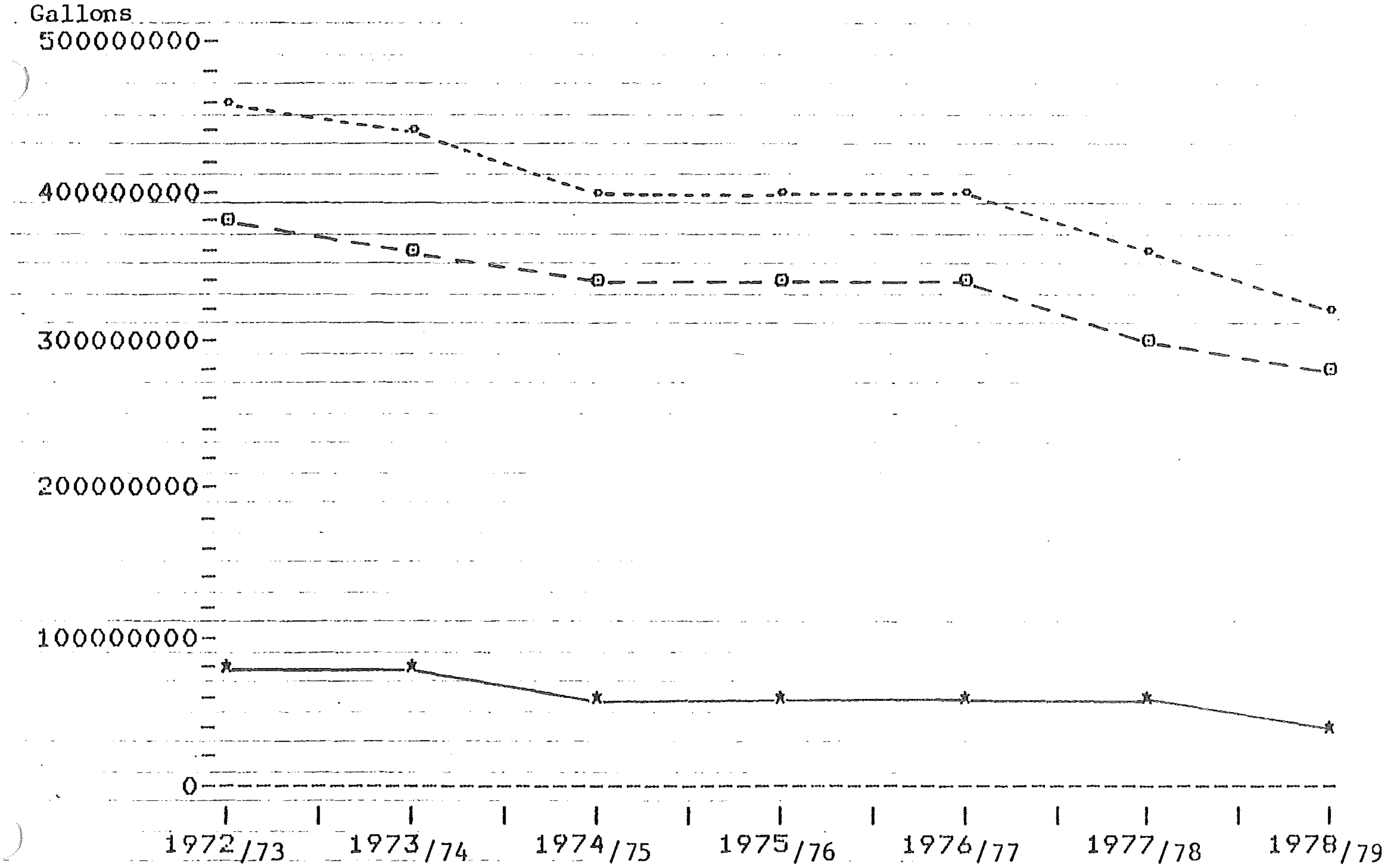
Since the OPEC oil embargo of 1973-74, the Maine Office of Energy Resources (OER) has been examining our energy resources, supplies, demands and use. Spot shortages of heating oil during the winter of 1978-79 re-emphasized the necessity to assess, define and understand our state's heating oil requirements. This report is written as an aid to energy planners in defining adequate supplies and equitable allocation of heating oil when shortages occur.

YEARLY HEATING OIL USE

The page which follows shows total heating oil use in Maine from 1973-1979. The graph indicates #2 heating oil use, kerosene use and total (#2 plus kerosene) use. A tabulation of the data and annual growth rates are included.

This data indicates that our heating oil use has been decreasing since 1972. Maine citizens have been conserving energy. While our population has increased, our heating oil use has decreased significantly.

YEARLY HEATING OIL USE



ABSCISSA = TIME
⊖ = NUM2 YEARLY
* = KERO YEARLY
∘ = HEATING OIL USE

(**physical unit = gallon)

	1973/74	1974/75	1975/76
NUM2 YEARLY	364877000.00	341509000.00	349971000.00
FC1	¯2.94	¯6.40	2.48
KERO YEARLY	71583000.00	60526000.00	59403000.00
FC2	¯9.01	¯15.45	¯1.86
HEATING OIL USE	436460000.00	402035000.00	409374000.00
FC3	¯3.99	¯7.89	1.83

	1976/77	1977/78	1978/79
NUM2 YEARLY	335769000.00	309671000.00	272645000.00
FC1	¯4.06	¯7.77	¯11.96
KERO YEARLY	62198000.00	50661000.00	42374000.00
FC2	4.71	¯18.55	¯16.36
HEATING OIL USE	397967000.00	360332000.00	315019000.00
FC3	¯2.79	¯9.46	¯12.58

HISTORIC MONTHLY HEATING OIL USE

The pages which follow contain a tabulation of monthly heating oil use and percent change from the same month of the previous year. It should be remembered that heating oil consumption is directly related to degree days (weather) and will vary from year to year. A graph of each month by year is included.

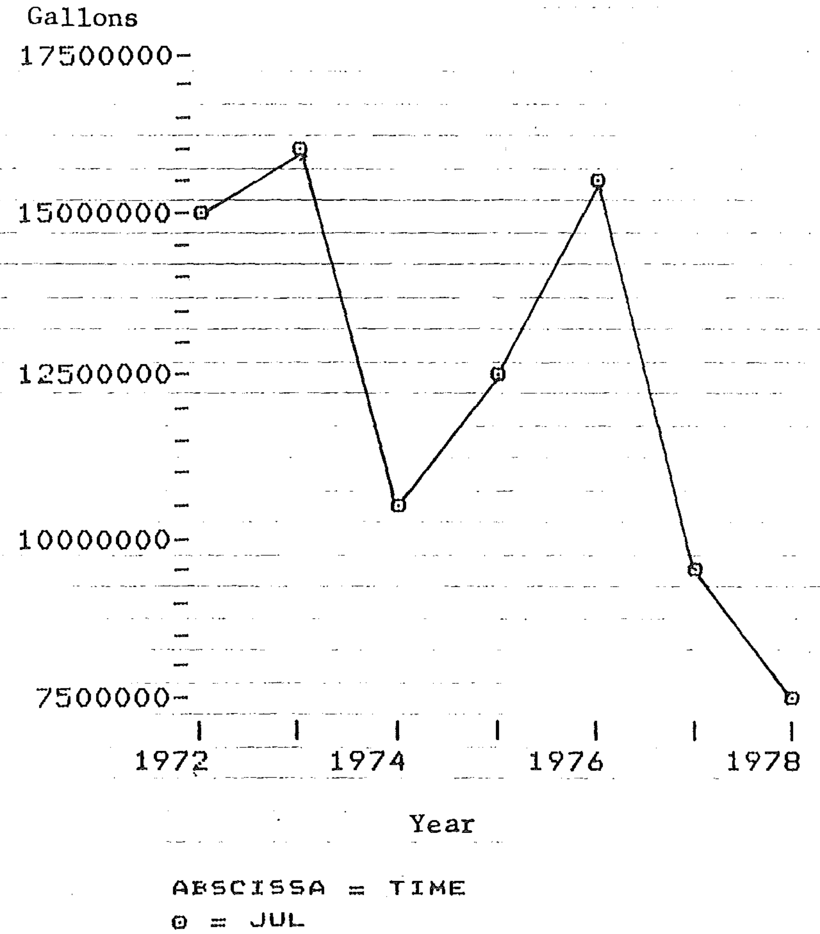
A general downward trend in heating oil use for each month from year to year is apparent. This may be an indication that voluntary conservation has worked or the harsh economic reality of higher heating bills necessitates action or both.

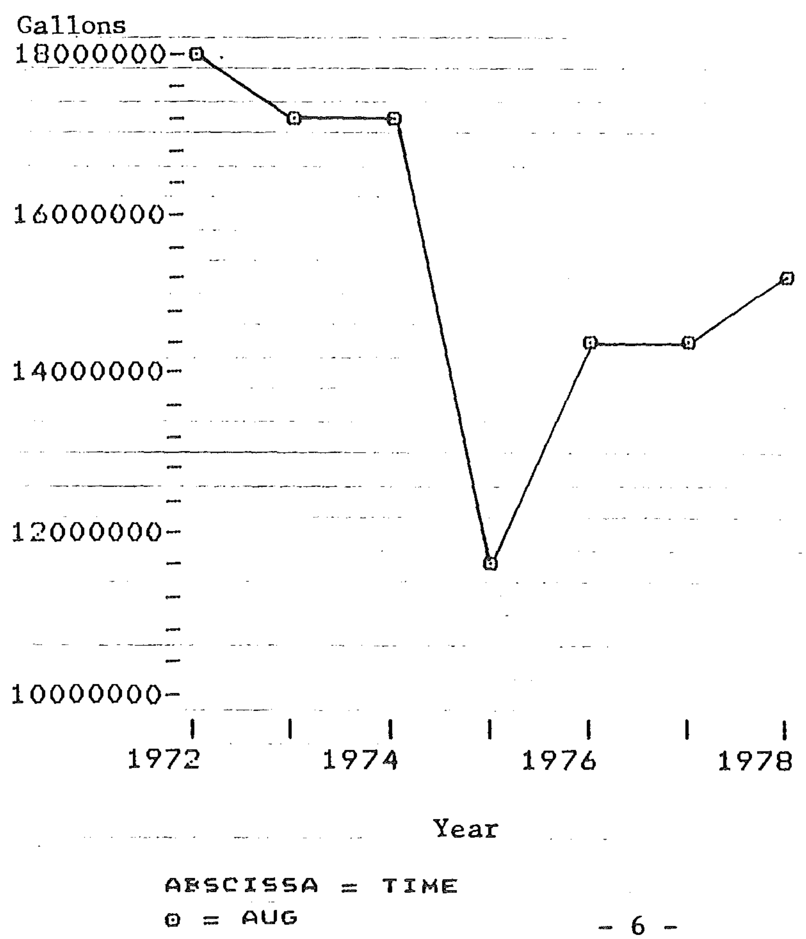
Historic Monthly Heating
Oil Use
in Maine
(Reported in Gallons)

	1973	1974	1975	1976	1977	1978
JUL	16120000.00	10427000.00	12375000.00	15400000.00	9405000.00	7597000.00
JULPC	8.49	¯35.32	18.68	24.44	¯38.93	¯19.22
AUG	17188000.00	17072000.00	11481000.00	14596000.00	14551000.00	15199000.00
AUGPC	¯3.84	¯.67	¯32.75	27.13	¯.31	4.45
SEP	22144000.00	20857000.00	26123000.00	19959000.00	16904000.00	15202000.00
SEPPC	2.96	¯5.81	25.25	¯23.60	¯15.31	¯10.07
OCT	43478000.00	41658000.00	37226000.00	29932000.00	22035000.00	25282000.00
OCTPC	91.91	¯4.19	¯10.64	¯19.59	¯26.38	14.74
NOV	48510000.00	32652000.00	33313000.00	43854000.00	27686000.00	30607000.00
NOVPC	¯14.55	¯32.69	2.02	31.64	¯36.87	10.55
DEC	56585000.00	61155000.00	55921000.00	54268000.00	47242000.00	42216000.00
DECPC	¯14.21	8.08	¯8.56	¯2.96	¯12.95	¯10.64

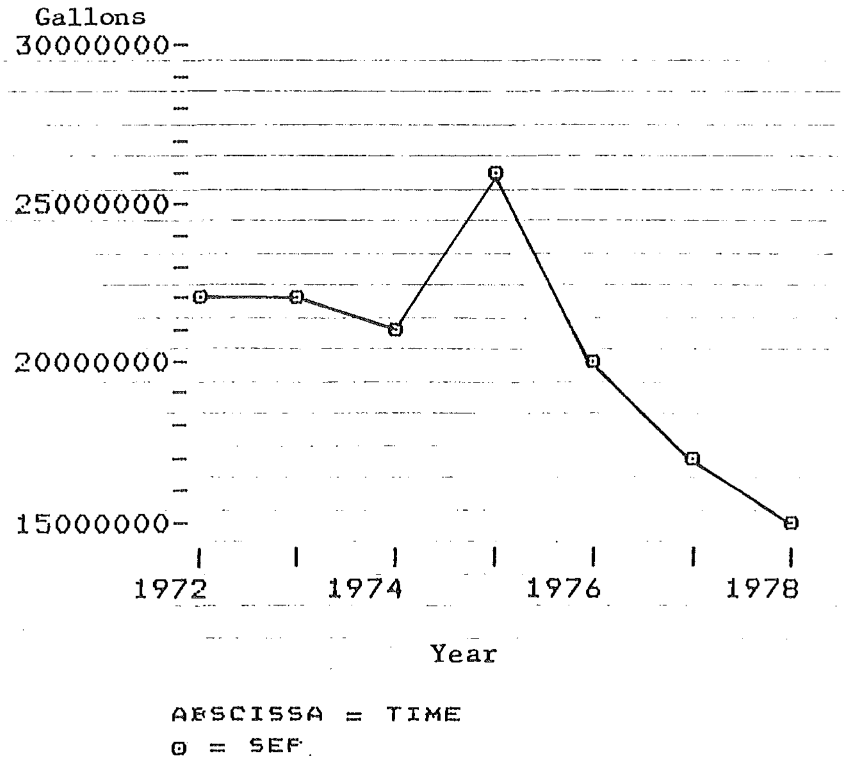
	1974	1975	1976	1977	1978	1979
JAN	61960000.00	59915000.00	71991000.00	65701000.00	57021000.00	46901000.00
JANPC	¯18.10	¯3.30	20.16	¯8.74	¯13.21	¯17.75
FEB	49765000.00	48216000.00	46617000.00	53009000.00	52939000.00	40700000.00
FEBPC	¯18.03	¯3.11	¯3.32	13.71	¯.13	¯23.12
MAR	45884000.00	38121000.00	46381000.00	42399000.00	44961000.00	33237000.00
MARPC	¯1.28	¯16.92	21.67	¯8.59	6.04	¯26.08
APR	38487000.00	32240000.00	29891000.00	25463000.00	30907000.00	28626000.00
APRPC	16.09	¯16.23	¯7.29	¯14.81	21.38	¯7.38
MAY	25900000.00	23944000.00	22317000.00	20393000.00	24040000.00	18956000.00
MAYPC	¯1.79	¯7.55	¯6.80	¯8.62	17.88	¯21.15
JUN	10439000.00	15778000.00	15738000.00	12993000.00	12641000.00	10496000.00
JUNPC	¯17.20	51.14	¯.25	¯17.44	¯2.71	¯16.97

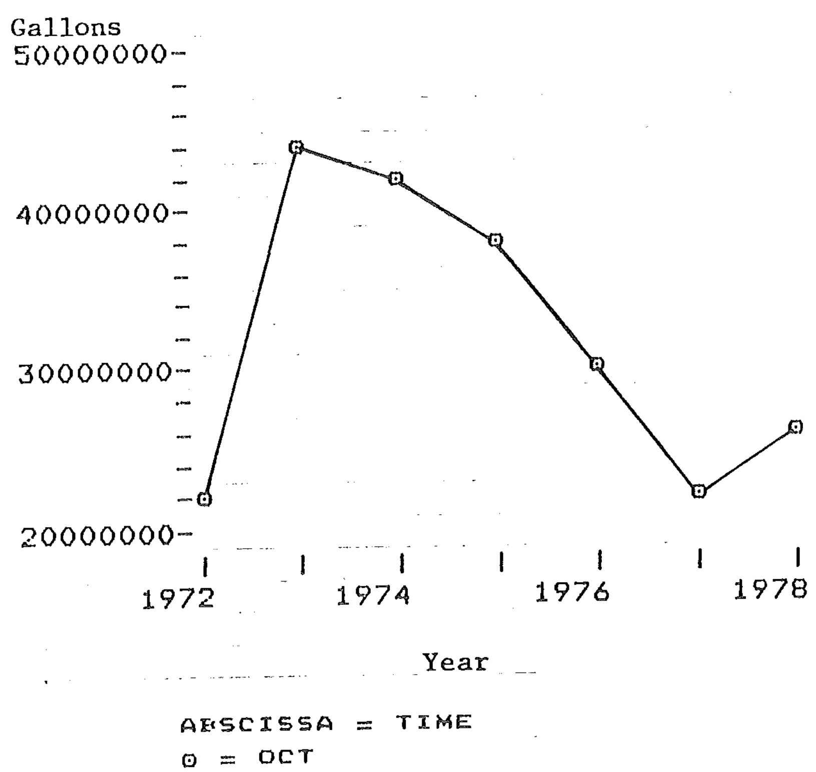
TOTAL HEATING OIL USE



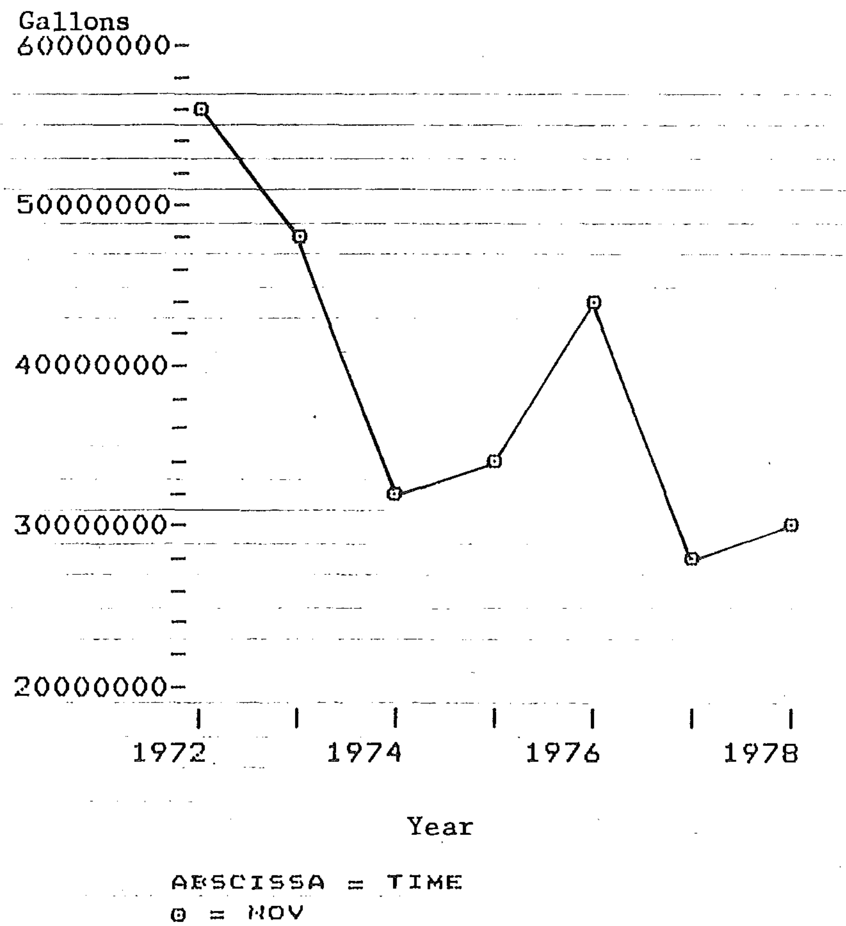


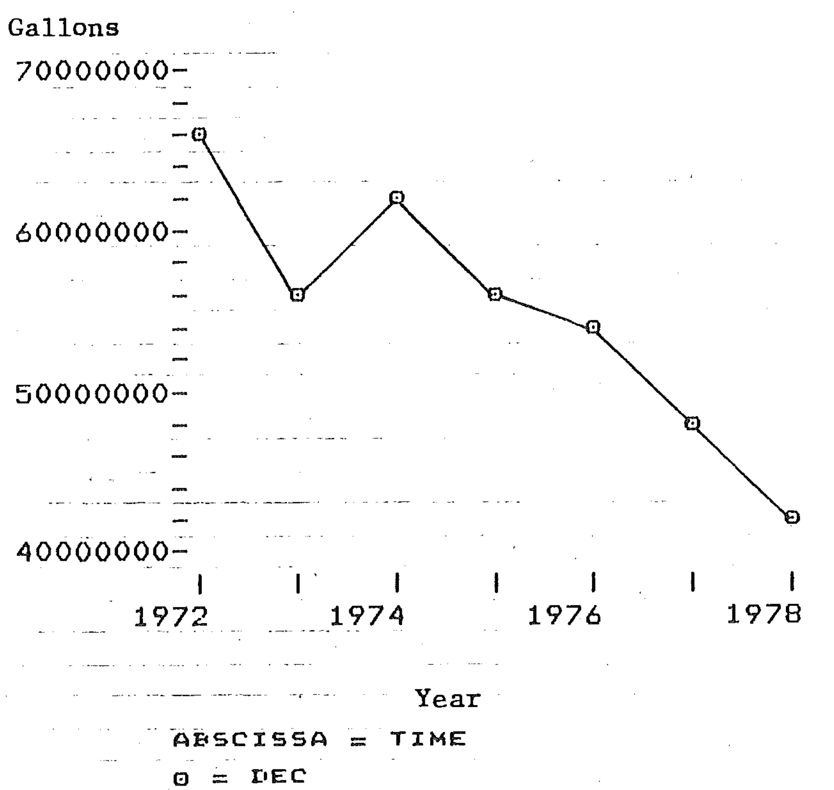
TOTAL HEATING OIL USE



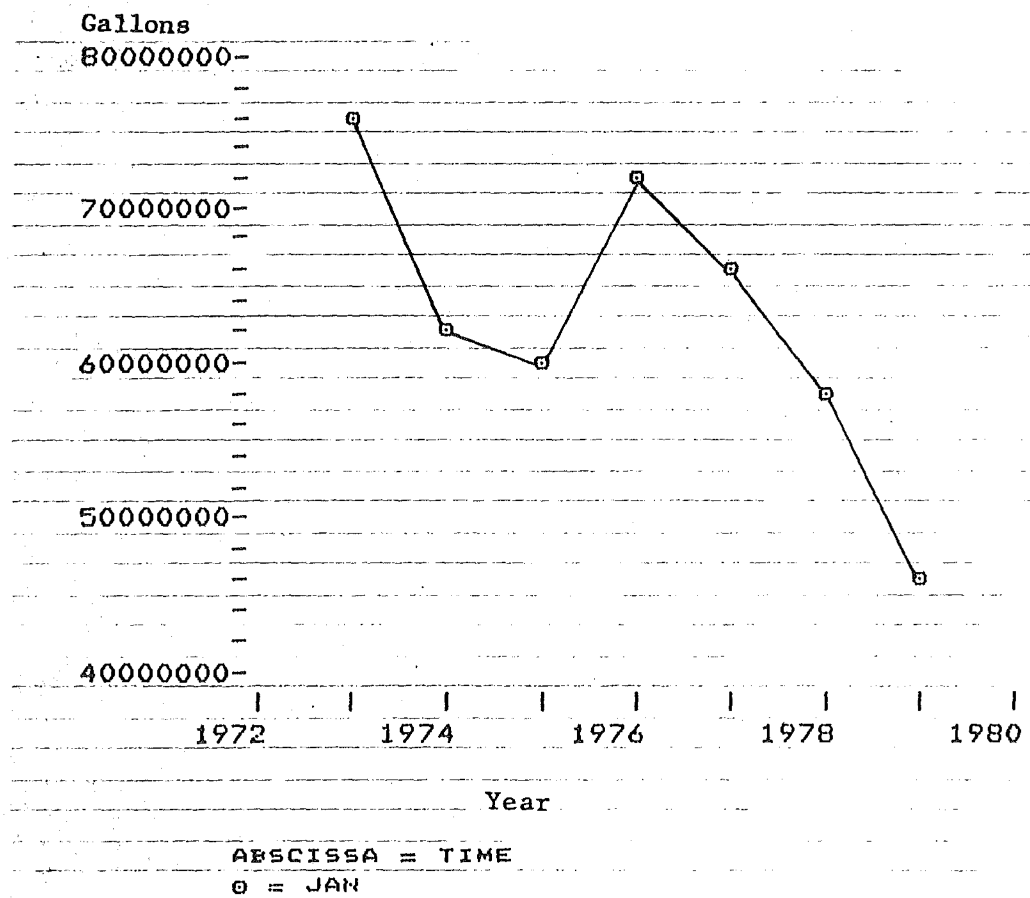


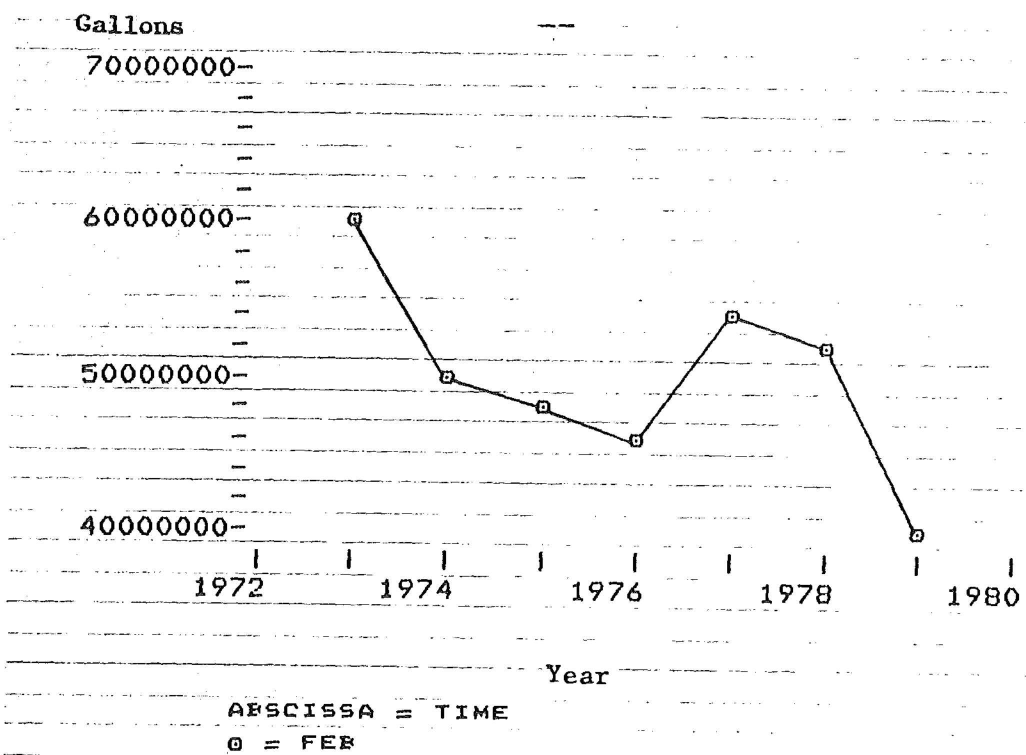
TOTAL HEATING OIL USE



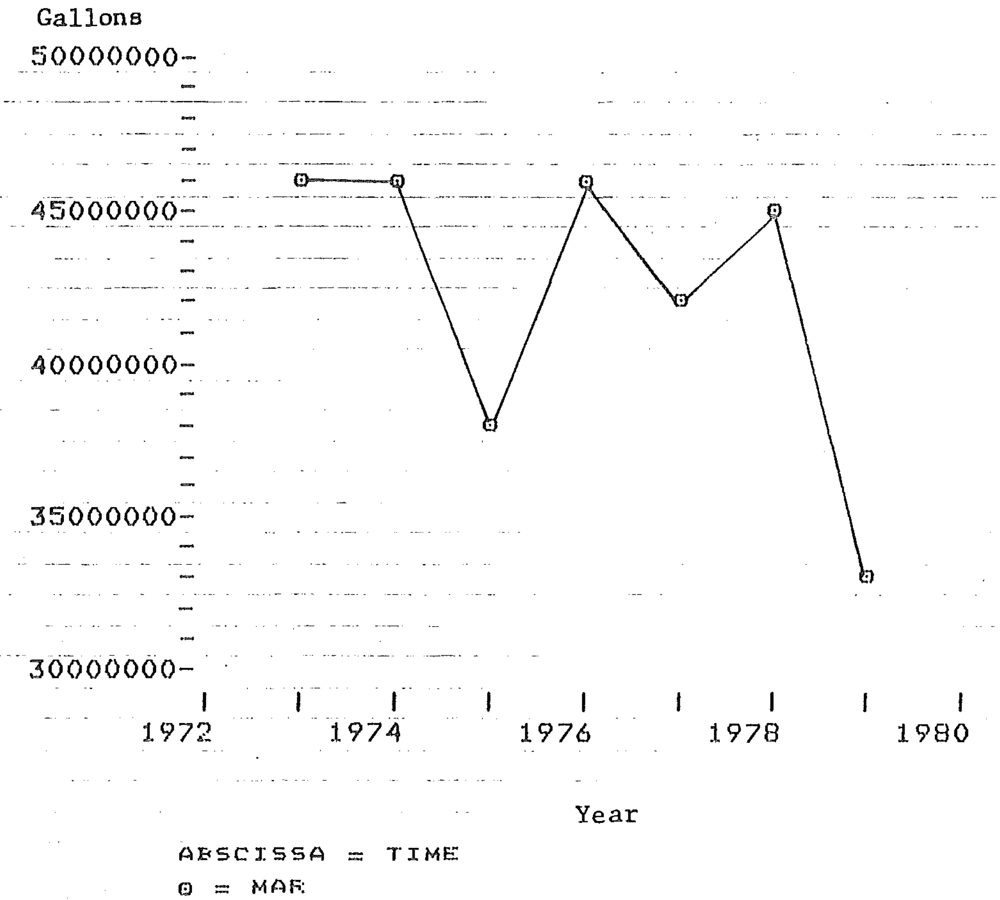


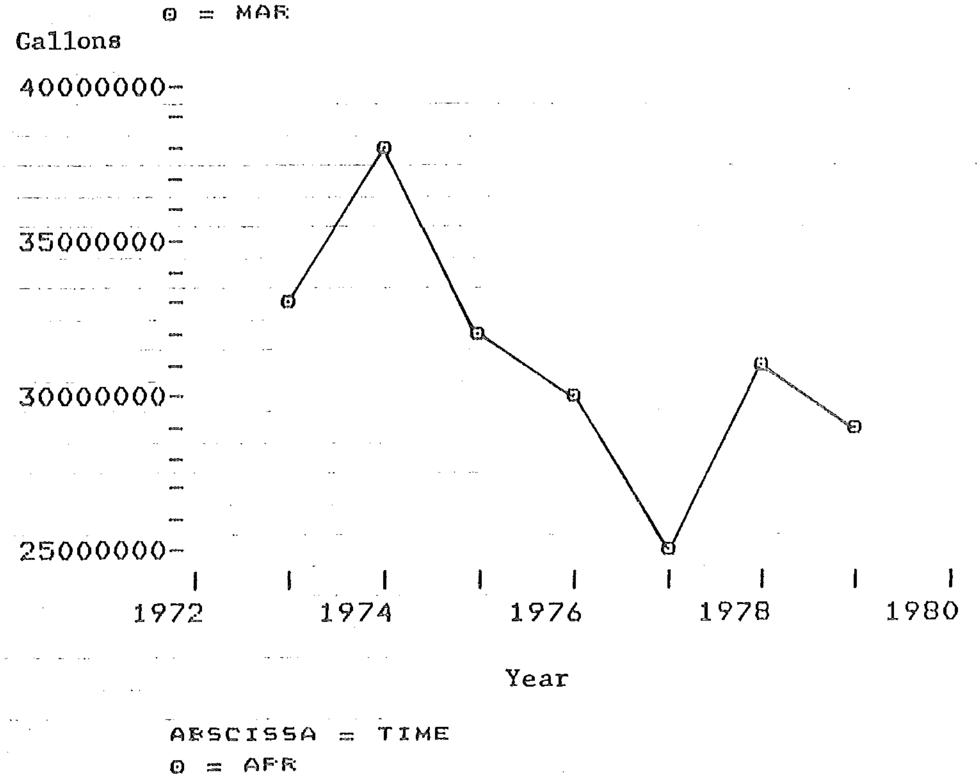
TOTAL HEATING OIL USE



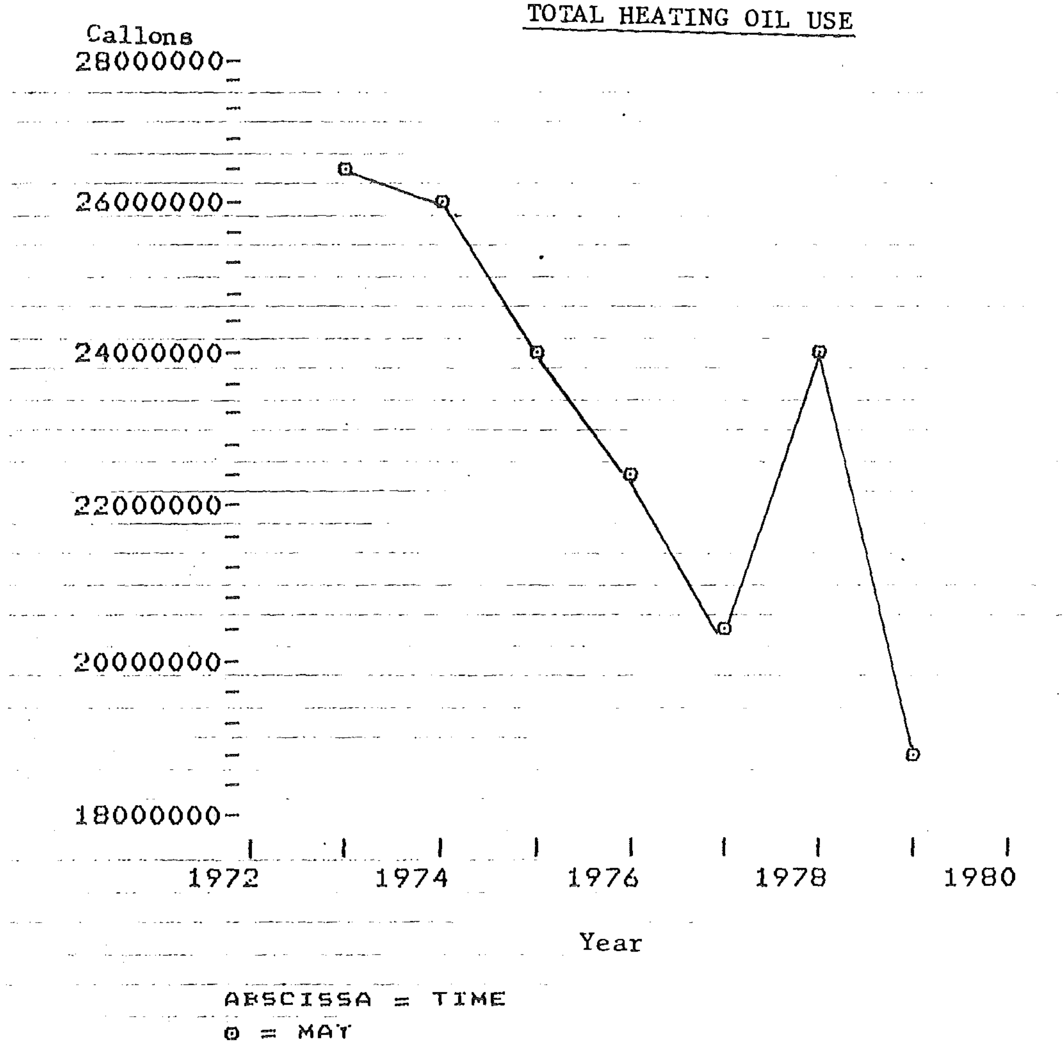


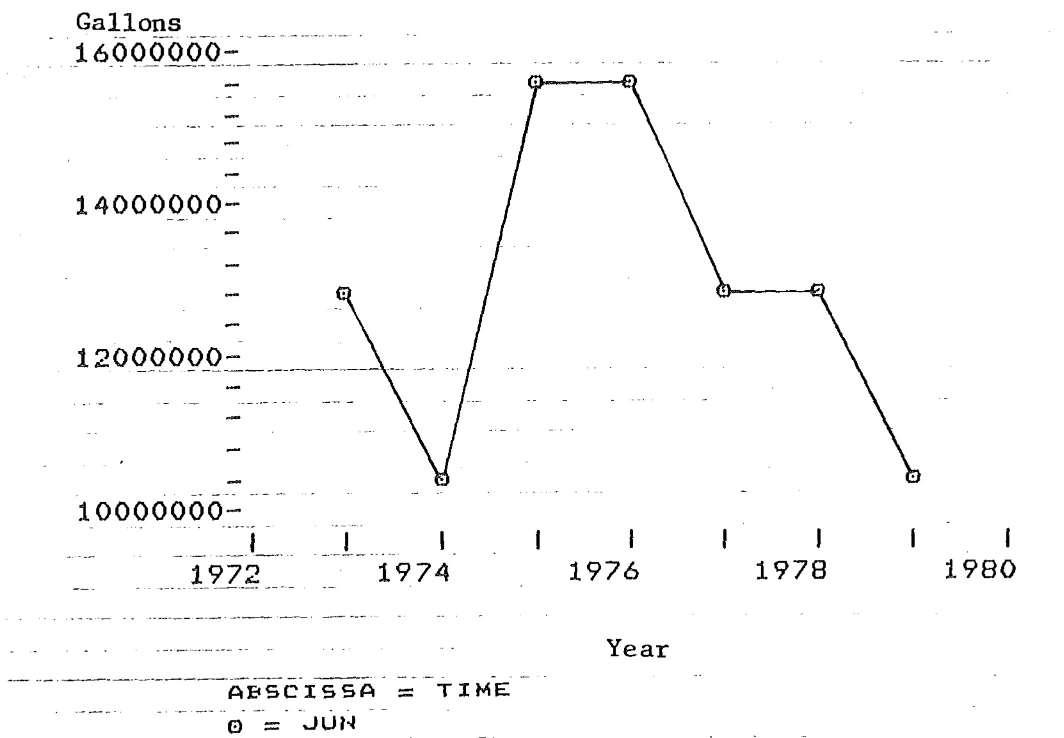
TOTAL HEATING OIL USE





TOTAL HEATING OIL USE





HISTORIC MONTHLY #2 HEATING OIL USE

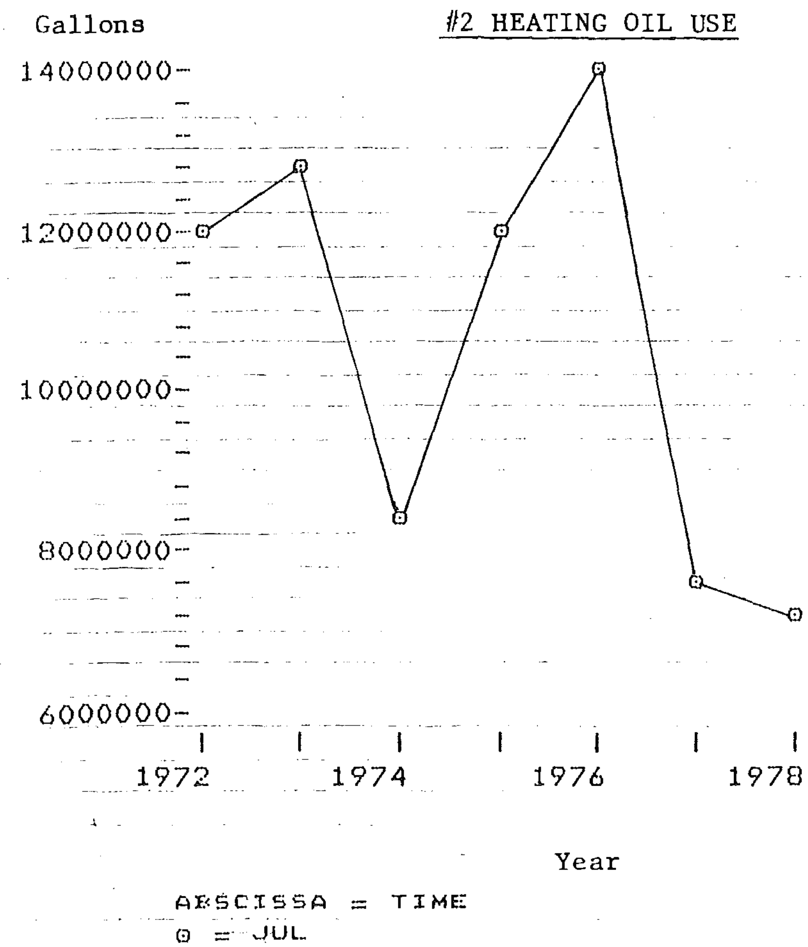
The pages which follow contain a tabulation of the monthly #2 heating oil use and graphs of this data. The trends follow the patterns described in the previous section, HISTORIC MONTHLY HEATING OIL USE.

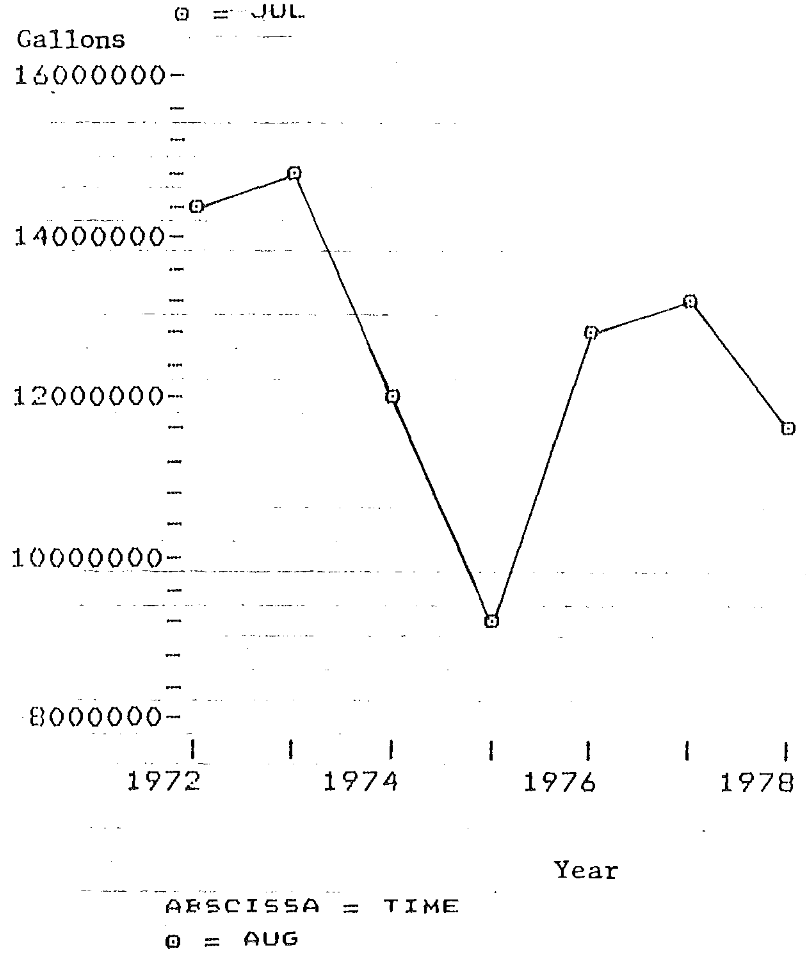
Historic Monthly #2 Heating Oil
Use in Maine
(Reported in Gallons)

	1973	1974	1975	1976	1977	1978
JUL	12985000.00	8472000.00	11830000.00	13931000.00	7537000.00	7313000.00
JULPC	6.59	¯34.76	39.64	17.76	¯45.90	¯2.97
AUG	14670000.00	12089000.00	9120000.00	12738000.00	13121000.00	11551000.00
AUGPC	3.25	¯17.59	¯24.56	39.67	3.01	¯11.97
SEP	16826000.00	17065000.00	23145000.00	16471000.00	13940000.00	12702000.00
SEPPC	¯2.13	1.42	35.63	¯28.84	¯15.37	¯8.88
OCT	37046000.00	35549000.00	28444000.00	24776000.00	18726000.00	21198000.00
OCTPC	149.50	¯4.04	¯19.99	¯12.90	¯24.42	13.20
NOV	39880000.00	26470000.00	28976000.00	37379000.00	22241000.00	26887000.00
NOVPC	¯16.03	¯33.63	9.47	29.00	¯40.50	20.89
DEC	47560000.00	53211000.00	46147000.00	49155000.00	40178000.00	37416000.00
DECPC	¯14.04	11.88	¯13.28	6.52	¯18.26	¯6.87

	1974	1975	1976	1977	1978	1979
JAN	50153000.00	49862000.00	61837000.00	54938000.00	49930000.00	39177000.00
JANPC	¯20.36	¯.58	24.02	¯11.16	¯9.12	¯21.54
FEB	40646000.00	40587000.00	40304000.00	43897000.00	47931000.00	35000000.00
FEBPC	¯18.81	¯.15	¯.70	8.91	9.19	¯26.98
MAR	39089000.00	33848000.00	40156000.00	35300000.00	37871000.00	29426000.00
MARPC	¯1.65	¯13.41	18.64	¯12.09	7.28	¯22.30
APR	32976000.00	28924000.00	26819000.00	20004000.00	27212000.00	25462000.00
APRPC	15.46	¯12.29	¯7.28	¯25.41	36.03	¯6.43
MAY	23520000.00	21176000.00	18795000.00	16891000.00	21193000.00	16655000.00
MAYPC	6.44	¯9.97	¯11.24	¯10.13	25.47	¯21.41
JUN	9526000.00	14256000.00	14398000.00	10289000.00	9791000.00	9858000.00
JUNPC	¯15.26	49.65	1.00	¯28.54	¯4.84	.68

#2 HEATING OIL USE





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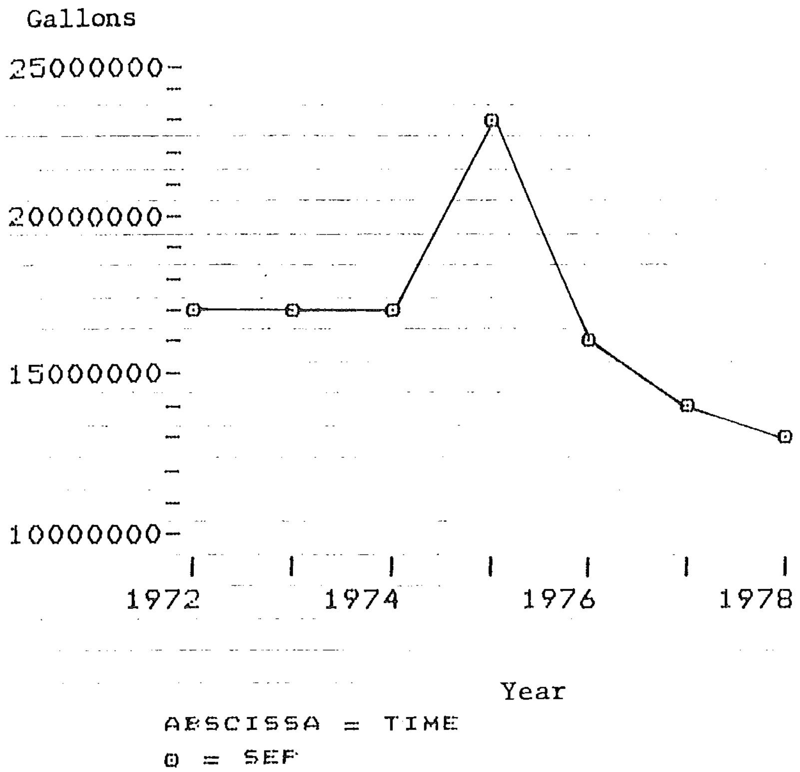

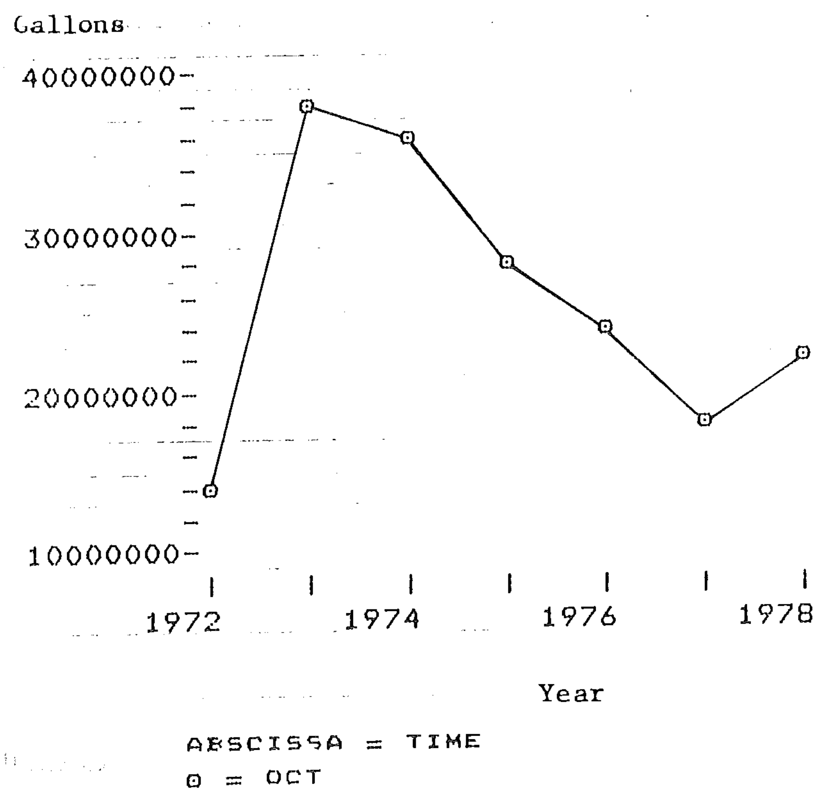

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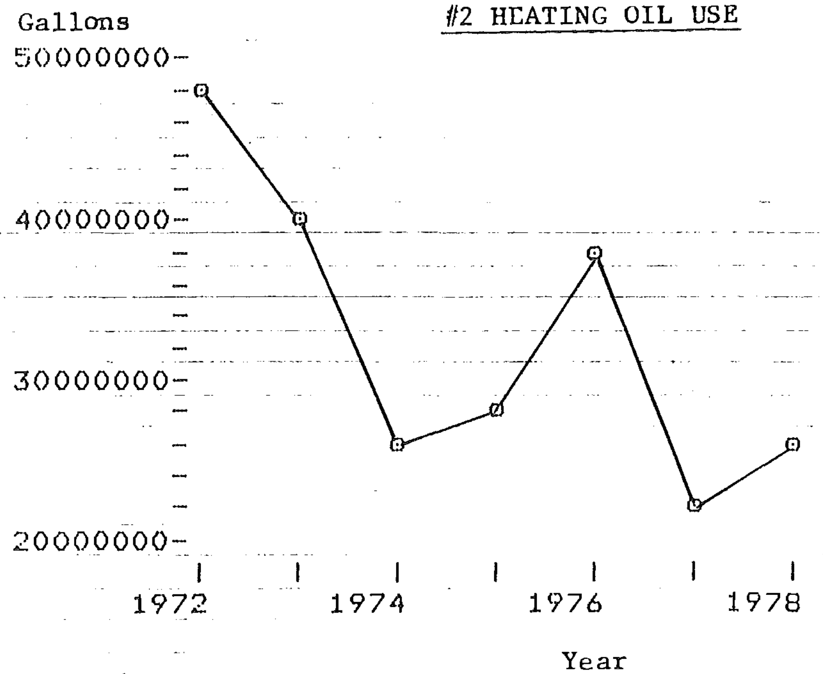

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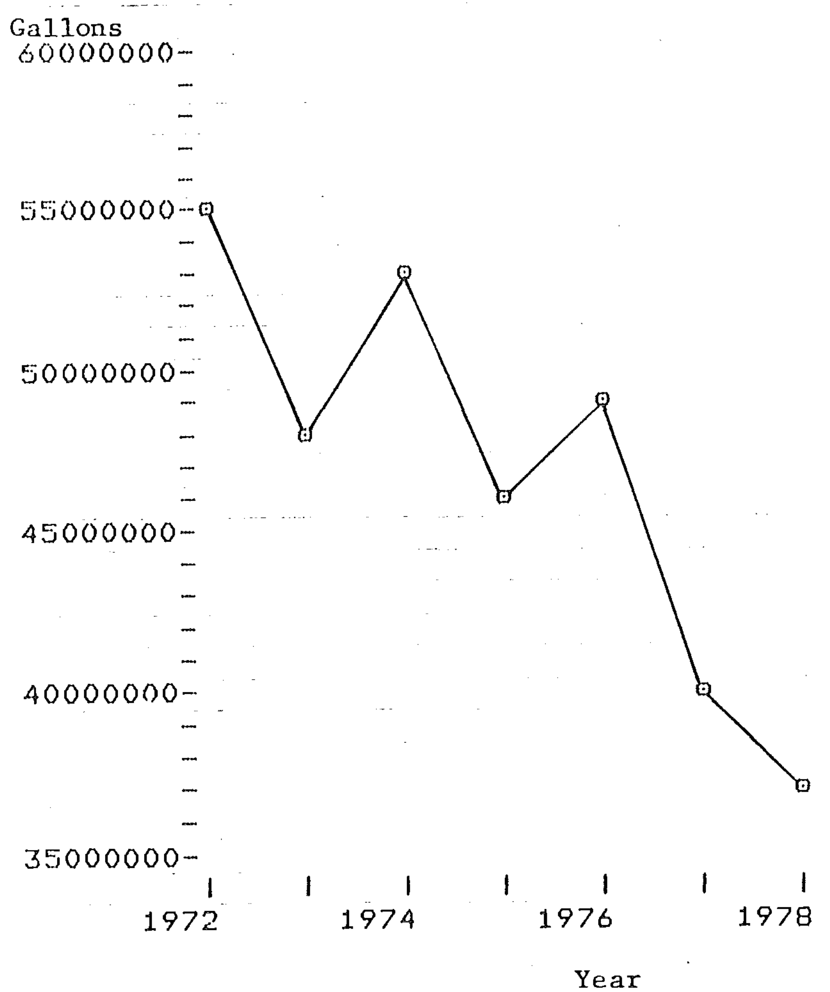
⊡ = NOV



ABSCISSA = TIME
⊡ = DEC

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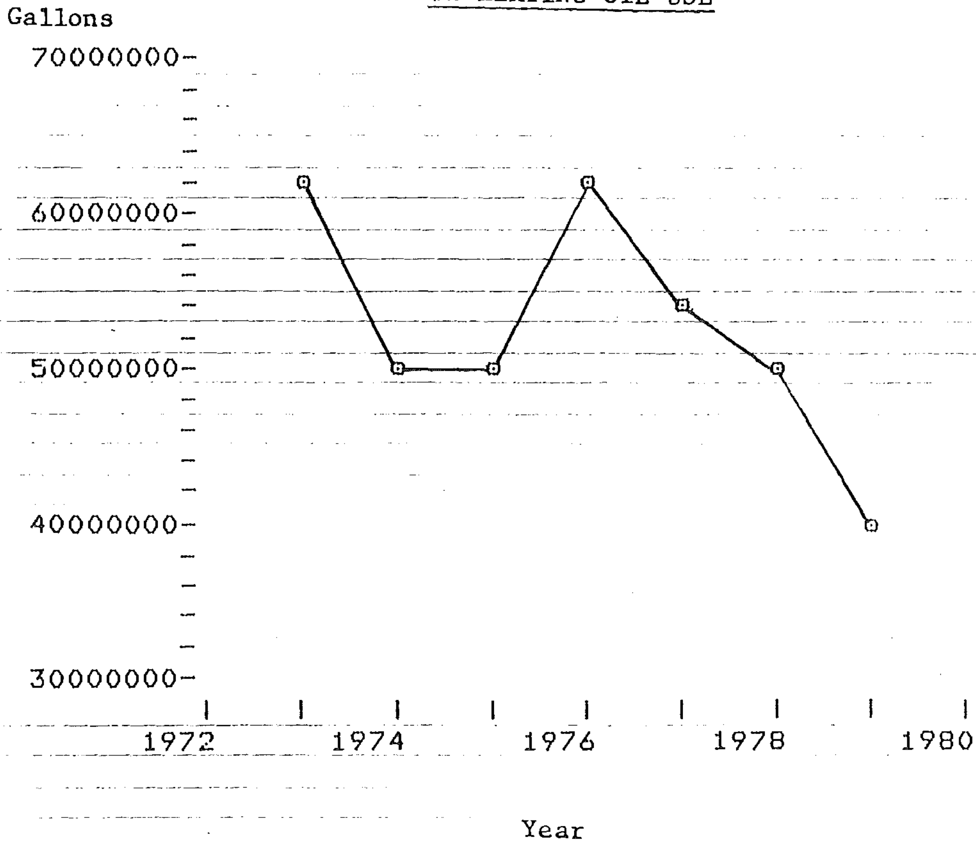

ABSCISSA = TIME
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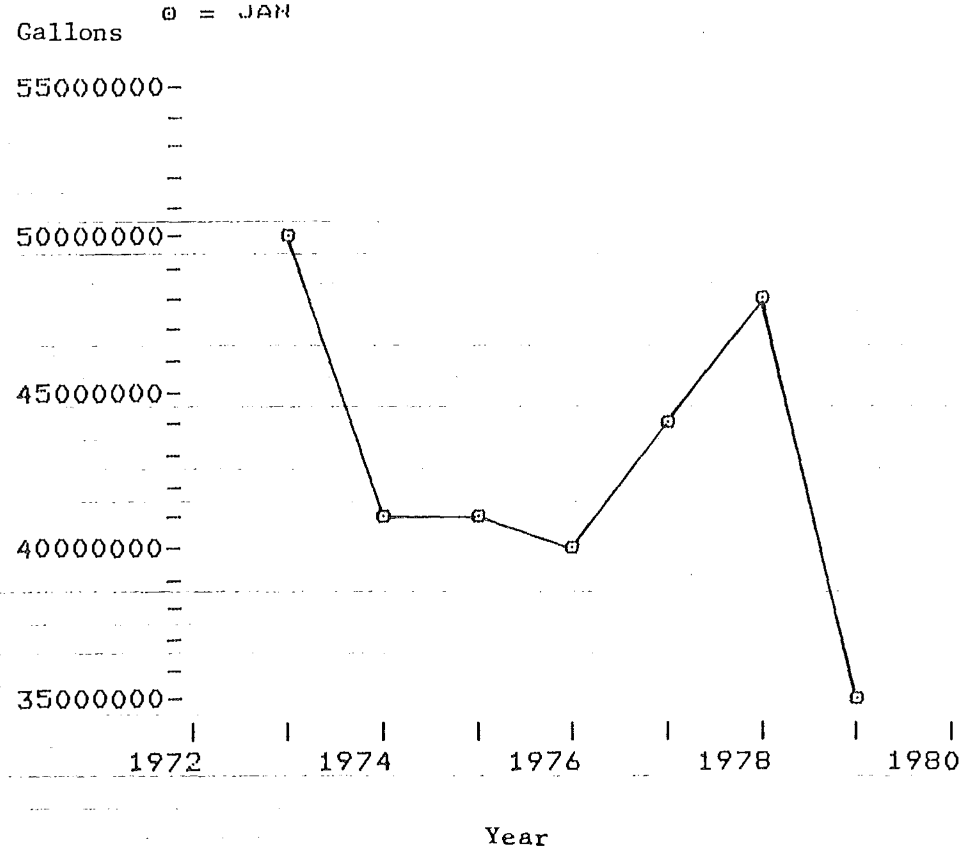

ABSCISSA = TIME
⊙ = FEB

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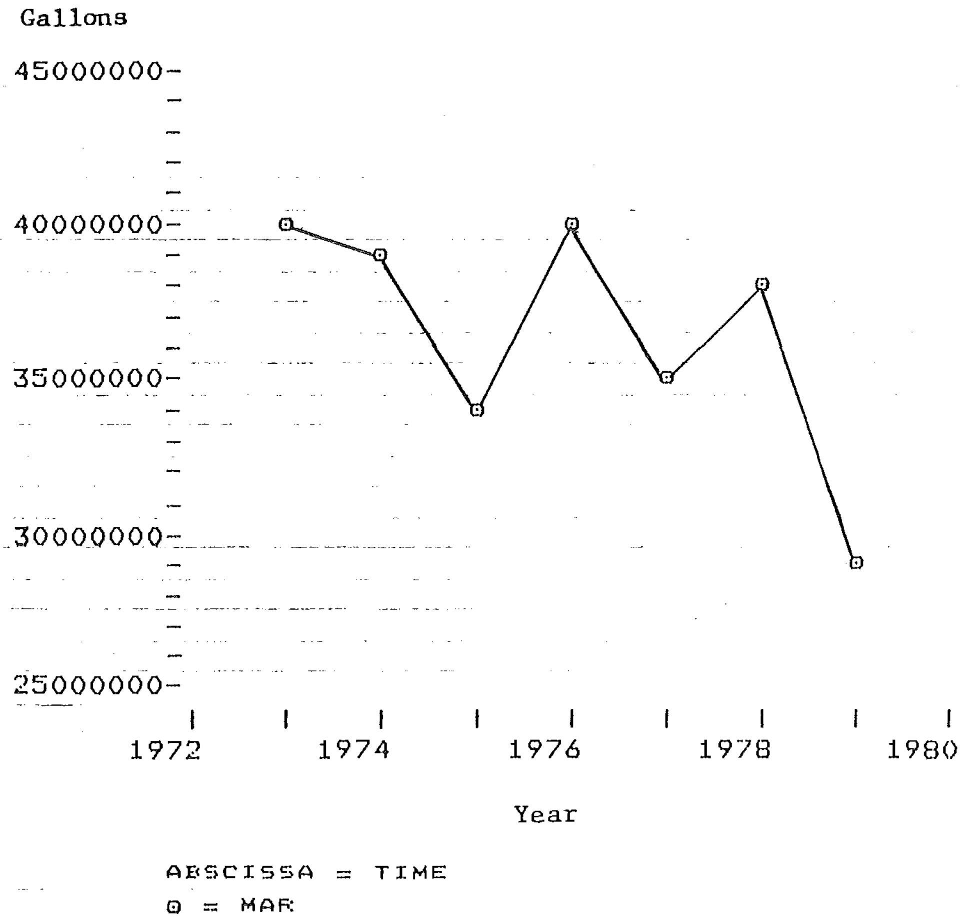

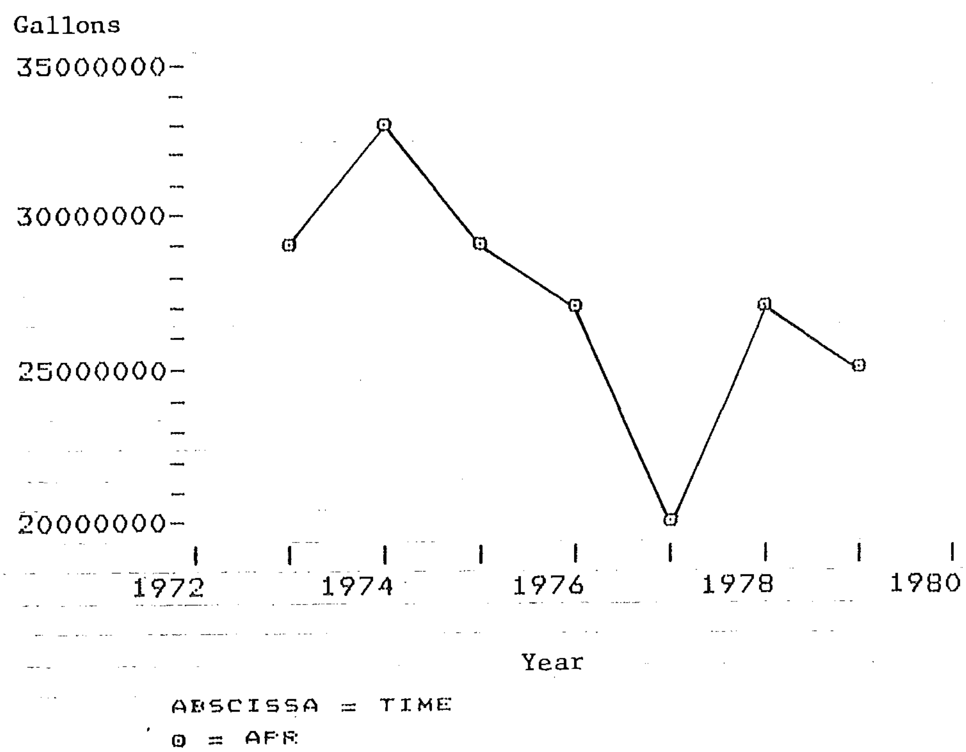

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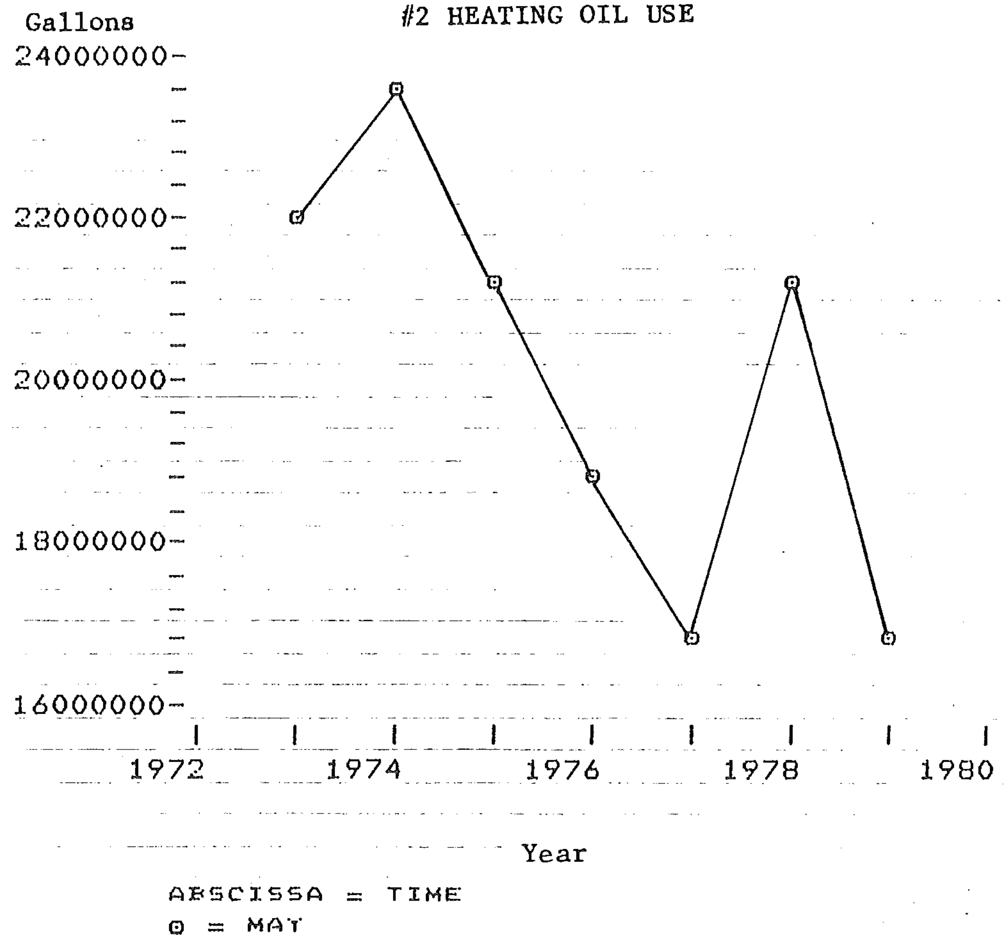
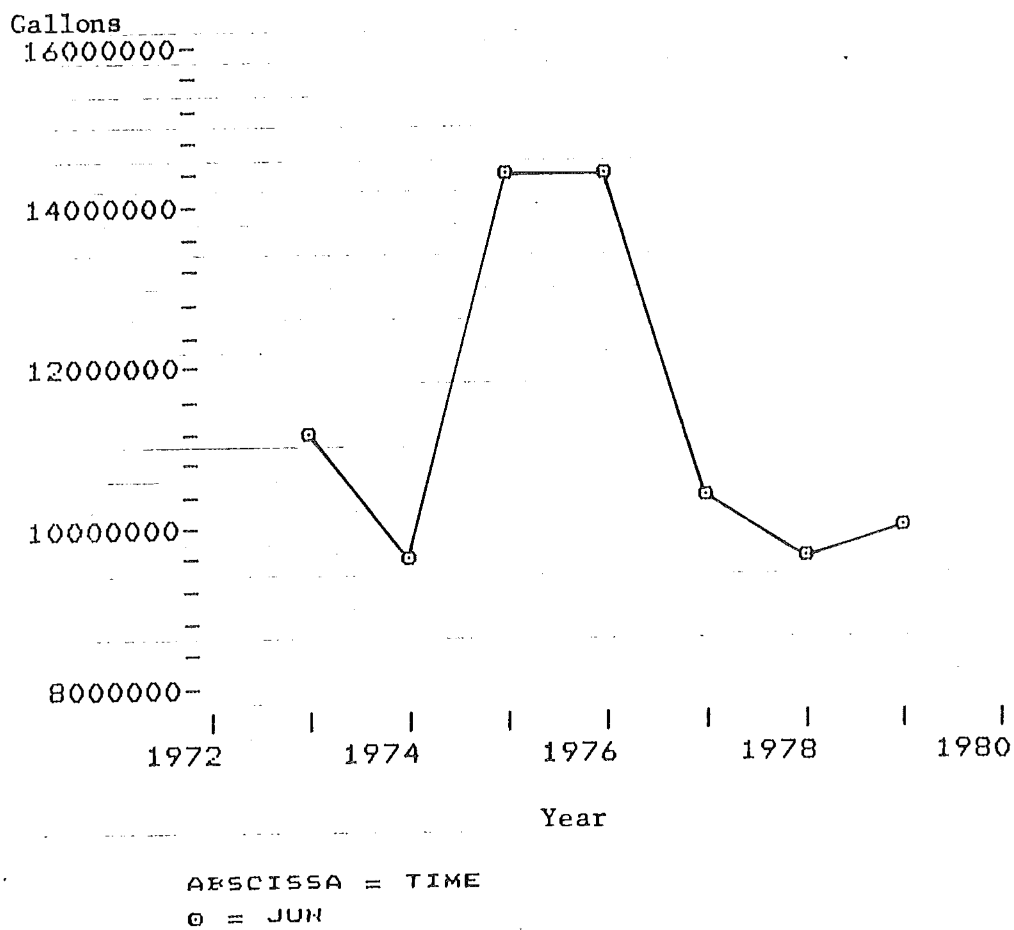




HISTORIC MONTHLY KEROSENE USE

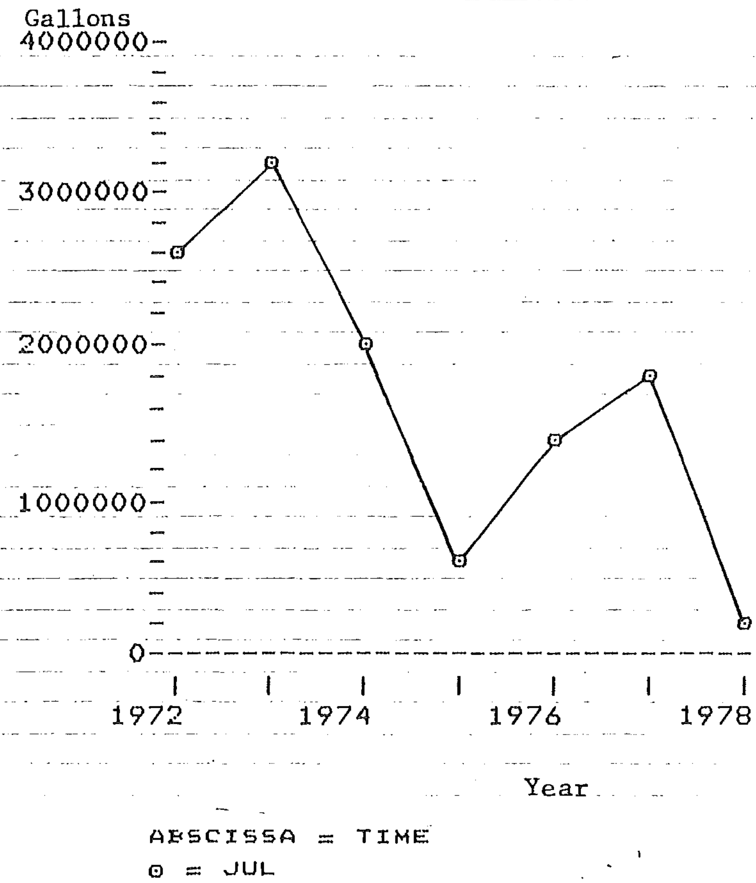
The following pages contain a tabulation of the monthly kerosene use data and a graphic illustration of each month by year. The trends follow those described in the section HISTORIC MONTHLY HEATING OIL USE.

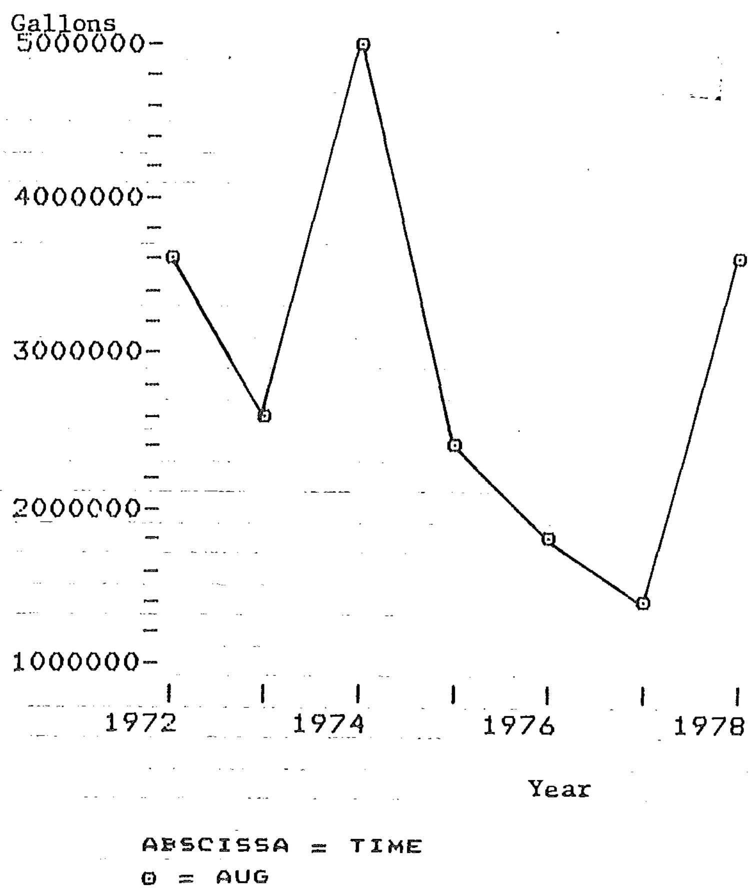
Historic Monthly Kerosene
Use in Maine
(Reported in Gallons)

	1973	1974	1975	1976	1977	1978
JUL	3135000.00	1955000.00	545000.00	1469000.00	1868000.00	284000.00
JULFC	17.15	¯37.64	¯72.12	169.54	27.16	¯84.80
AUG	2518000.00	4983000.00	2361000.00	1858000.00	1430000.00	3648000.00
AUGFC	¯31.31	97.90	¯52.62	¯21.30	¯23.04	155.10
SEP	5318000.00	3792000.00	2978000.00	3488000.00	2964000.00	2500000.00
SEPFC	23.24	¯28.69	¯21.47	17.13	¯15.02	¯15.65
OCT	6432000.00	6109000.00	8782000.00	5156000.00	3309000.00	4084000.00
OCTFC	¯17.62	¯5.02	43.76	¯41.29	¯35.82	23.42
NOV	8630000.00	6182000.00	4337000.00	6475000.00	5445000.00	3720000.00
NOVFC	¯6.99	¯28.37	¯29.84	49.30	¯15.91	¯31.68
DEC	9025000.00	7944000.00	9774000.00	5113000.00	7064000.00	4800000.00
DECFC	¯15.09	¯11.98	23.04	¯47.69	38.16	¯32.05

	1974	1975	1976	1977	1978	1979
JAN	11807000.00	10053000.00	10154000.00	10763000.00	7091000.00	7724000.00
JANFC	¯6.84	¯14.86	1.00	6.00	¯34.12	8.93
FEB	9119000.00	7629000.00	6313000.00	9112000.00	5008000.00	5700000.00
FEBFC	¯14.37	¯16.34	¯17.25	44.34	¯45.04	13.82
MAR	6795000.00	4273000.00	6225000.00	7099000.00	7090000.00	3811000.00
MARFC	.86	¯37.12	45.68	14.04	¯.13	¯46.25
APR	5511000.00	3316000.00	3072000.00	5459000.00	3695000.00	3164000.00
APRFC	20.04	¯39.83	¯7.36	77.70	¯32.31	¯14.37
MAY	2380000.00	2768000.00	3522000.00	3502000.00	2847000.00	2301000.00
MAYFC	¯44.35	16.30	27.24	¯.57	¯18.70	¯19.18
JUN	913000.00	1522000.00	1340000.00	2704000.00	2850000.00	638000.00
JUNFC	¯33.21	66.70	¯11.96	101.79	5.40	¯77.61

KEROSENE USE





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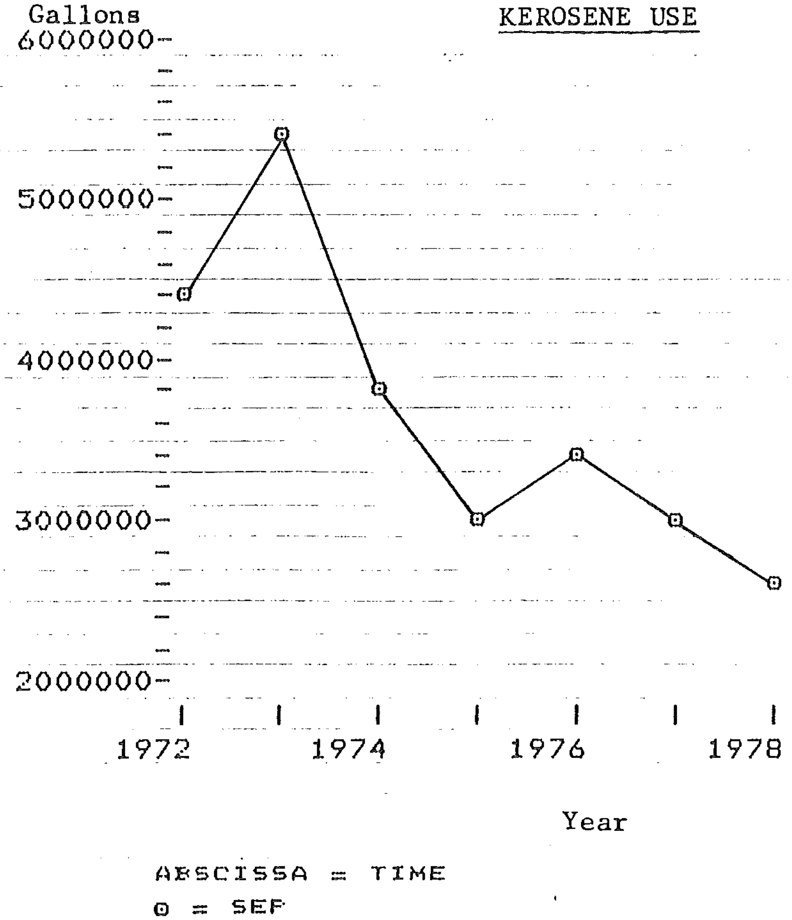

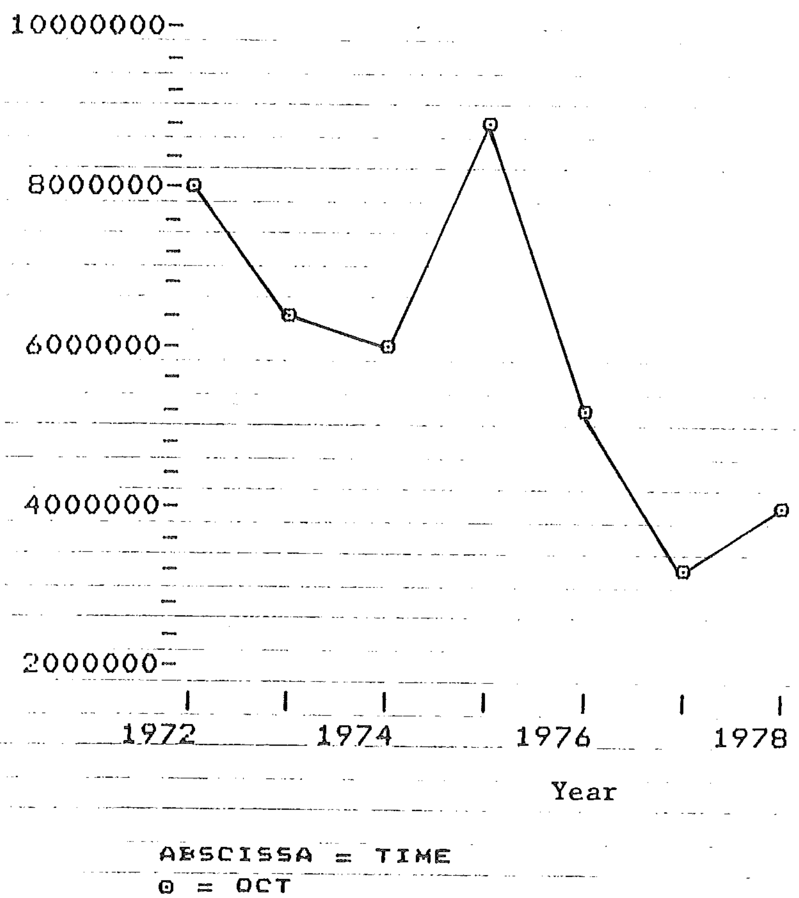

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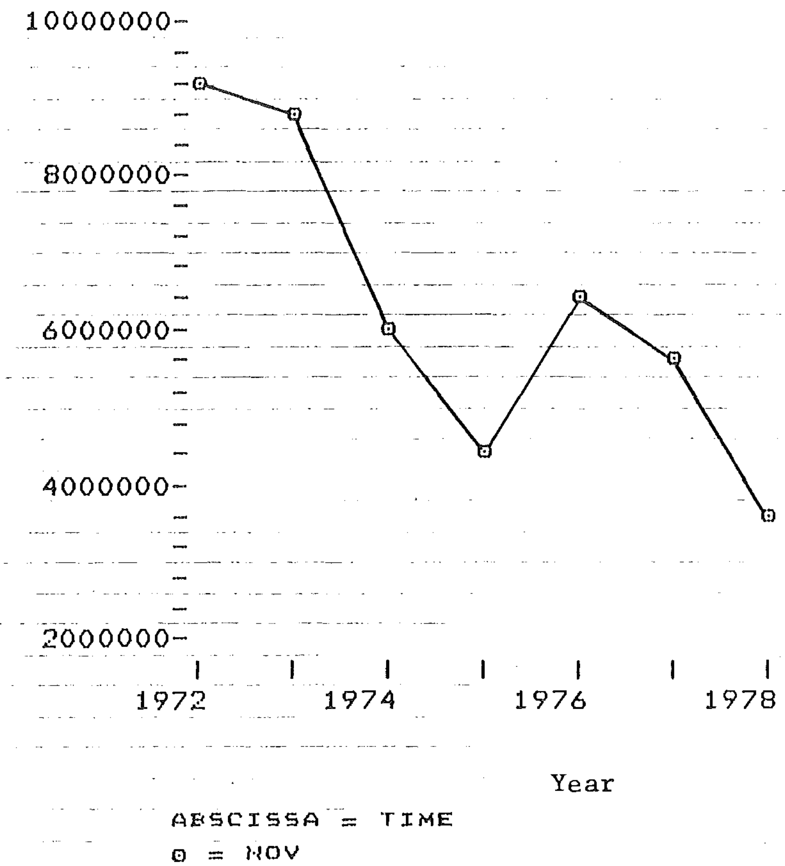

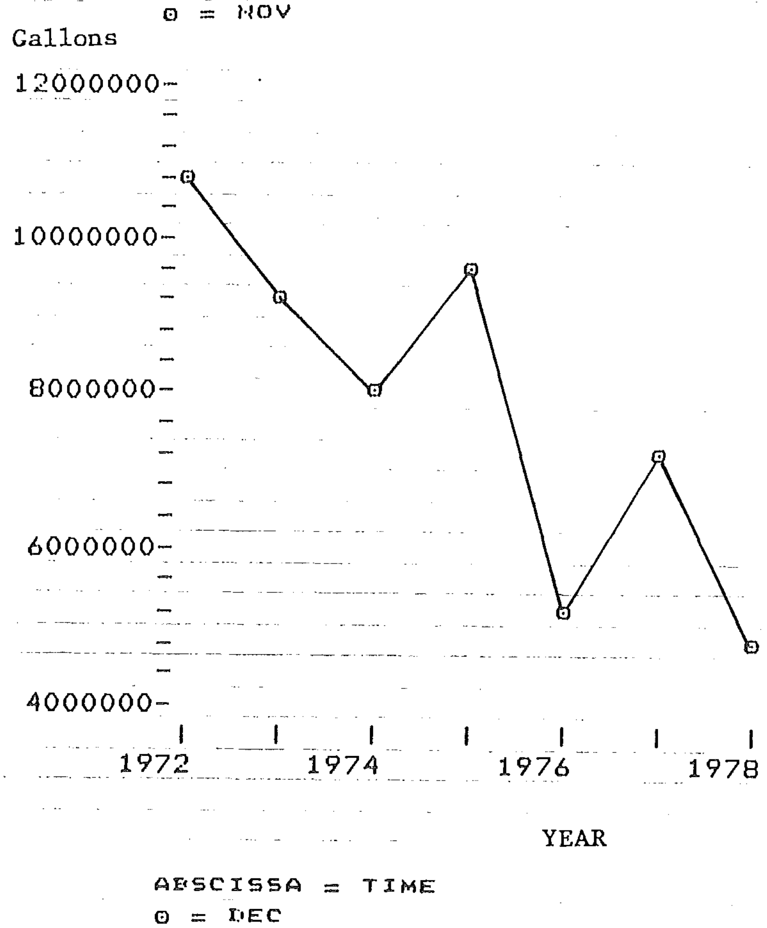

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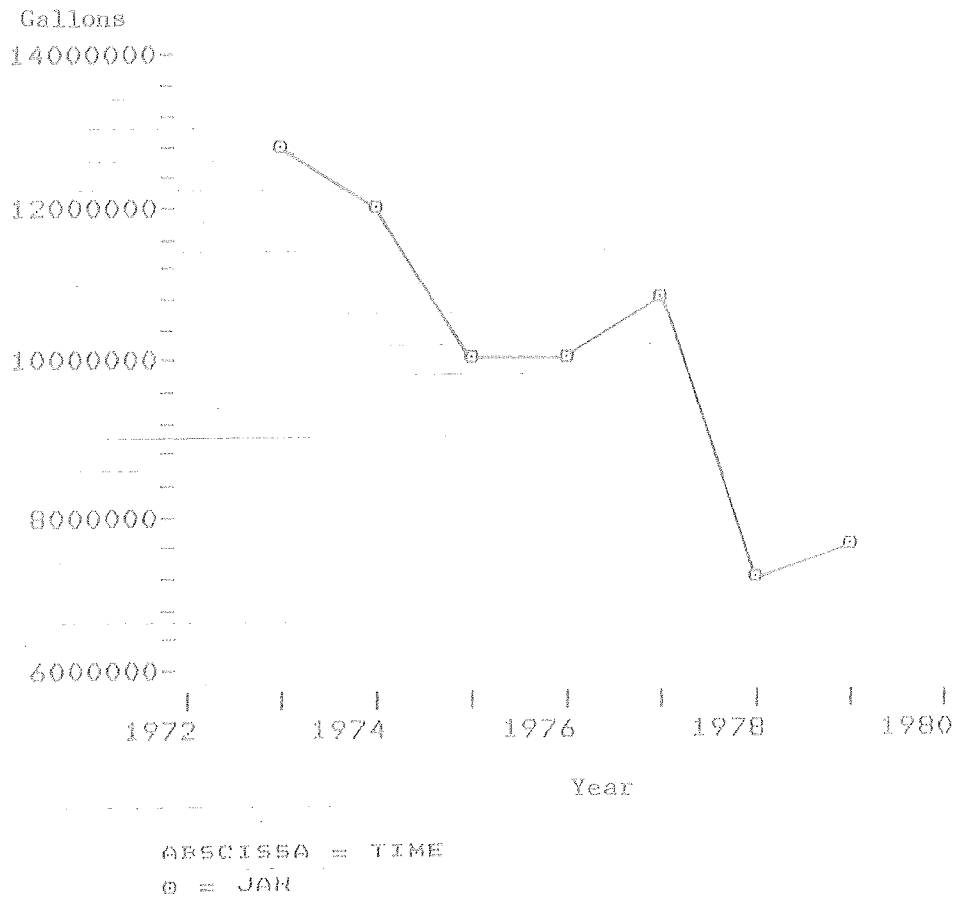

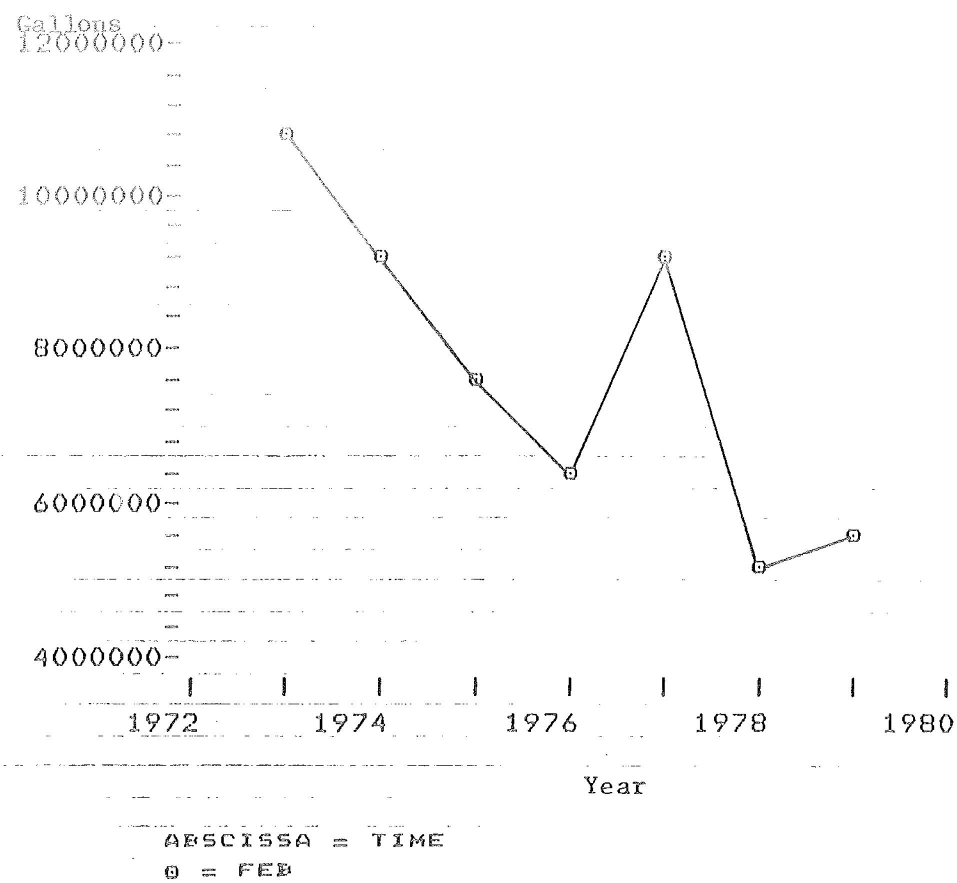

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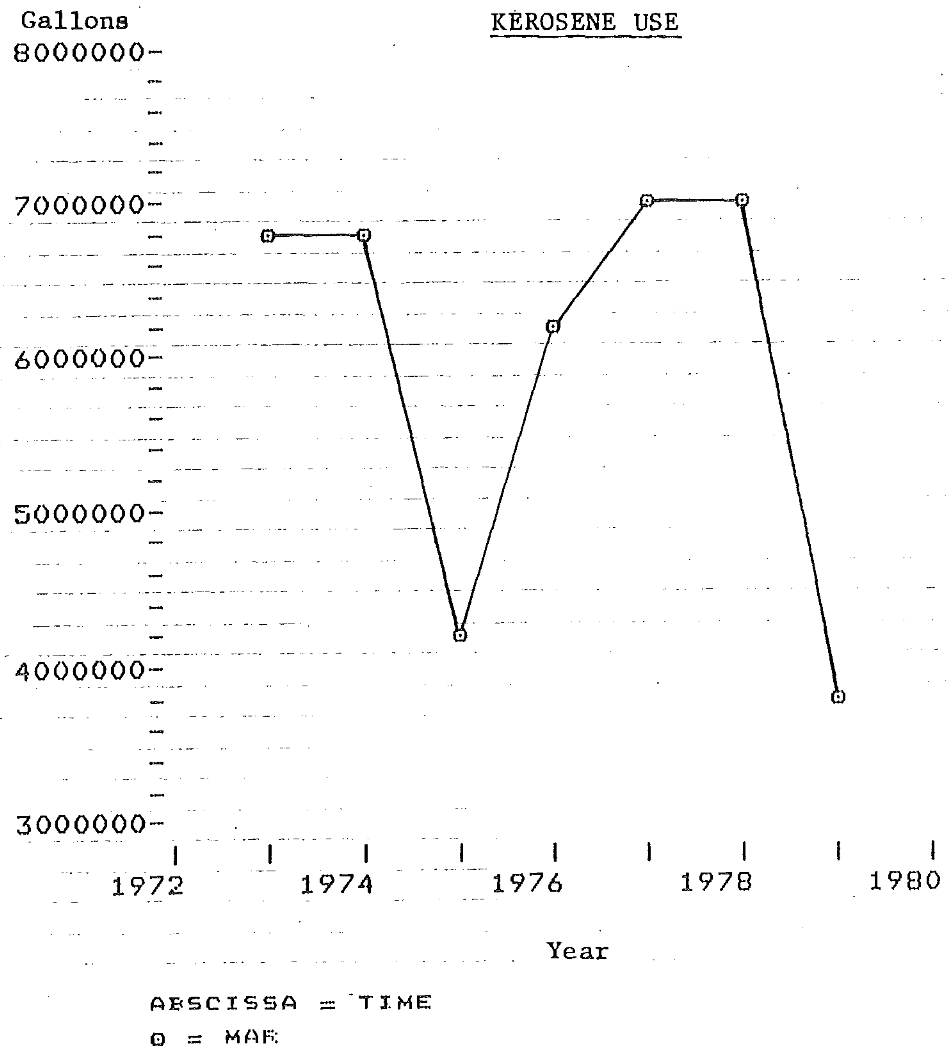

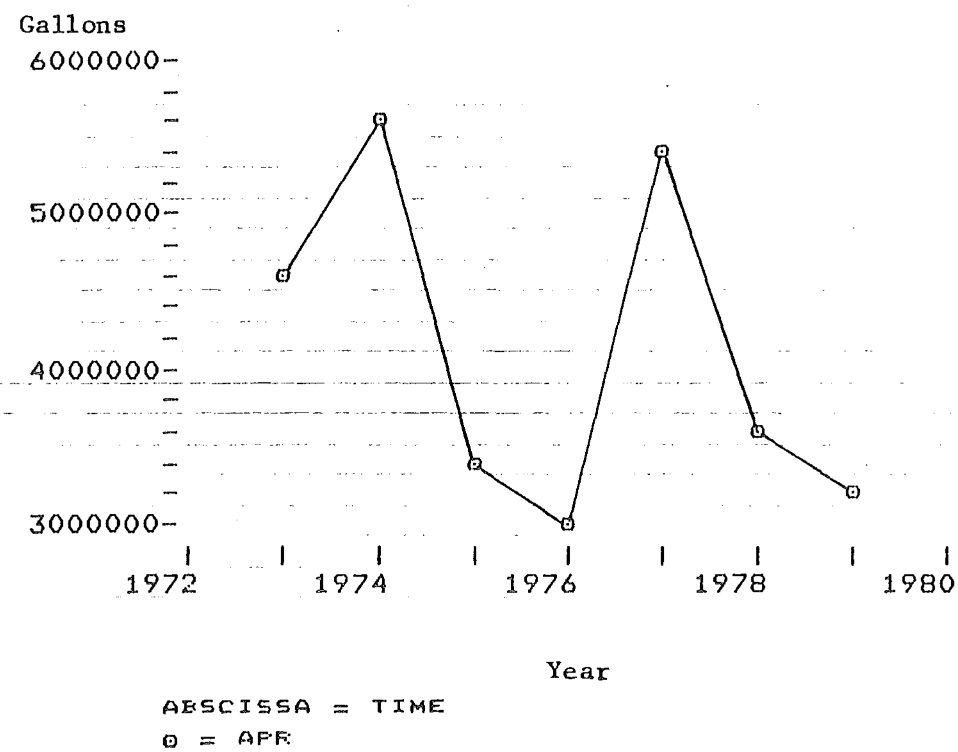

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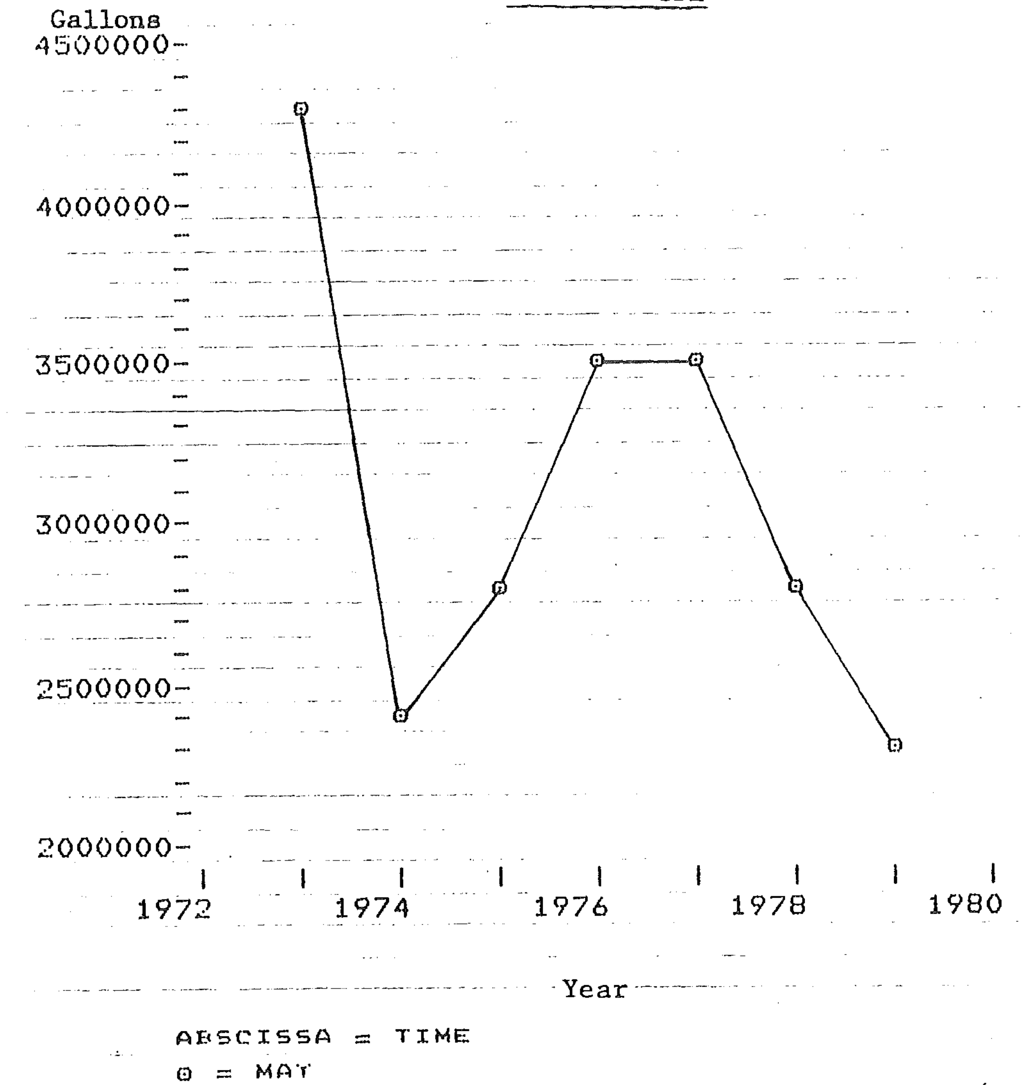
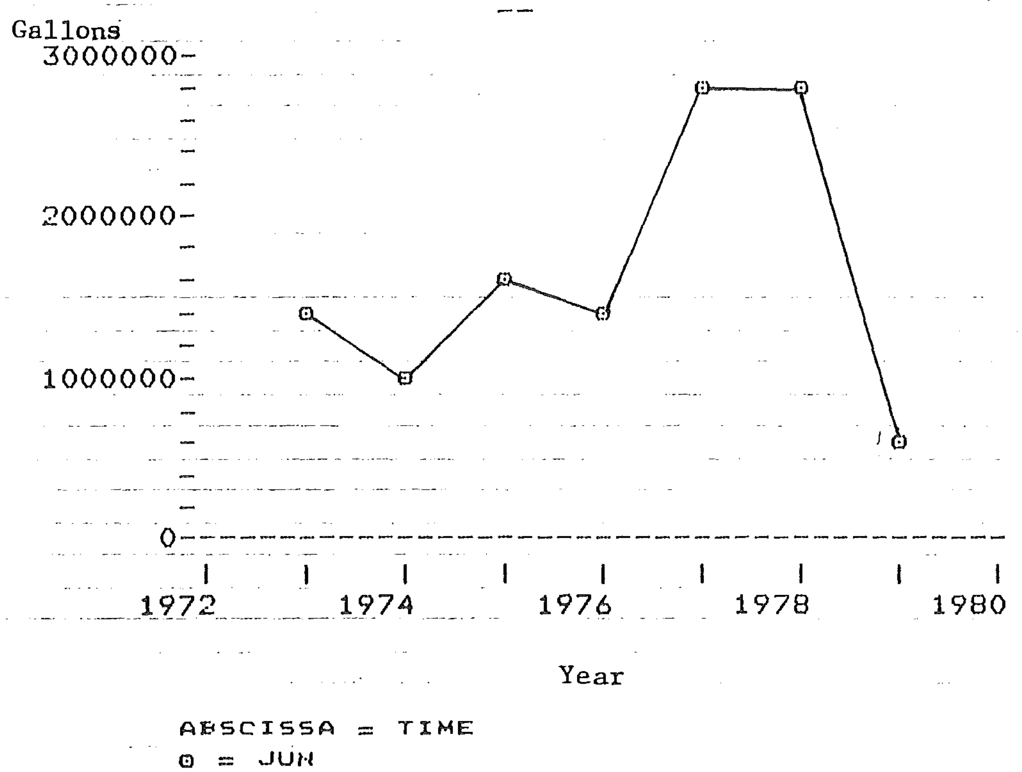




DAILY HEATING OIL USE

The following pages contain a tabulation of average daily use patterns each month. This raw scale data is not corrected. The following section is corrected for degree days.

TABULATION OF DAILY USE PATTERNS

	1978 7	1978 8	1978 9	1978 10	1978 11	1978 12
KERO USE PER DAY	9161.29	117677.42	83333.33	131741.94	124000.00	154838.71
PERCENT KERO USE	.67	8.61	5.90	9.64	8.78	11.33
KERO USE PER DDAY	17750.00	152000.00	11312.22	8119.28	4407.58	3931.20
NUM2 USE PER DAY	235903.23	372612.90	423400.00	683806.45	896233.33	1206967.74
PERCENT NUM2 USE	2.68	4.24	4.66	7.77	9.86	13.72
NUM2 USE PER DDAY	457062.50	481291.67	57475.11	42143.14	31856.64	30643.73
TOT USE PER DAY	245064.52	490290.32	506733.33	815548.39	1020233.33	1361806.45
PERCENT TOT USE	2.41	4.82	4.83	8.03	9.72	13.40
TOT USE PER DDAY	474812.50	633291.67	68787.33	50262.43	36264.22	34574.94

	1979 1	1979 2	1979 3	1979 4	1979 5	1979 6
KERO USE PER DAY	249161.29	203571.43	122935.48	105466.67	74225.81	21266.67
PERCENT KERO USE	18.23	13.45	8.99	7.47	5.43	1.51
KERO USE PER DDAY	5390.09	4453.13	3458.26	4526.47	9059.06	9114.29
NUM2 USE PER DAY	1263774.19	1250000.00	949225.81	848733.33	537258.06	328600.00
PERCENT NUM2 USE	14.37	12.84	10.79	9.34	6.11	3.62
NUM2 USE PER DDAY	27339.15	27343.75	26702.36	36426.32	65570.87	140828.57
TOT USE PER DAY	1512935.48	1453571.43	1072161.29	954200.00	611483.87	349866.67
PERCENT TOT USE	14.89	12.92	10.55	9.09	6.02	3.33
TOT USE PER DDAY	32729.24	31796.88	30160.62	40952.79	74629.92	149942.86

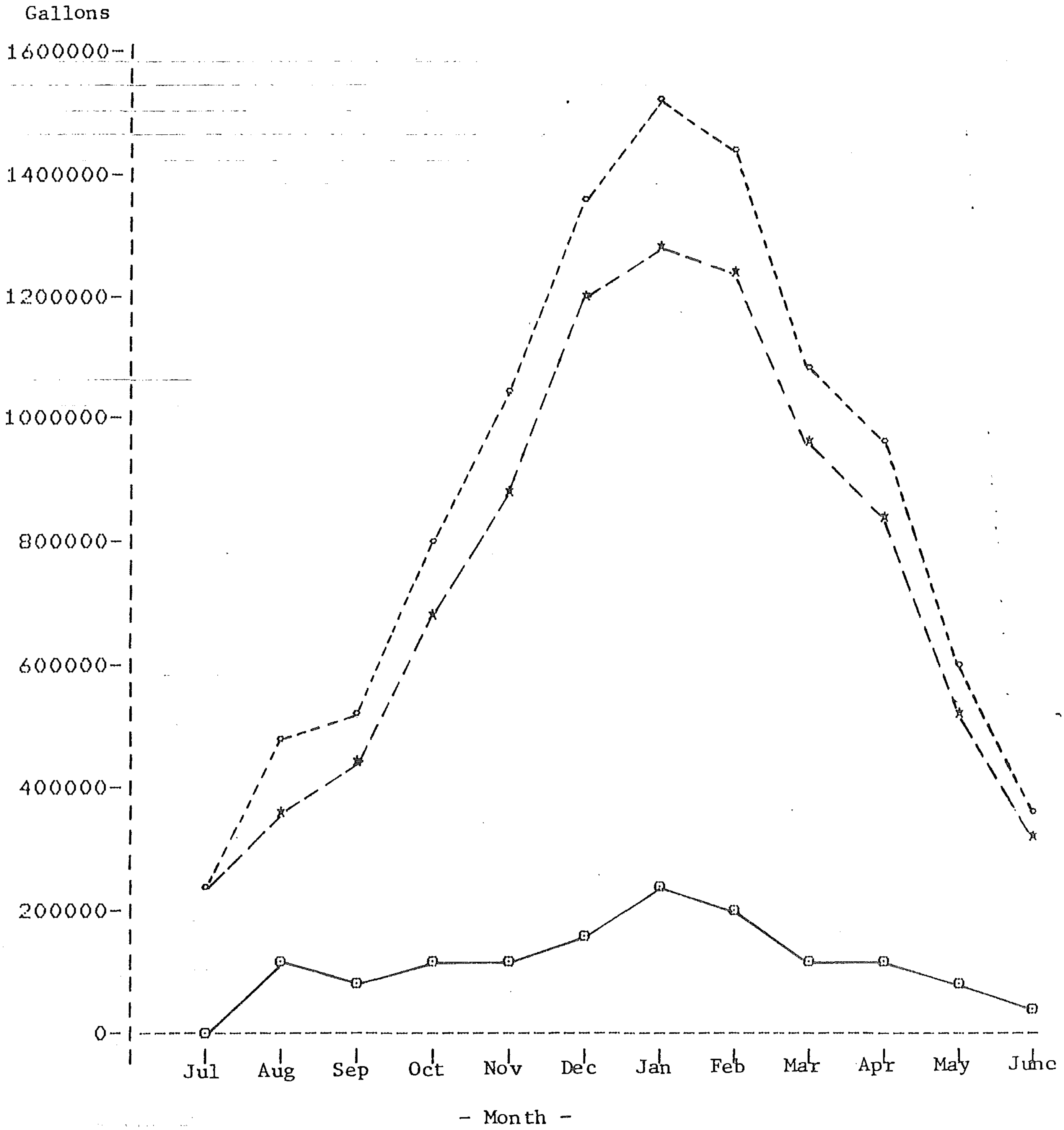
Heating Oil Use in an Average Day

by Month

	1978 7	1978 8	1978 9	1978 10	1978 11	1978 1
KERO USE PER DAY	9161.29	117677.42	83333.33	131741.94	124000.00	154838
NUM2 USE PER DAY	235903.23	372612.90	423400.00	683806.45	896233.33	1206967
TOT USE PER DAY	245064.52	490290.32	506733.33	815548.39	1020233.33	1361806

	1979 1	1979 2	1979 3	1979 4	1979 5	1979 6
KERO USE PER DAY	249161.29	203571.43	122935.48	105466.67	74225.81	21266
NUM2 USE PER DAY	1263774.19	1250000.00	949225.81	848733.33	537258.06	328600
TOT USE PER DAY	1512935.48	1453571.43	1072161.29	954200.00	611483.87	[illegible]

DAILY USE



ABSCISSA = TIME STARTING FROM 1978 7
⊡ = KERO USE PER DAY
☆ = NUM2 USE PER DAY
∘ = TOT USE PER DAY

CORRECTED DAILY HEATING OIL USE

The following data has been corrected by degree days per month.

Tabulation of Corrected Heating Oil Use

	1978 7	1978 8	1978 9	1978 10	1978 11	1978 12
CORRECTED KERO (Monthly use)	88428.85	132643.28	1221423.50	2779982.00	4664621.89	6748226.69
PERCENT CORRECTED KERO	.21	.31	2.88	6.56	11.01	15.93
CORRECTED KERO PER DAY	2852.54	4278.82	40714.12	89676.84	155487.40	217684.73

	1979 1	1979 2	1979 3	1979 4	1979 5	1979 6
CORRECTED KERO (Monthly use)	7919908.96	7074308.07	6090537.11	3863235.42	1403808.01	386876.22
PERCENT CORRECTED KERO	18.69	16.69	14.37	9.12	3.31	.91
CORRECTED KERO PER DAY	255480.93	252653.86	196468.94	128774.51	45284.13	12895.87

	1978 7	1978 8	1978 9	1978 10	1978 11	1978 12
CORRECTED NUM2 (Monthly use)	568973.52	853460.28	7858946.78	17887105.13	30013353.33	43419791.96
PERCENT CORRECTED NUM2	.21	.31	2.88	6.56	11.01	15.93
CORRECTED NUM2 PER DAY	18353.98	27530.98	261964.89	577003.39	1000445.11	1400638.45

	1979 1	1979 2	1979 3	1979 4	1979 5	1979 6
CORRECTED NUM2 (Monthly use)	50958691.14	45517881.83	39188051.39	24857030.78	9032454.68	2489259.16
PERCENT CORRECTED NUM2	18.69	16.69	14.37	9.12	3.31	.91
CORRECTED NUM2 PER DAY	1643828.75	1625638.64	1264130.69	828567.69	291369.51	82975.31

	1978 7	1978 8	1978 9	1978 10	1978 11	1978 12
CORRECTED TOT (Monthly use)	657402.37	986103.56	9080370.29	20667087.13	34677975.22	50168018.65
PERCENT CORRECTED TOT	.21	.31	2.88	6.56	11.01	15.93
CORRECTED TOT PER DAY	21206.53	31809.79	302679.01	666680.23	1155932.51	1618323.18

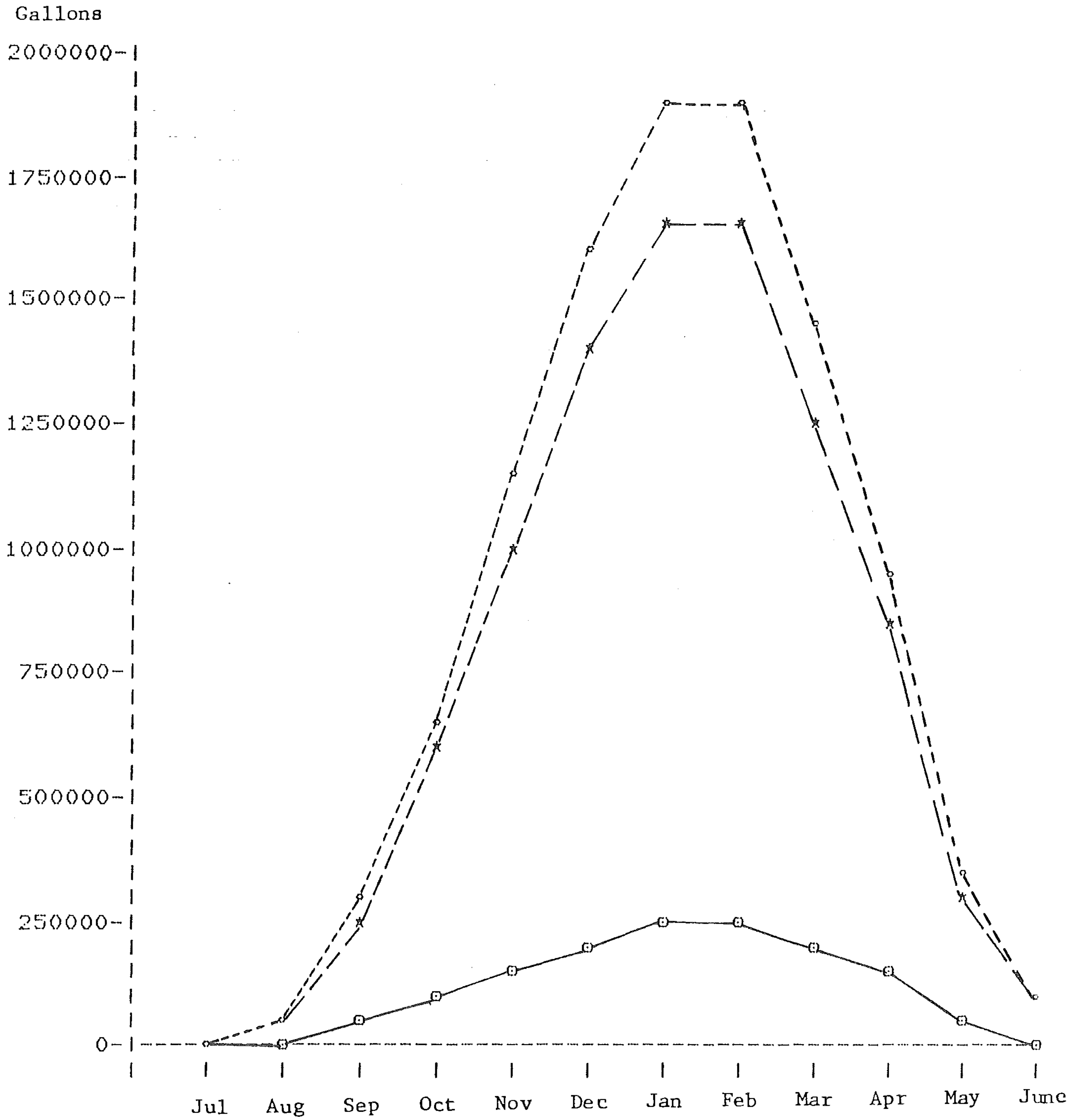
	1979 1	1979 2	1979 3	1979 4	1979 5	1979 6
CORRECTED TOT (Monthly use)	58878600.10	52592189.90	45278588.49	28720266.20	10436262.68	2876135.39
PERCENT CORRECTED TOT	18.69	16.69	14.37	9.12	3.31	.91
CORRECTED TOT PER DAY	1899309.68	1878292.50	1460599.63	957342.21	336653.63	95871.18

Corrected Use in an Average Day by Month

	1978 7	1978 8	1978 9	1978 10	1978 11	1978 12
CORRECTED KERO PER DAY	2852.54	4278.82	40714.12	89676.84	155487.40	217684.73
CORRECTED NUM2 PER DAY	18353.98	27530.98	261964.89	577003.39	1000445.11	1400638.45
CORRECTED TOT PER DAY	21206.53	31809.79	302679.01	666680.23	1155932.51	1618323.18

	1979 1	1979 2	1979 3	1979 4	1979 5	1979 6
CORRECTED KERO PER DAY	255480.93	252653.86	196468.94	128774.51	45284.13	12895.87
CORRECTED NUM2 PER DAY	1643828.75	1625638.64	1264130.69	828567.69	291369.51	82975.31
CORRECTED TOT PER DAY	1899309.68	1878292.50	1460599.63	957342.21	336653.63	95871.18

CORRECTED DAILY USE



ABSCISSA = TIME STARTING FROM 1978 7
⊙ = CORRECTED KERO PER DAY
★ = CORRECTED NUM2 PER DAY
∘ = CORRECTED TOT PER DAY

Data Sources

Ethyl Corp. : Monthly Reports of Home Heating Oil Sales

NOAA: Degree data

ANALYSIS OF MOTOR FUEL, DISTILLATE, RESIDUAL OILS AND ELECTRICITY CONSUMPTION PATTERNS IN MAINE

Maine Office of Energy Resources

PREPARED FOR

MAINE OFFICE OF ENERGY RESOURCES

JOHN JOSEPH, DIRECTOR

BY R. E. DOW

MAY 1979

TABLE OF CONTENTS

INTRODUCTION

The necessity for collection and analysis of motor fuel consumption data has been emphasized by the occurrence of spot gasoline shortages in March, April and May 1979. The Office of Energy Resources has the responsibility to assess, define and understand our states motor fuel requirements in order to plan for adequate supplies in the future and to ensure equitable allocation of these fuels when shortages occur. In light of these goals this analysis of motor fuel consumption data has been prepared.

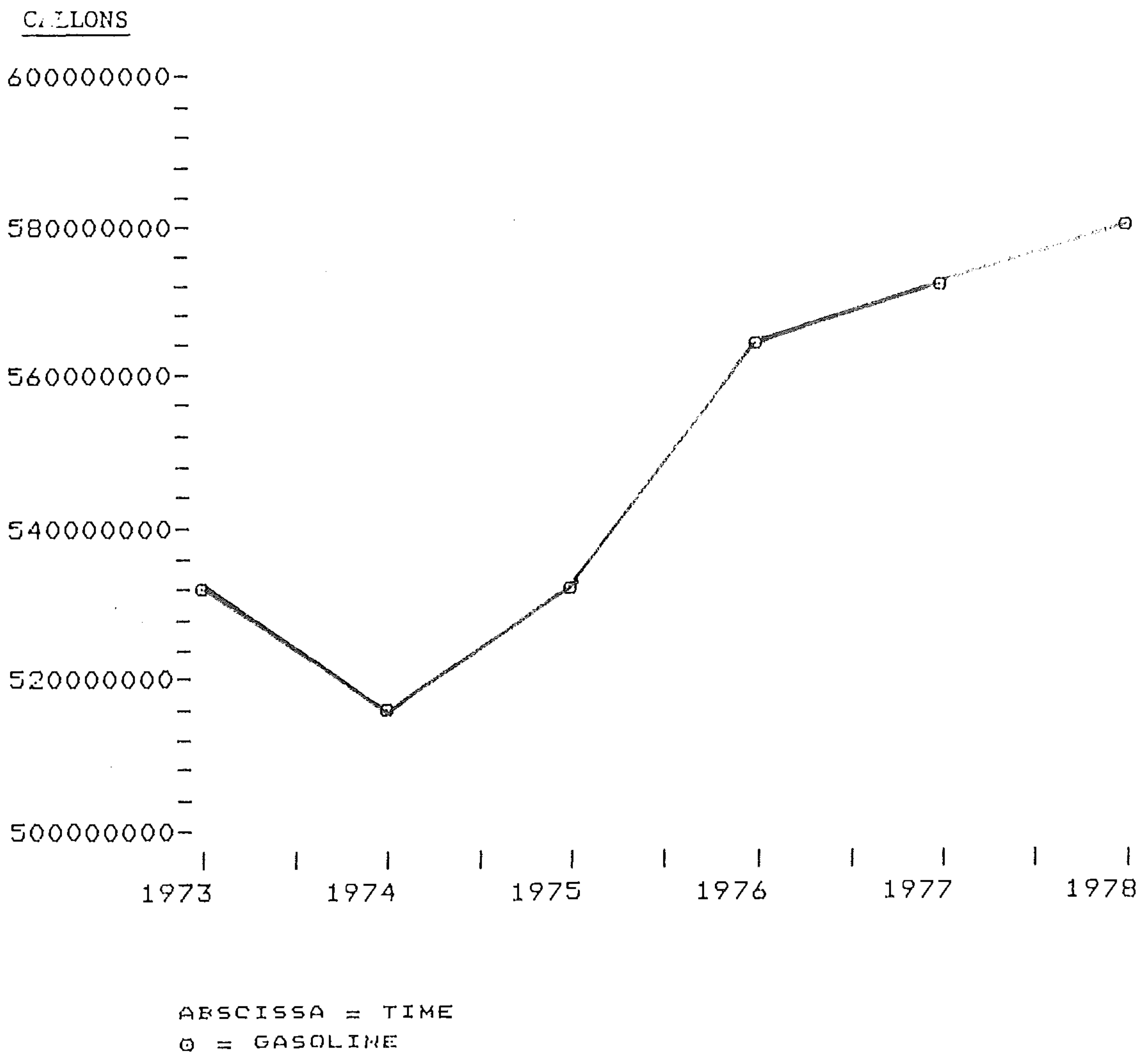
YEARLY GASOLINE CONSUMPTION PATTERN

The page which follows shows the gross gasoline consumption pattern in Maine from 1973-1979. A tabulation of the data and annual growth rates are shown.

This data indicates that Maine's average annual growth rate since 1976 is well below the national average. The average annual growth rate for the nation since 1976 has been 3.3% while the average annual growth rate in Maine has been 1.6%. It is interesting to note that gasoline consumption percapita in Maine fell below national gasoline consumption percapita in 1978.

All indications show that Maine gasoline consumers are attempting to conserve. For instance, tourism was high in 1978 but gasoline consumption increased by only 1.82 percent. It appears that the 55 mph law coupled with the switch to smaller automobiles and voluntary conservation efforts of Maine citizens has resulted in slowing the annual gasoline consumption growth rate.

TOTAL YEARLY GASOLINE CONSUMPTION IN MAINE



	1974	1975	1976
GASOLINE	516975509.00	531748568.00	563501866.00
GASOLINE PC	¯3.05	2.86	5.97

	1977	1978
GASOLINE	571495347.00	581915002.00
GASOLINE PC	1.42	1.82

MONTHLY CONSUMPTION PATTERNS

The following pages contain a tabulation of monthly gasoline consumption data and percent change from the same month of the previous year. A graphic illustration of each month by year is shown.

As would be expected, (because of the OPEC oil embargo of 1973-74), the gasoline consumption in each month of 1974 is below the 1973 level. Since 1974 gasoline consumption in the months of January, February, March and April has increased steadily and is now above pre-embargo levels. The data for the months of May and June is erratic, no clear and distinguishable pattern is apparent. This may be due to the fact that May and June mark the beginning of the tourist season. Therefore, gasoline consumption in these months is dependent upon the weather and the regional economic condition. We would expect consumption to be lower if long periods of inclement weather prevail or in times of economic recession. The remaining months of July, August, September, October, November, and December show a general increase since 1974 with consumption leveling off in 1976 and continuing at 1976 levels through 1979. Spot gasoline shortages in March and April of 1979 will contribute to the continuation of this pattern and could cause 1979 consumption to fall below the 1978 levels.

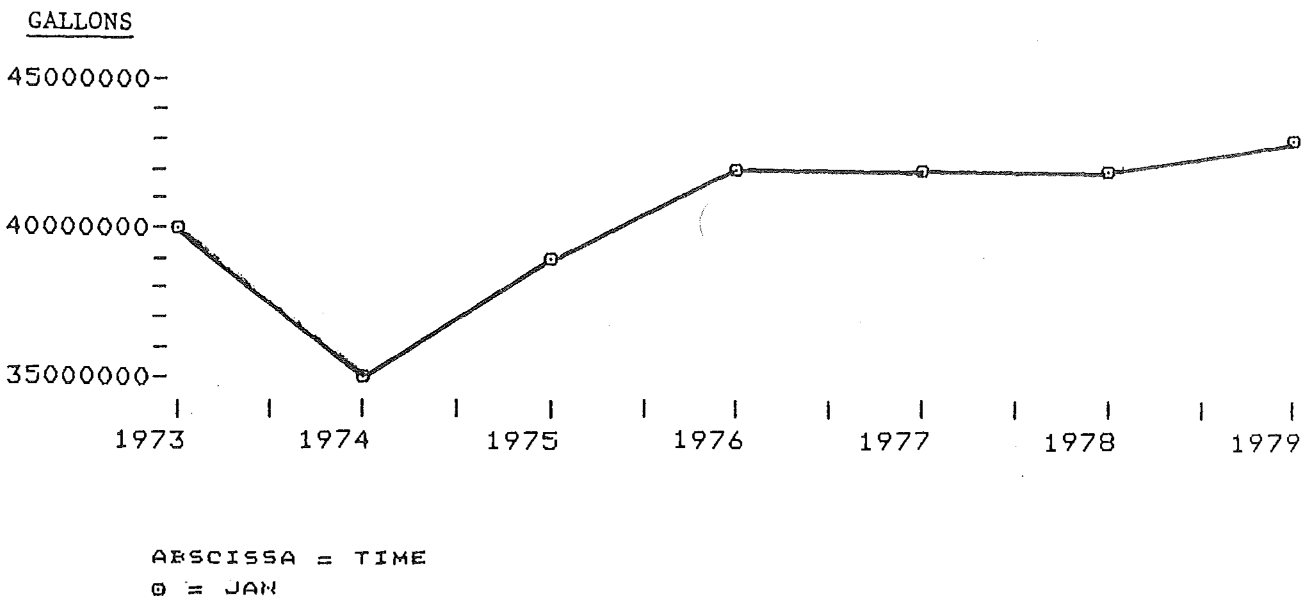
In summary the data indicates an increase in overall gasoline consumption since 1974 and shows a leveling off in 1976 and continuing through 1979. We should bare in mind that population and number of registered vehicles has increased since 1976 and that both economic and environmental conditions effect the gasoline consumption pattern in Maine. The citizens of Maine have demonstrated their sense of responsibility and ability to conserve energy. In 1978 Maine citizens consumed less gasoline percapita than was consumed nationally percapita. This is especially impressive in light of the fact that Maine is a largely rural state and the automobile is the most widely used mode of transportation.

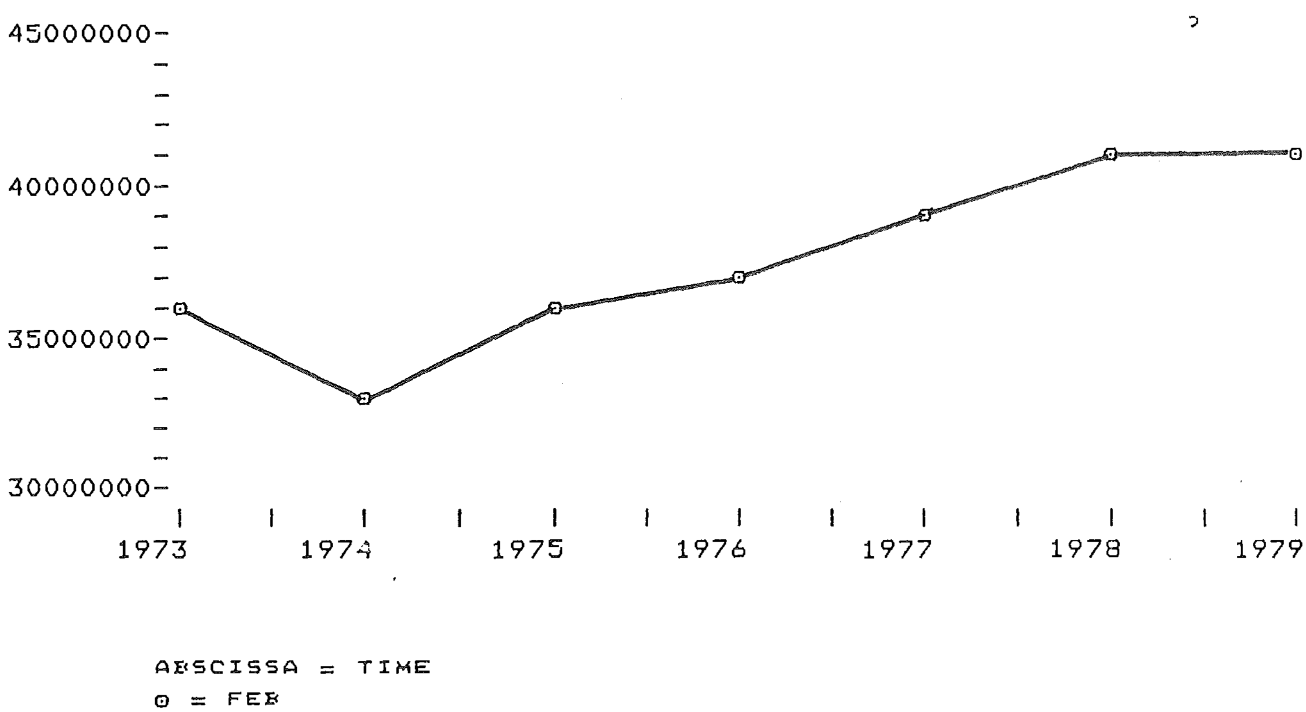
TABULATION OF MONTHLY GASOLINE
CONSUMPTION IN MAINE (1974-1979)

GALLONS

	1974	1975	1976	1977	1978	1979
JAN	35268633.00	39133395.00	41897822.00	42217909.00	41662887.00	43259896.00
JANPC	¯11.41	10.96	7.06	.76	¯1.31	3.83
FEB	32887394.00	35767118.00	36775717.00	38565123.00	40502478.00	40978934.00
FEBPC	¯8.27	8.76	2.82	4.87	5.02	1.18
MAR	37609859.00	37754461.00	41299660.00	41761590.00	44207762.00	43861237.00
MARPC	¯5.24	.38	9.39	1.12	5.86	¯.78
APR	37771485.00	38526202.00	42198286.00	42780528.00	40886324.00	.00
APRPC	¯4.47	2.00	9.53	1.38	¯4.43	¯100.00
MAY	44643069.00	45665111.00	44456613.00	47442990.00	49612059.00	.00
MAYPC	¯.20	2.29	¯2.65	6.72	4.57	¯100.00
JUN	45233086.00	46394064.00	50938447.00	49368505.00	52503215.00	.00
JUNPC	¯4.05	2.57	9.80	¯3.08	6.35	¯100.00
JUL	55731984.00	55631151.00	58229132.00	57597582.00	57601674.00	.00
JULPC	1.21	¯.18	4.67	¯1.08	.01	¯100.00
AUG	57044861.00	56415452.00	57642913.00	61122652.00	61758642.00	.00
AUGPC	¯4.59	¯1.10	2.18	6.04	1.04	¯100.00
SEP	42975829.00	45037013.00	49882392.00	49340137.00	49886809.00	.00
SEPPC	¯4.94	4.80	10.76	¯1.09	1.11	¯100.00
OCT	46115341.00	45991435.00	47164488.00	47963573.00	48315380.00	.00
OCTPC	.52	¯.27	2.55	1.69	.73	¯100.00
NOV	40186259.00	40291711.00	45544033.00	46256122.00	48535513.00	.00
NOVPC	¯6.06	.26	13.04	1.56	4.93	¯100.00
DEC	41507709.00	45141455.00	47472363.00	47078636.00	46442259.00	.00
DECPC	9.97	8.75	5.16	¯.83	¯1.35	¯100.00

GASOLINE CONSUMPTION





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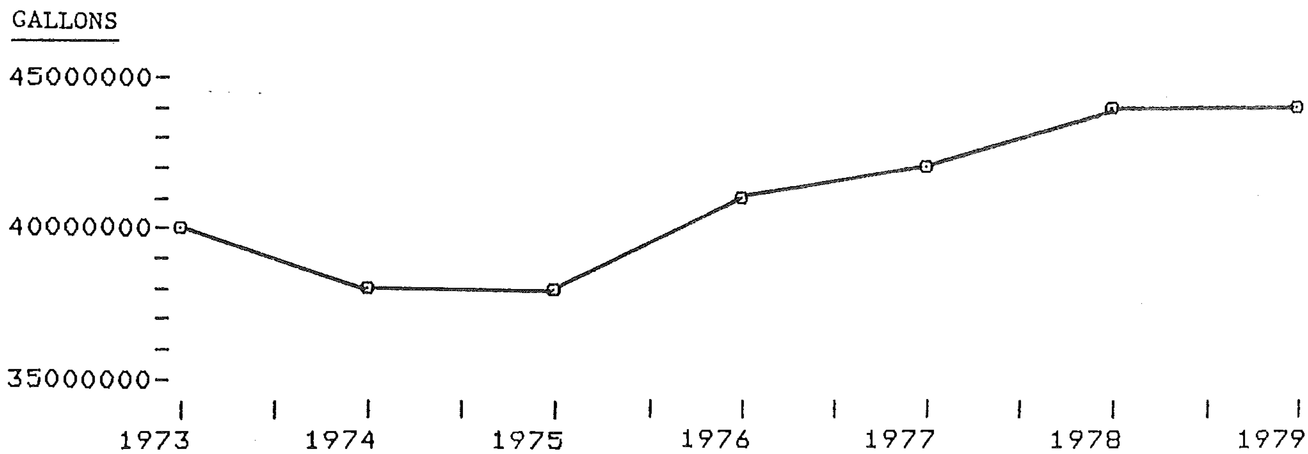

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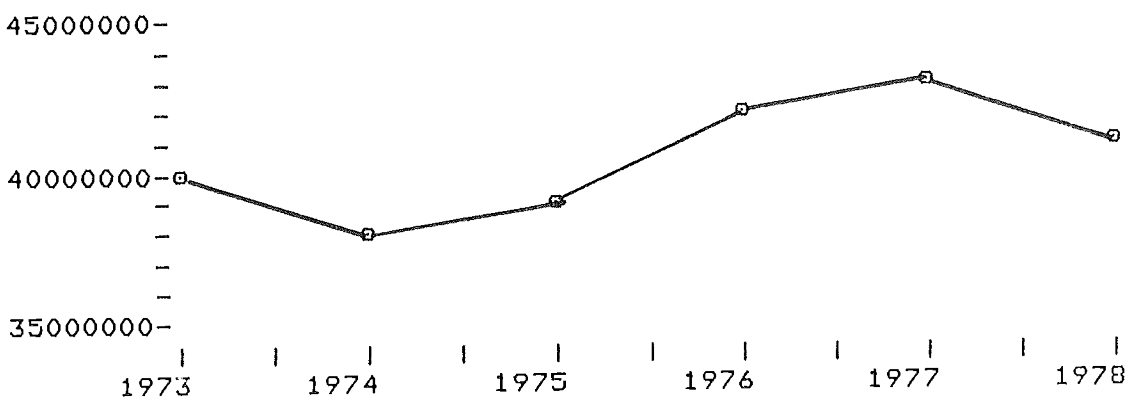
O = MAR



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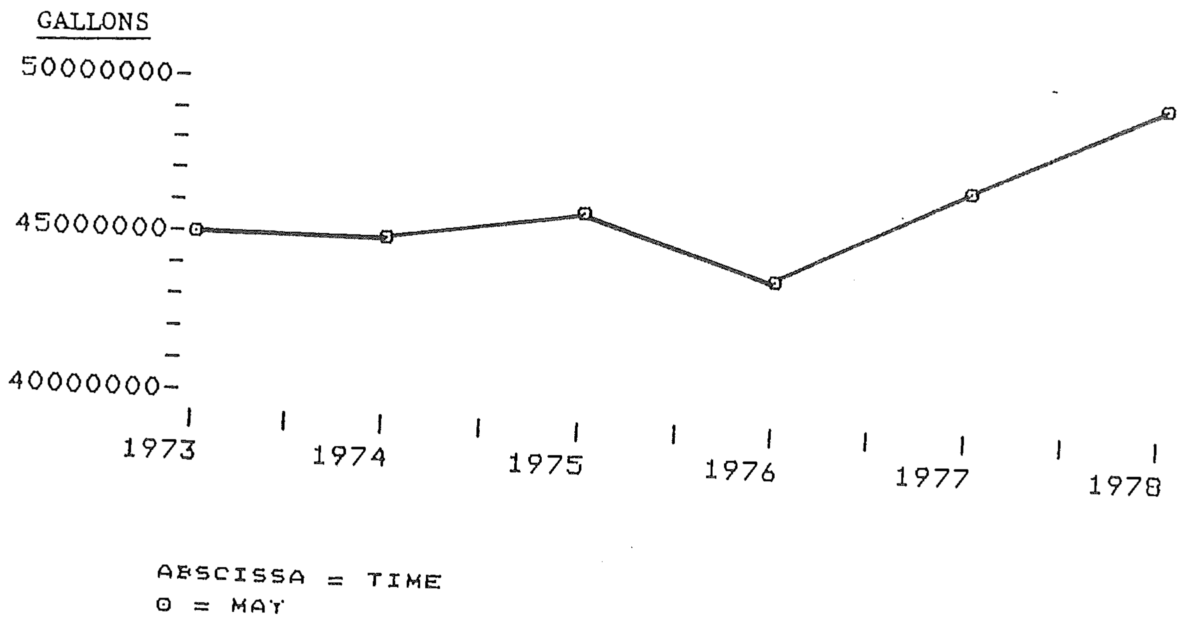
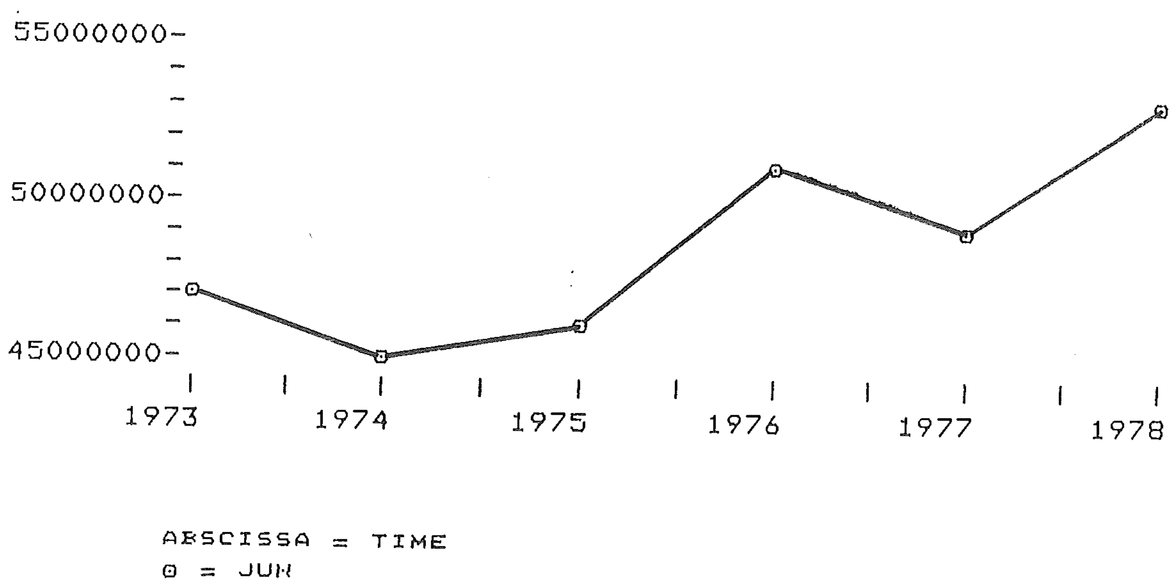
GASOLINE CONSUMPTION





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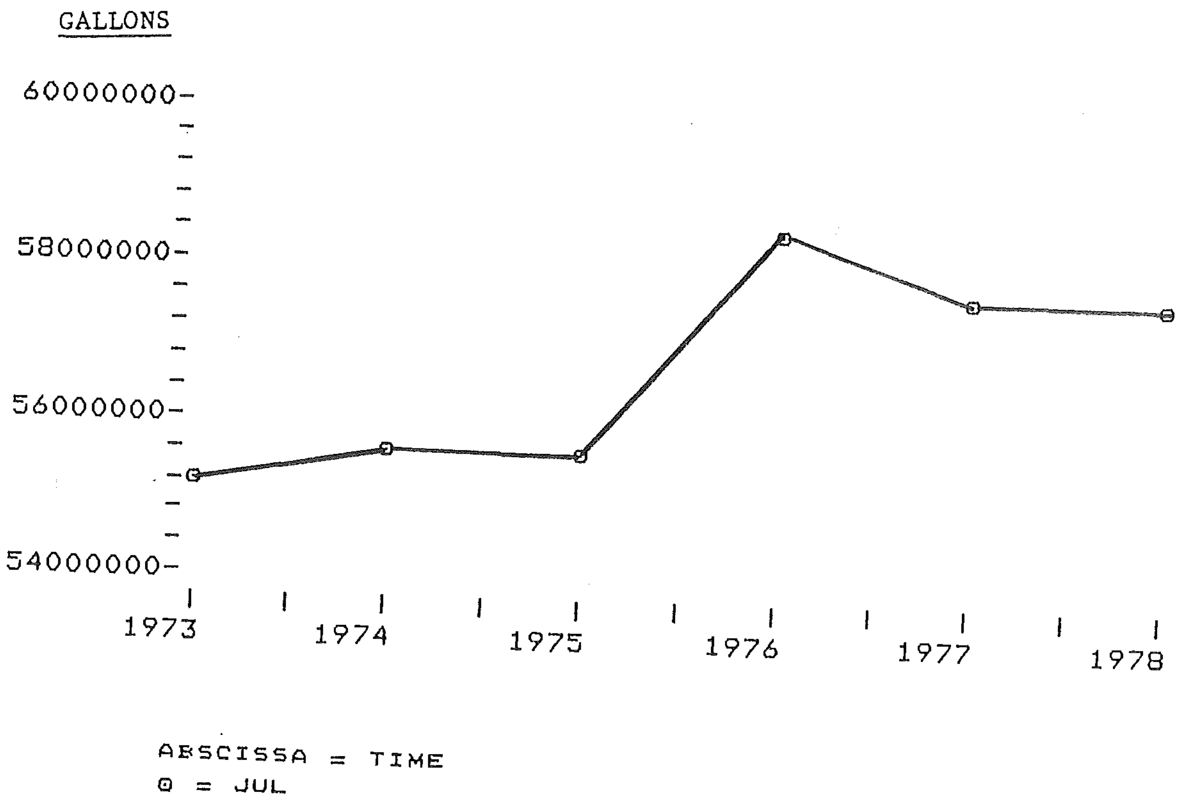

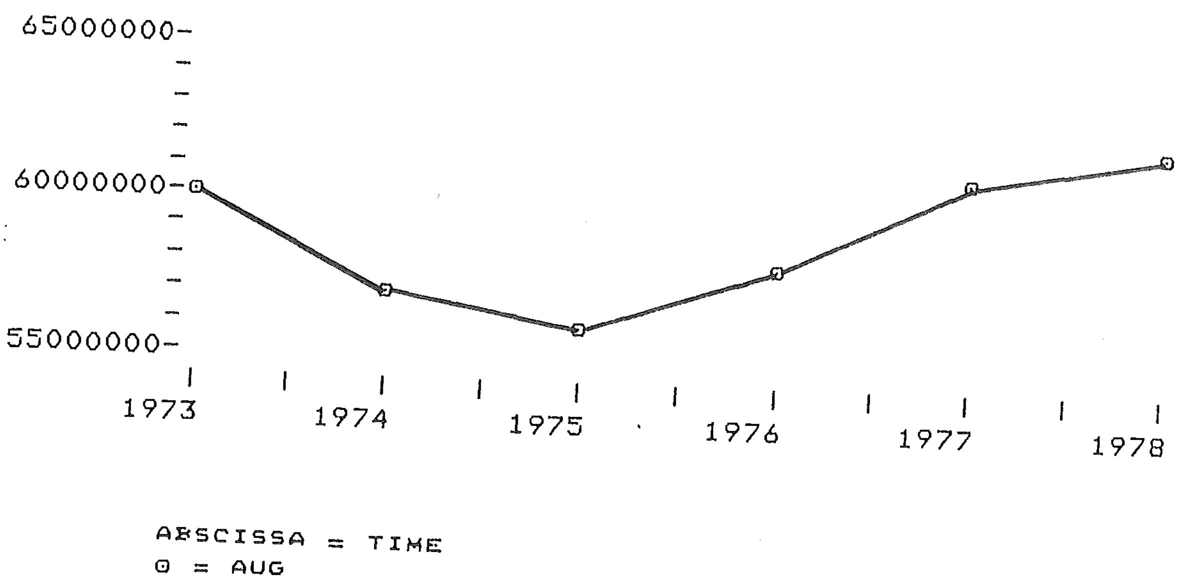

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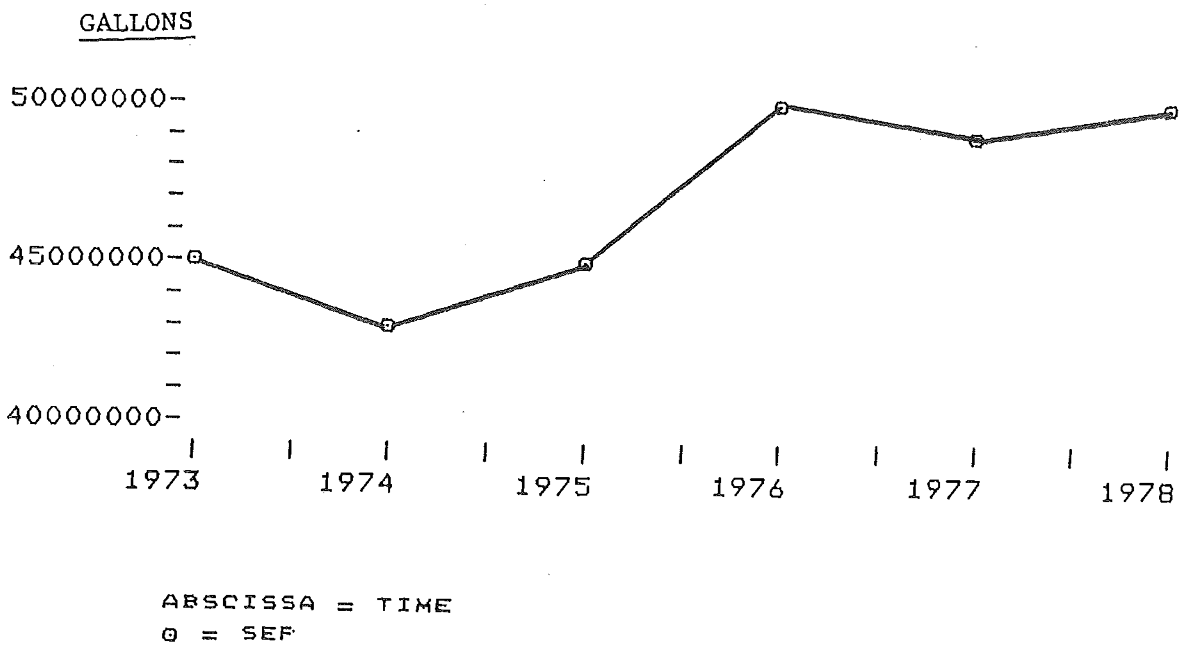

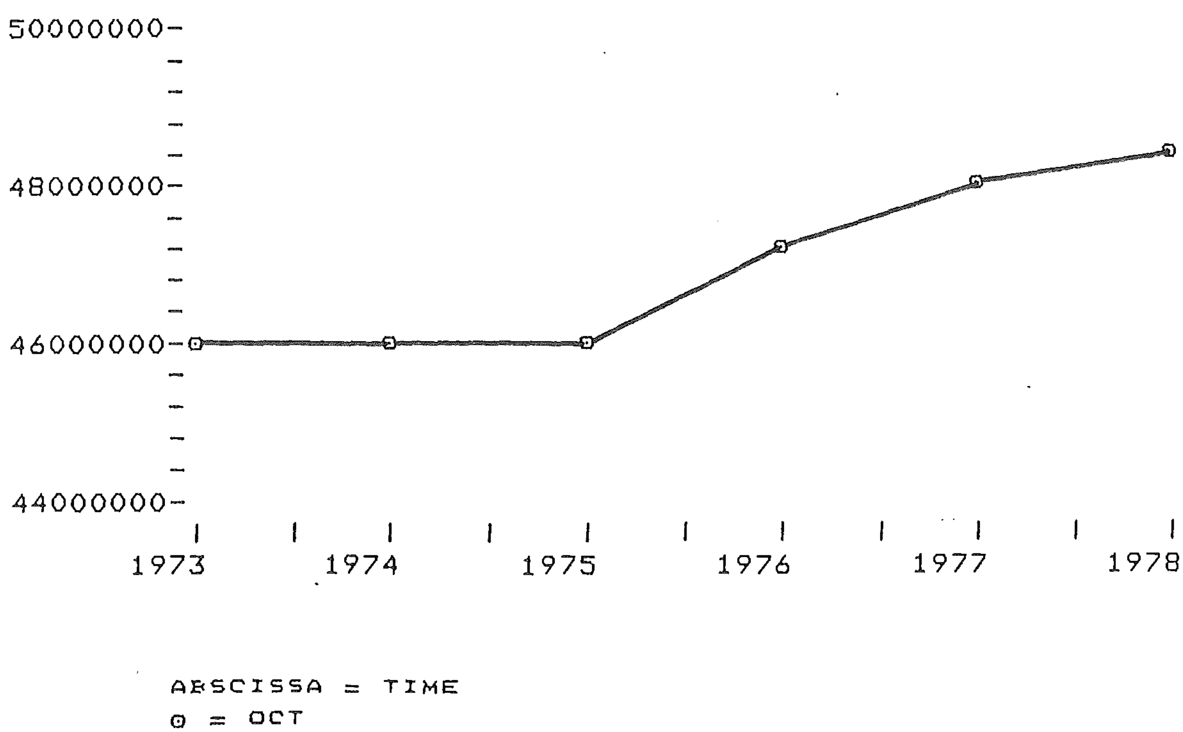

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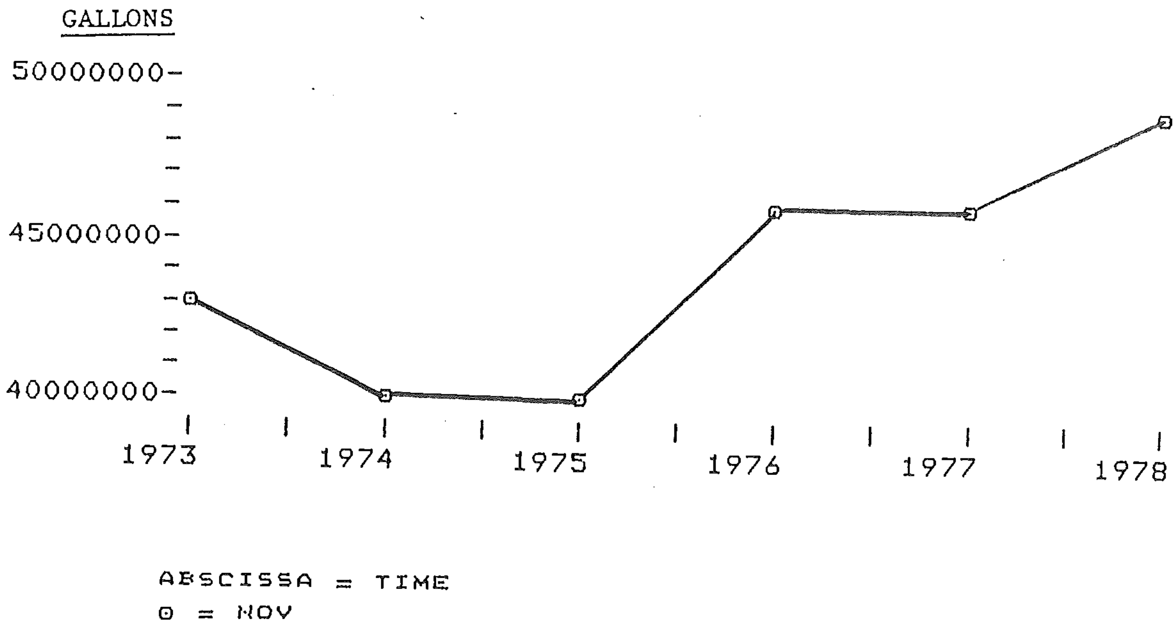
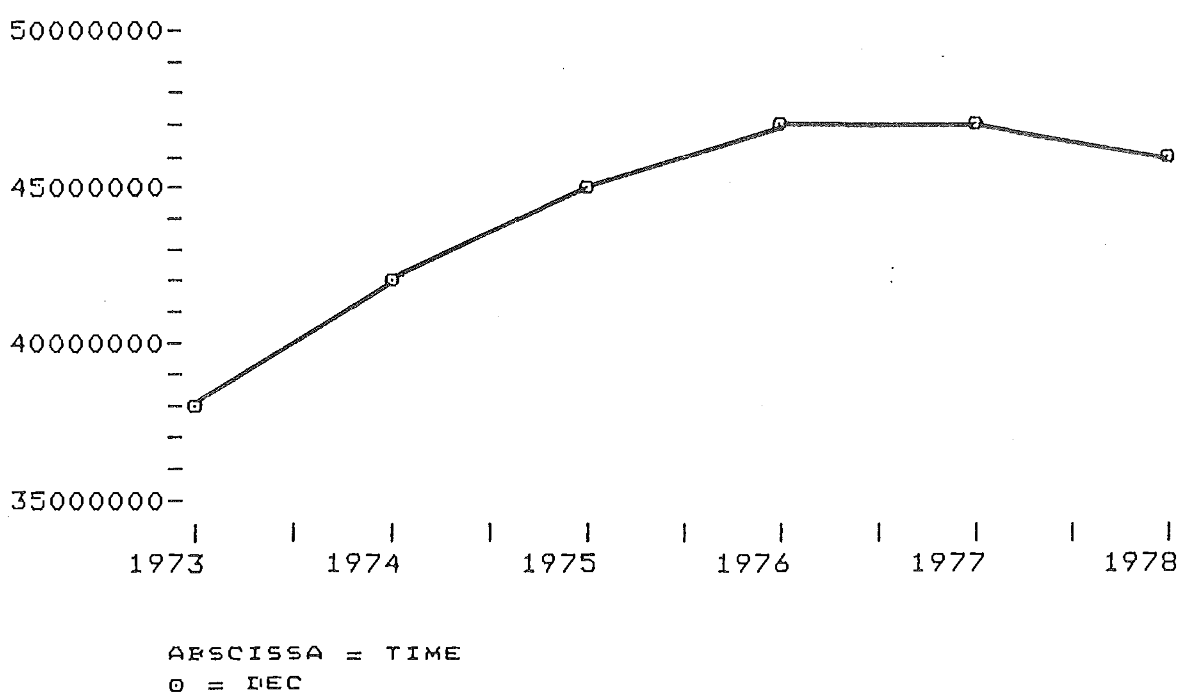




BASELINE GASOLINE CONSUMPTION

Baseline gasoline consumption was calculated based on the consumption pattern in April since 1973. April was chosen since this is a non-tourist month and the consumption pattern is relatively flat.

$BLC_i = G_i/fDA$

where:

i = year i (1973, 1978)

BLC_i = Baseline consumption in year i

G_i = gallons consumed in April of year i

FDA = Fraction of day in April

Baseline consumption per auto:

$BLCPA_i = BLC_i/RA_i$

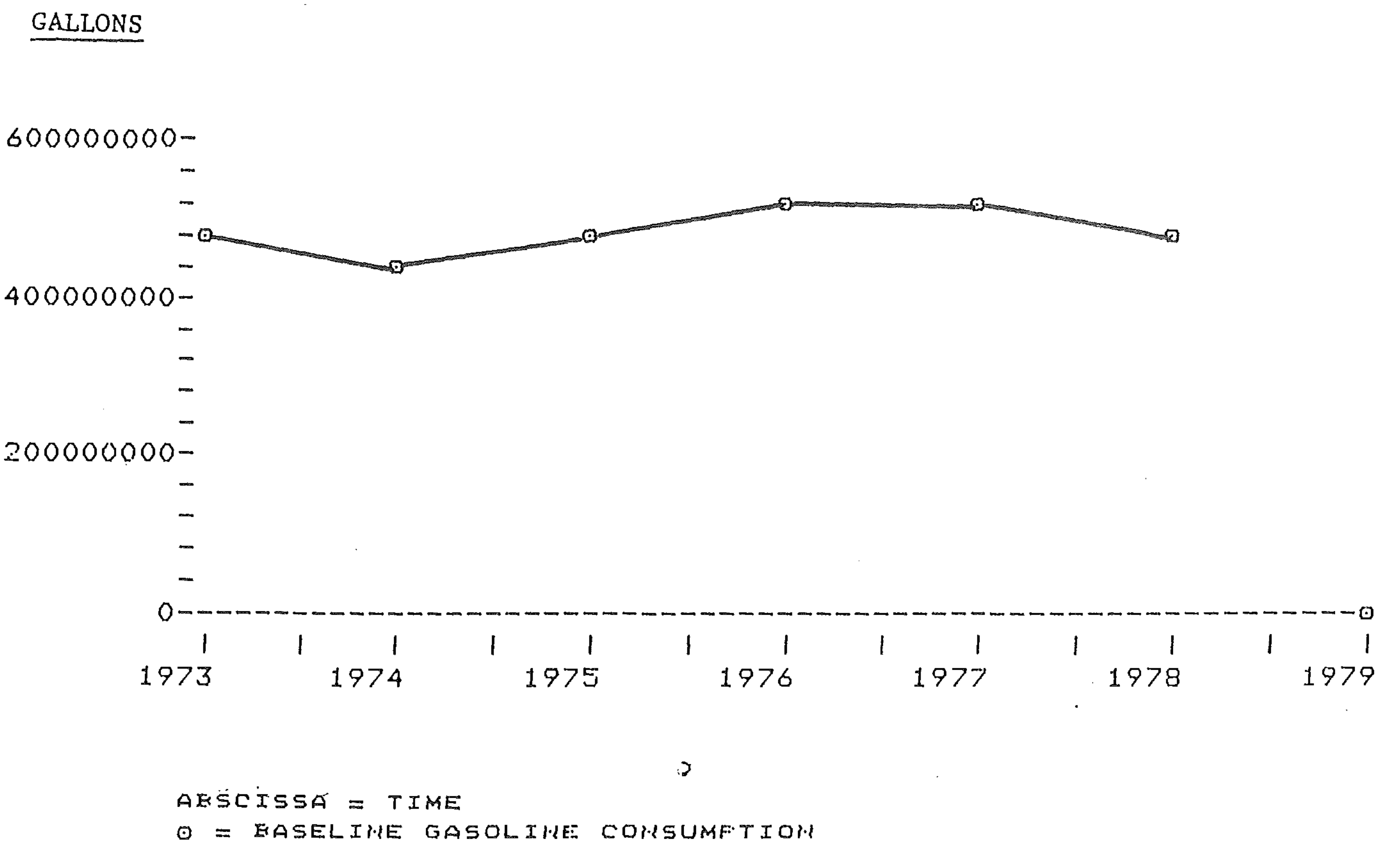
i = see above

$BLCPA_i$ = Baseline consumption per auto in year i

BLC_i = See above

RA_i = Registered autos in year i

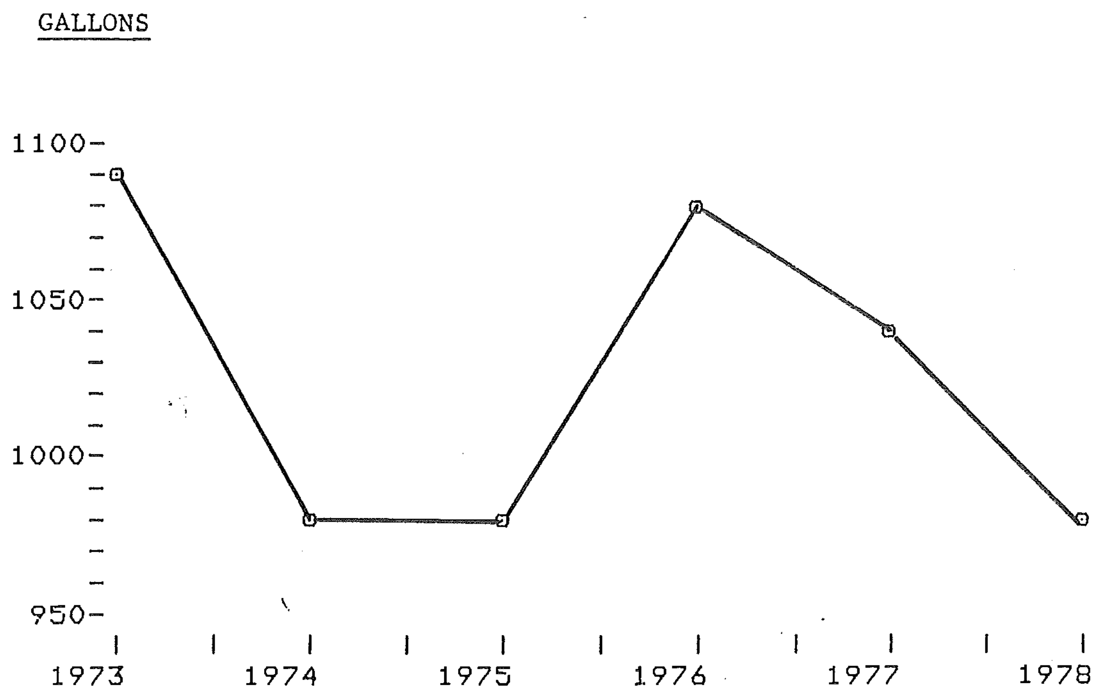
BASELINE GASOLINE CONSUMPTION IN MAINE



	1974	1975	1976
BASELINE GASOLINE CONSUMPTION	459553067.50	468735457.67	513412479.67
PC1	¯4.47	2.00	9.53

	1977	1978
BASELINE GASOLINE CONSUMPTION	520496424.00	497450275.33
PC1	1.38	¯4.43

BASELINE GASOLINE CONSUMPTION PER REGISTERED AUTO IN MAINE



ABSCISSA = TIME
⊙ = BASELINE CONSUMPTION PER AUTO

	1974	1975	1976
BASELINE CONSUMPTION PER AUTO	978.26	978.15	1080.49
PC2	¯10.36	¯.01	10.46

	1977	1978
BASELINE CONSUMPTION PER AUTO	1035.53	982.35
PC2	¯4.16	¯5.14

GASOLINE CONSUMED BY TOURISTS

Gasoline consumption by tourists increased from 1973-1975 then fell sharply to 50 million gallons in 1976 and 1977. In 1978 the tourist gasoline consumption rose dramatically to 84.5 million gallons, well above the 1975 level.

$$GCT_i = GC_i - BLC_i$$

where:

i = year index (1973-1978)

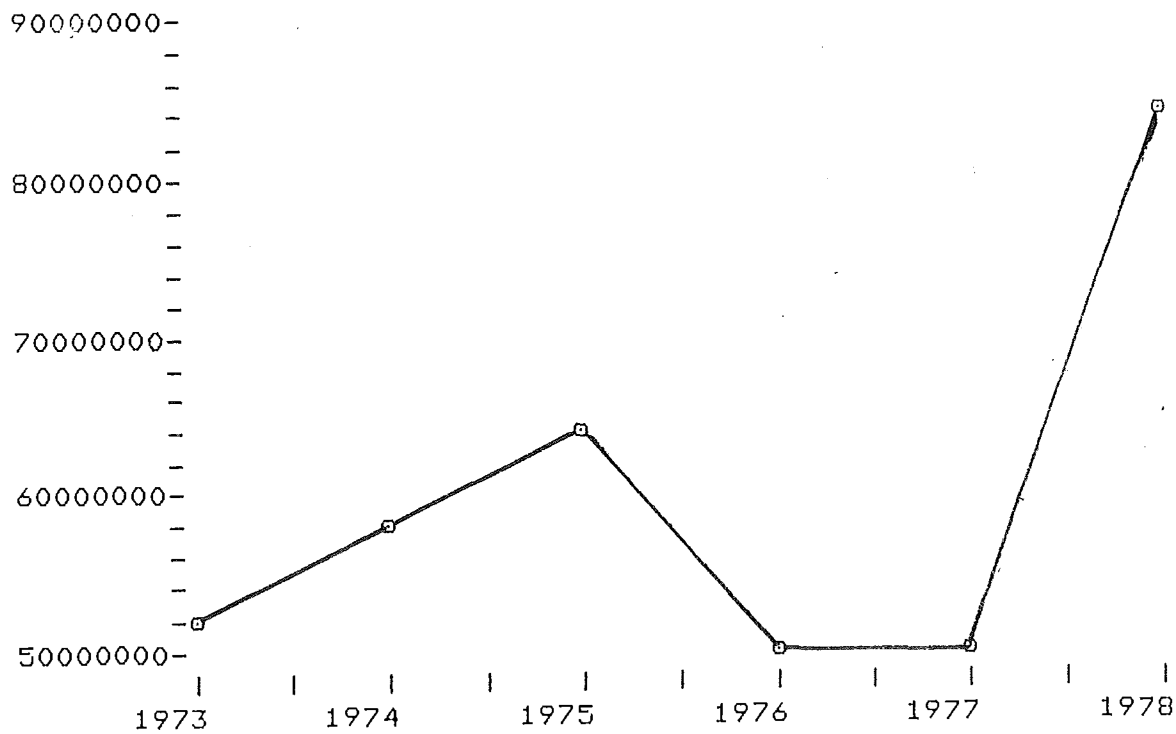
GCT_i = Gasoline consumed by tourists in year i

GC_i = total gasoline consumed in year i

BLC_i = Baseline consumption in year i

GALLONS

GASOLINE CONSUMED BY TOURISTS



ABSCISSA = TIME
⊙ = GASOLINE CONSUMED TOURISTS

	1974	1975	1976
GASOLINE CONSUMED TOURISTS	57422441.50	63013110.33	50089386.33
PC	10.07	9.74	¯20.51

	1977	1978
GASOLINE CONSUMED TOURISTS	50998923.00	84464726.67
PC	1.82	65.62

	1973	1974	1975
PERCENT CONSUMED TOURISTS	9.78	11.11	11.85

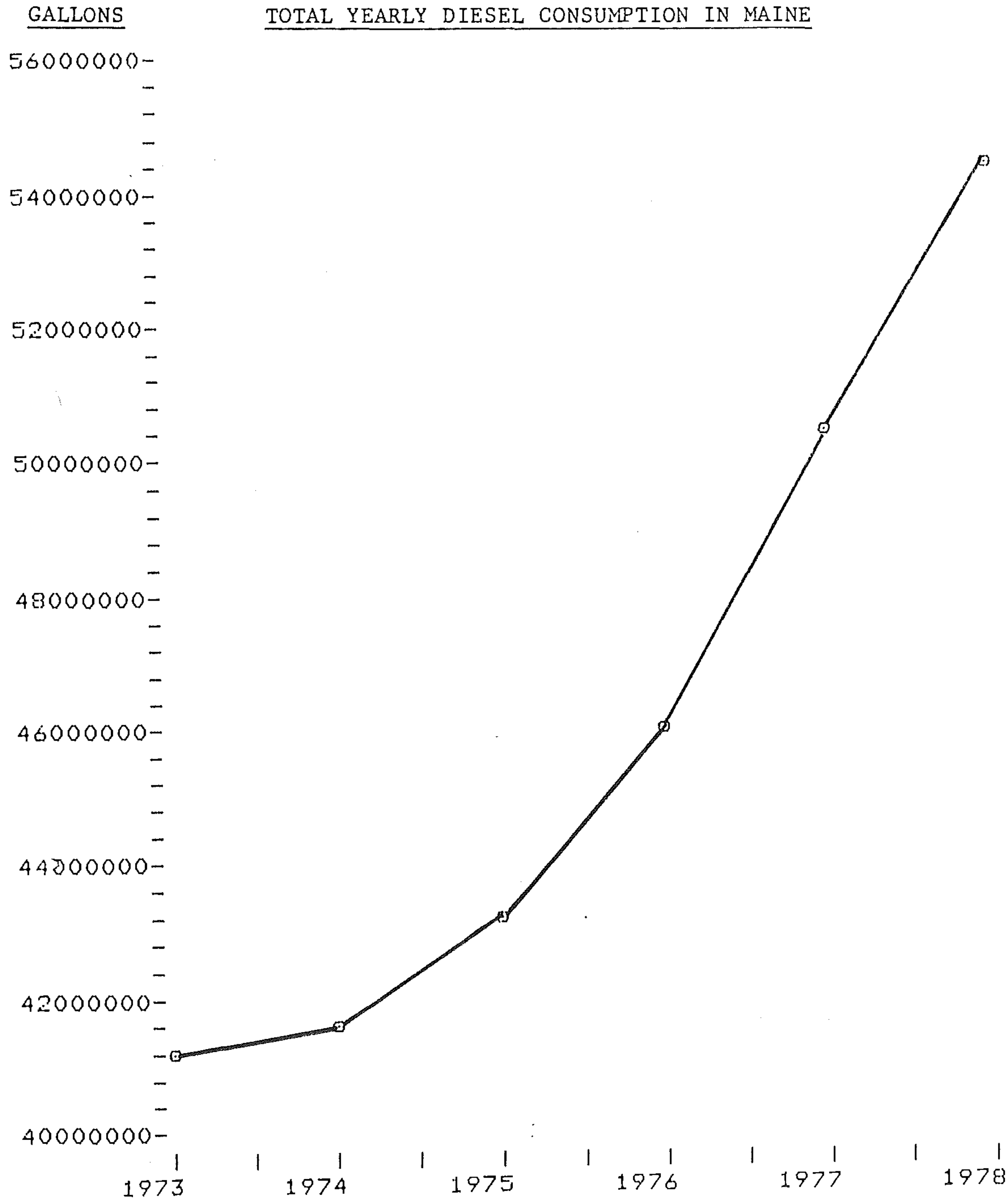
	1976	1977	1978
PERCENT CONSUMED TOURISTS	8.89	8.92	14.51

YEARLY DIESEL CONSUMPTION PATTERN

Since 1974 diesel consumption in Maine has risen dramatically as shown on the following page.

The reason for this sharp increase may be attributed to conversion of large vehicles to diesel (buses, trucks), increased trucking (logging industry), and more diesel automobiles.

TOTAL YEARLY DIESEL CONSUMPTION IN MAINE



ABSCISSA = TIME
⊙ = TOTAL DIESEL

	1974	1975	1976	1977	1978
TOTAL DIESEL	41633490.00	43316766.00	45850229.00	50369536.00	54345613.00
PERCENT CHANGE	.93	4.04	5.85	9.86	7.89

MONTHLY DIESEL CONSUMPTION PATTERN

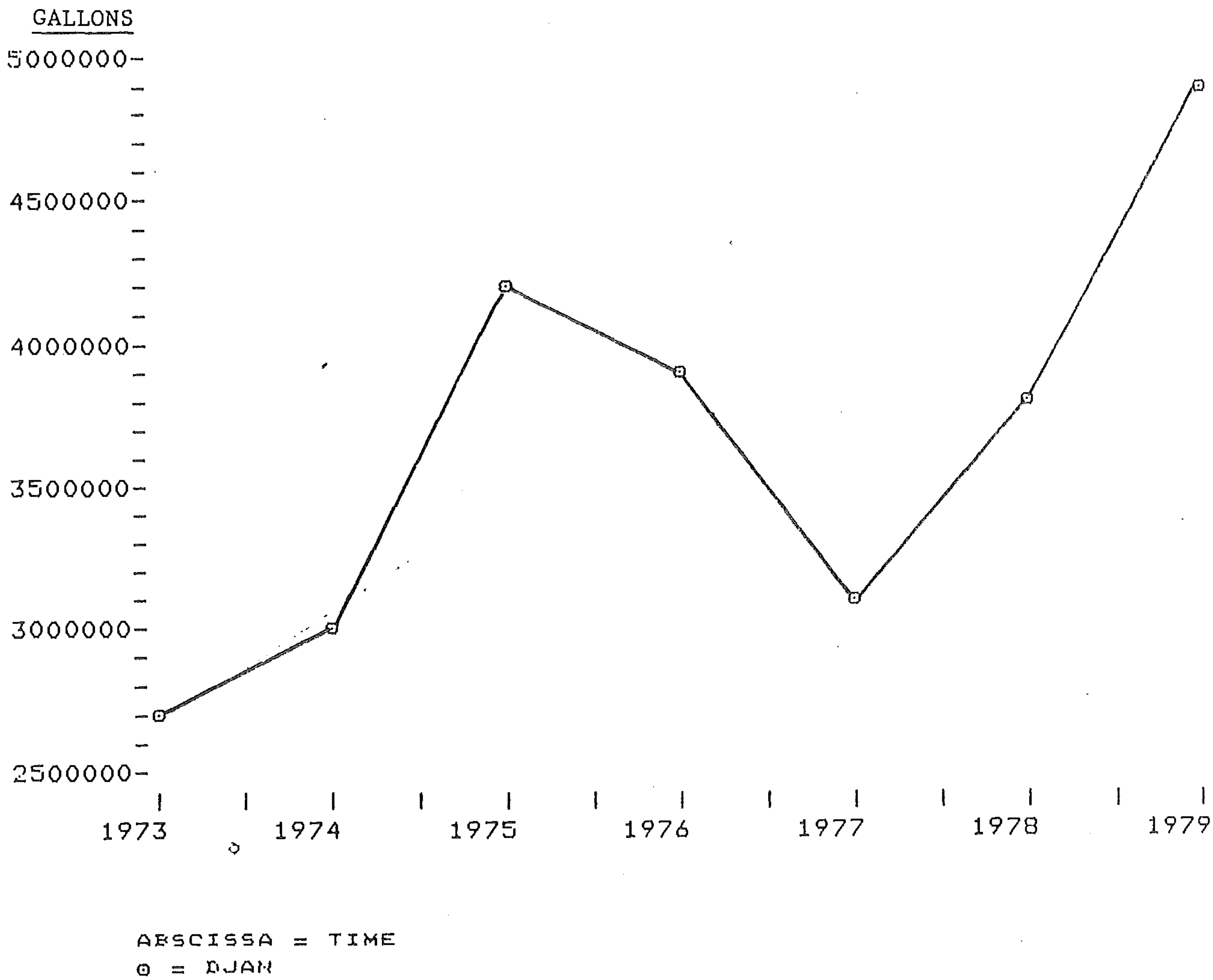
The monthly diesel consumption patterns are rather erratic. One interesting trend is the occurrence of substantially larger consumption figures occurring each three months. This is probably due to the fact that construction companies report quarterly.

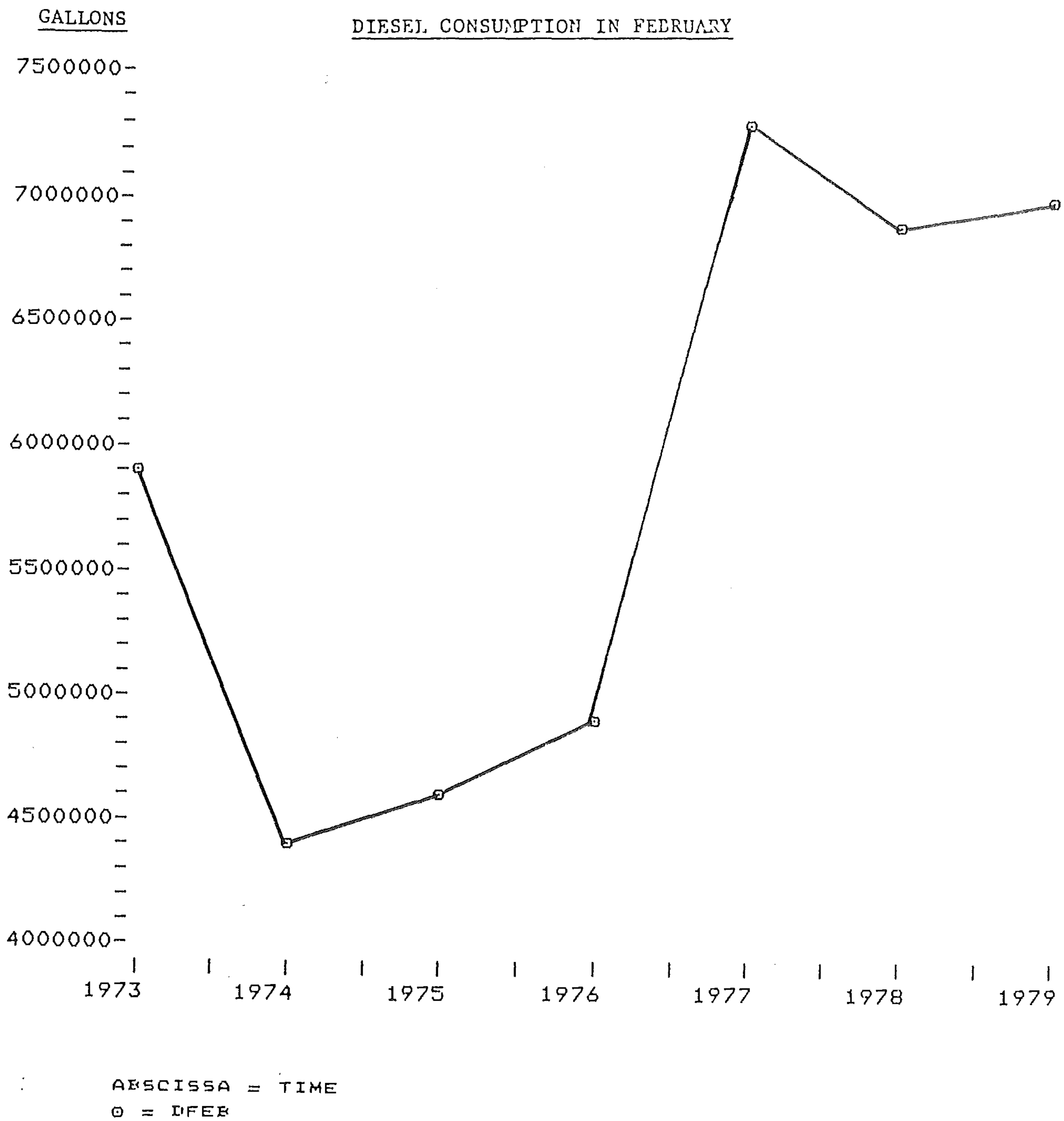
TABULATION OF MONTHLY DIESEL
CONSUMPTION IN MAINE

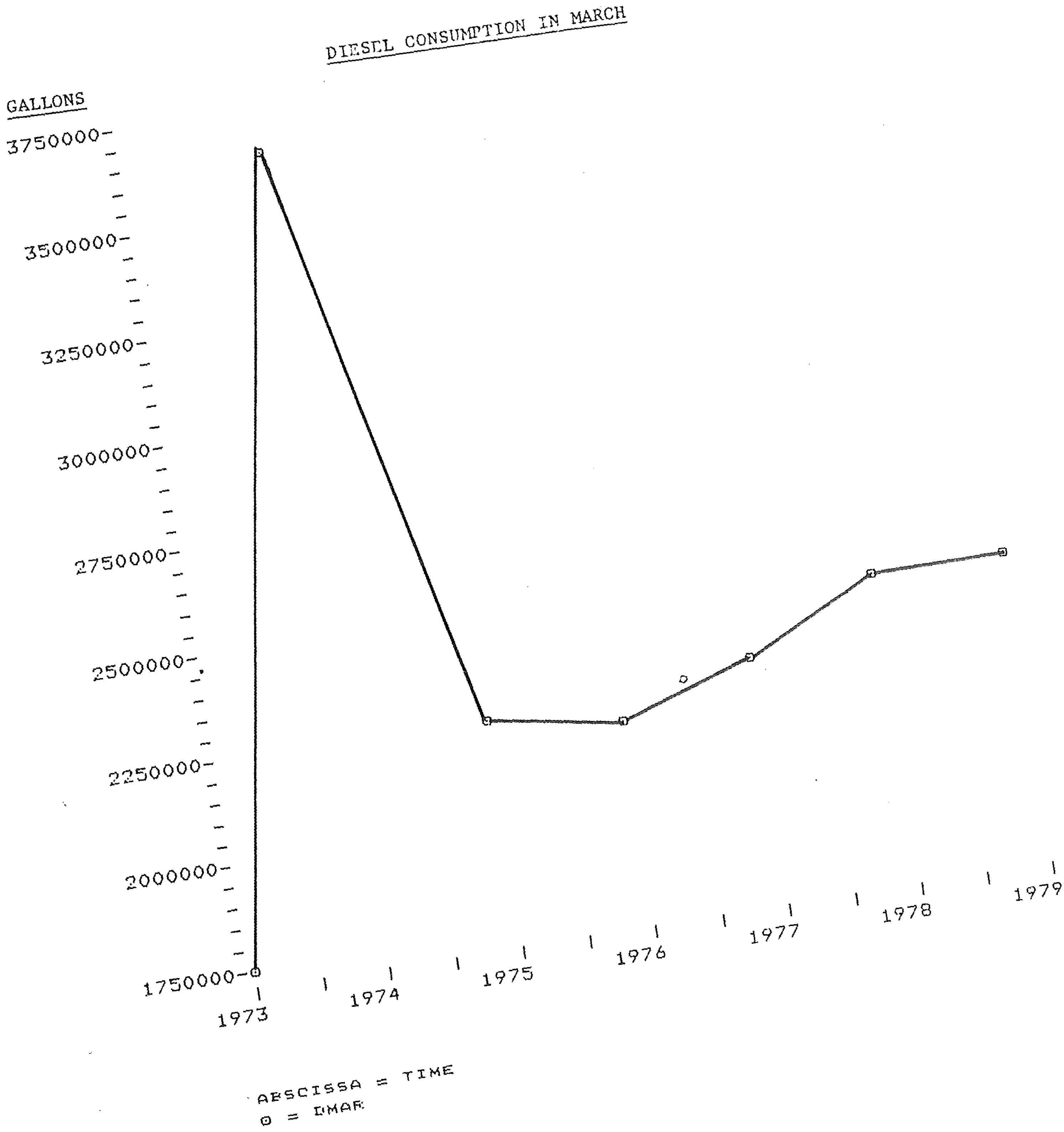
GALLONS

	1974	1975	1976	1977	1978	1979
DJAN	2991531.00	4155067.00	3873798.00	3076932.00	3816746.00	4922367.00
DJANPC	12.78	38.89	¯6.77	¯20.57	24.04	28.97
DFEB	4403234.00	4620221.00	4932594.00	7284026.00	6862481.00	7035452.00
DFEBPC	¯25.23	4.93	6.76	47.67	¯5.79	2.52
DMAR	3650910.00	2233067.00	2196985.00	2309741.00	2458296.00	2436357.00
DMARPC	106.33	¯38.84	¯1.62	5.13	6.43	¯.89
DAPR	2342047.00	3614895.00	4323534.00	3365013.00	4516315.00	4047083.00
DAPRPC	¯9.10	54.35	19.60	¯22.17	34.21	¯10.39
DMAY	5505190.00	4436779.00	4914703.00	6756401.00	6652214.00	.00
DMAYPC	¯3.44	¯19.41	10.77	37.47	¯1.54	¯100.00
DJUN	2548815.00	2295183.00	2480452.00	2358860.00	2853574.00	.00
DJUNPC	33.22	¯9.95	8.07	¯4.90	20.97	¯100.00
DJUL	2470001.00	3213504.00	3821009.00	4179740.00	3729008.00	.00
DJULPC	¯18.88	30.10	18.90	9.39	¯10.78	¯100.00
DAUG	5810425.00	5572236.00	5607670.00	5962112.00	7358273.00	.00
DAUGPC	5.38	¯4.10	.64	6.32	23.42	¯100.00
DSEP	1806928.00	1896683.00	1742793.00	2210731.00	1958617.00	.00
DSEPPC	24.07	4.97	¯8.11	26.85	¯11.40	¯100.00
DOCT	3422760.00	4148525.00	3033774.00	4710316.00	5438285.00	.00
DOCTPC	49.93	21.20	¯26.87	55.26	15.45	¯100.00
DNOV	5098109.00	4393610.00	6756626.00	5900682.00	6327621.00	.00
DNOVPC	¯24.50	¯13.82	53.78	¯12.67	7.24	¯100.00
DDEC	1583540.00	2736996.00	2166291.00	2254982.00	2374183.00	.00
DDECPC	¯6.69	72.84	¯20.85	4.09	5.29	¯100.00

DIESEL CONSUMPTION IN JANUARY

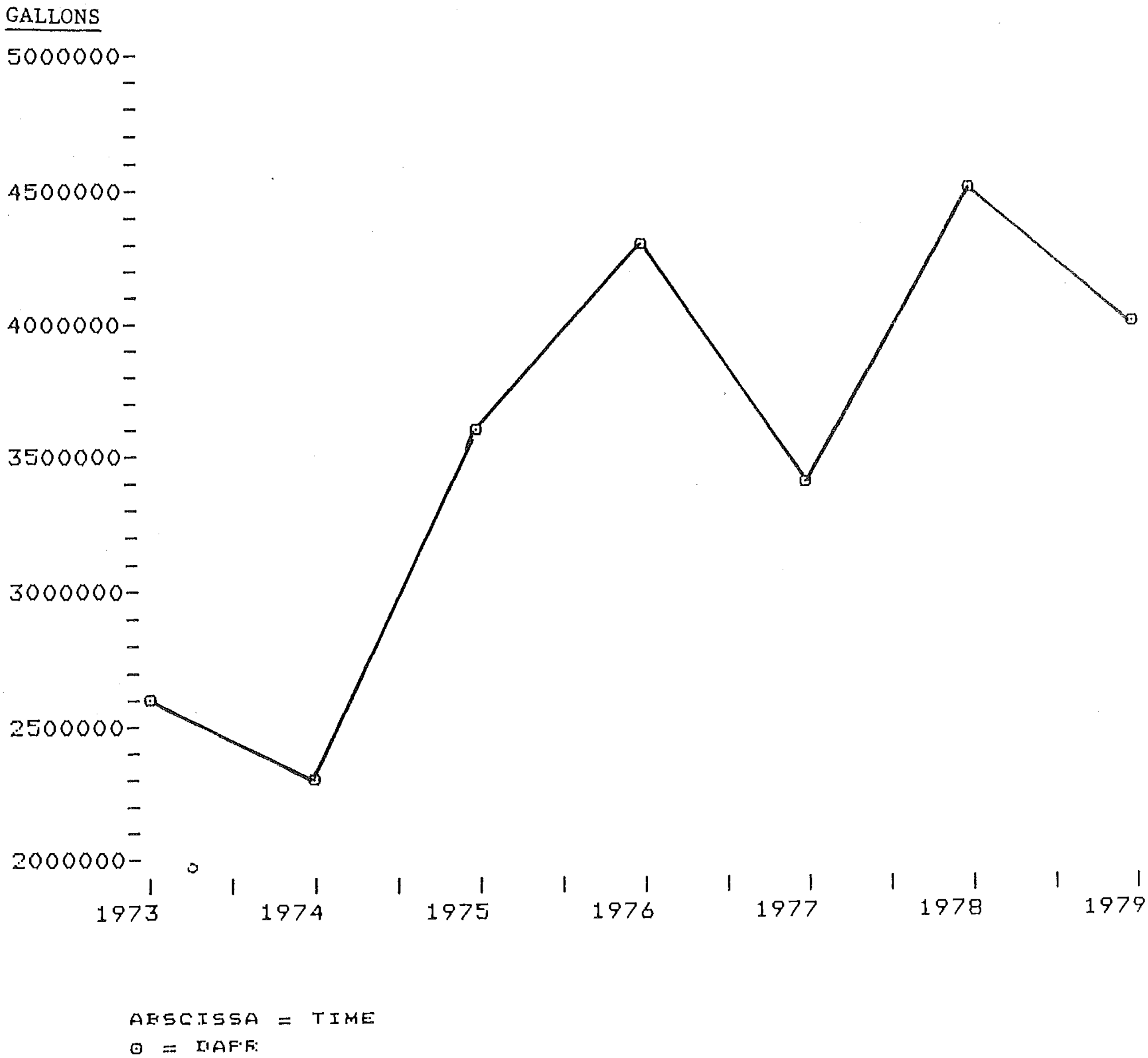


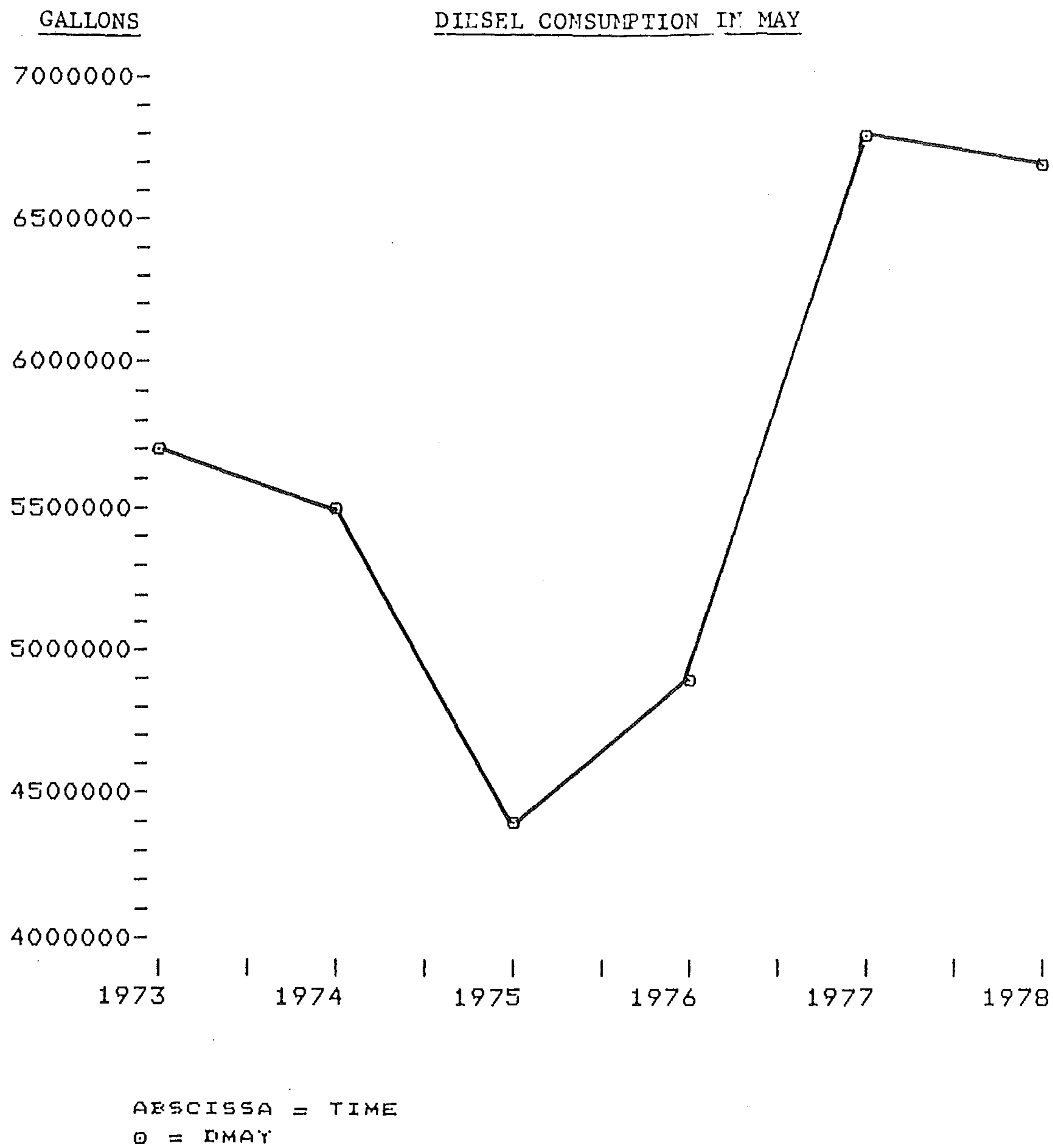

GALLONS
DIESEL CONSUMPTION IN FEBRUARY
7500000
7000000
6500000
6000000
5500000
5000000
4500000
4000000
1973
1974
1975
1976
1977
1978
1979
ABSCISSA = TIME
⊙ = DFEB

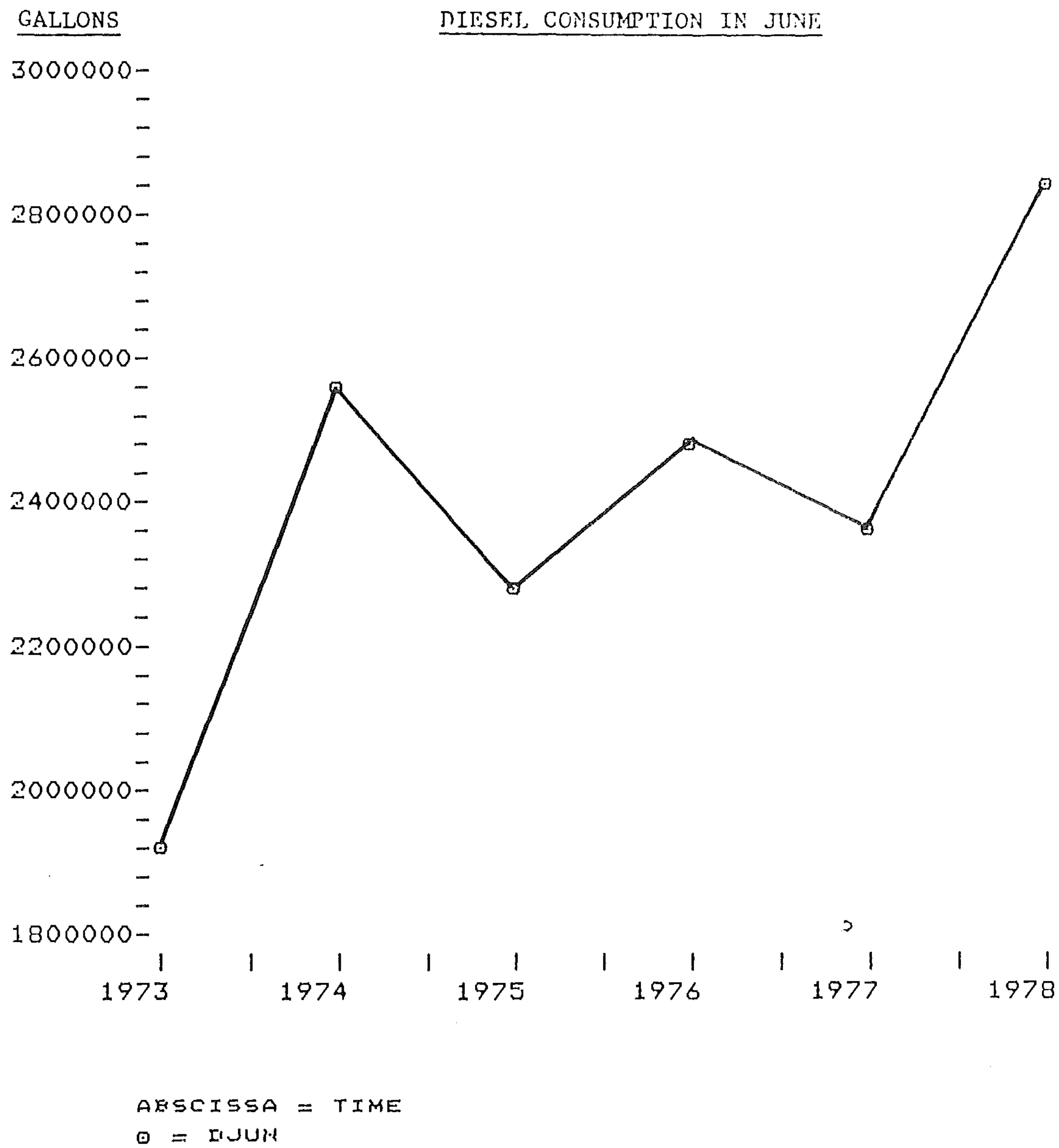


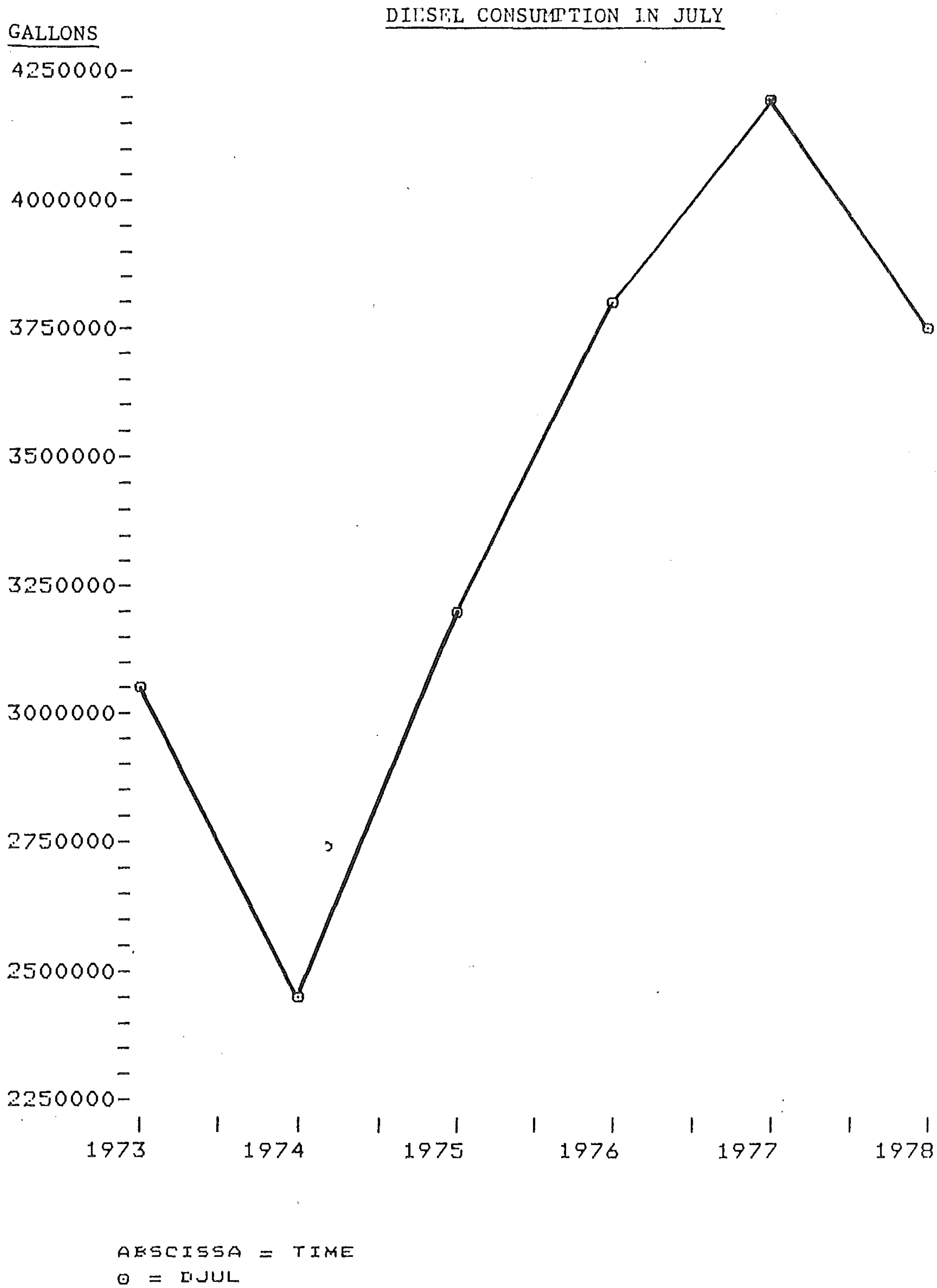
DIESEL CONSUMPTION IN MARCH
GALLONS
3750000
3500000
3250000
3000000
2750000
2500000
2250000
2000000
1750000
1973
1974
1975
1976
1977
1978
1979
ABSCISSA = TIME
⊡ = DMAR

DIESEL CONSUMPTION IN APRIL

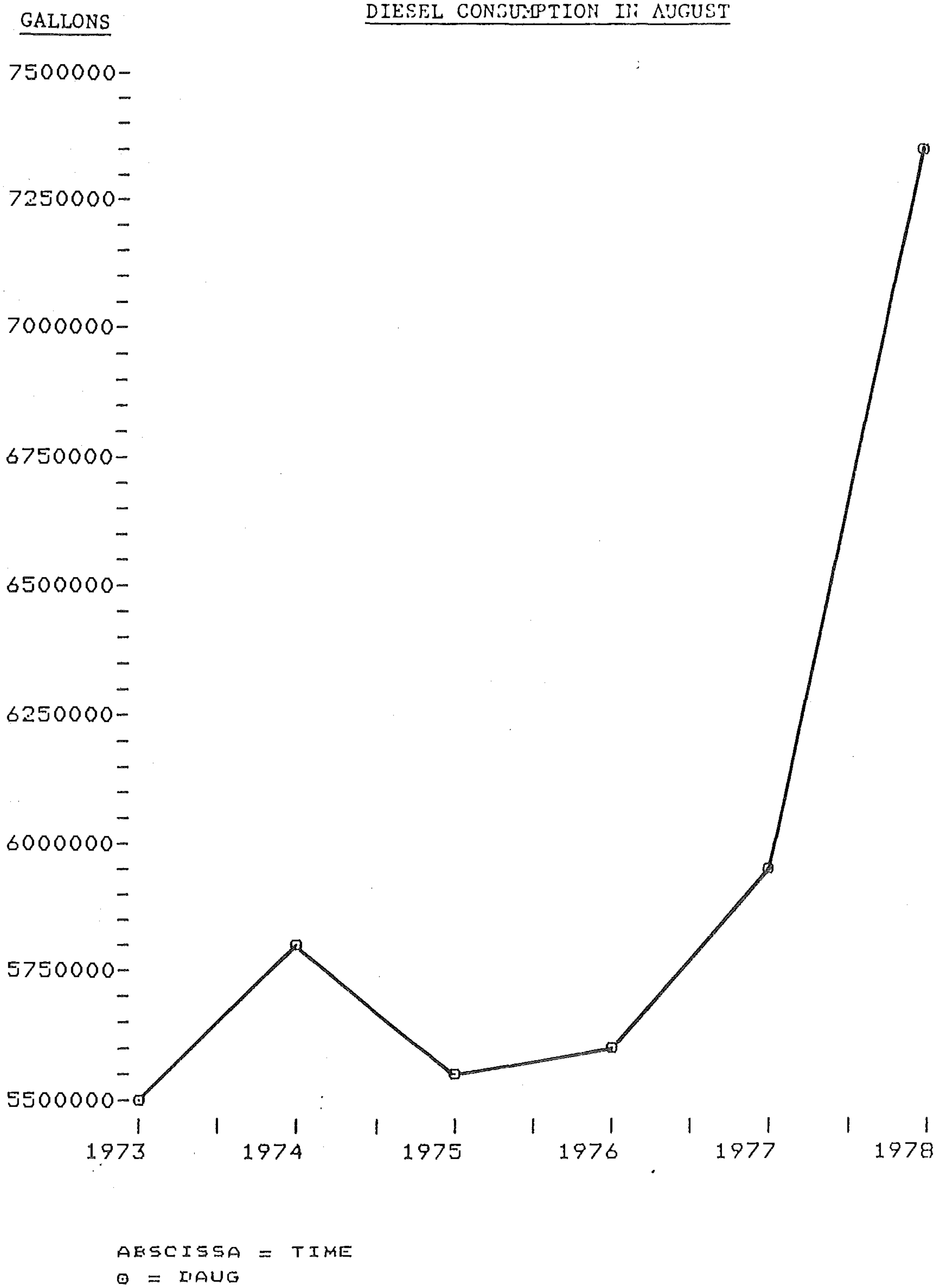



GALLONS
DIESEL CONSUMPTION IN MAY
7000000
6500000
6000000
5500000
5000000
4500000
4000000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊙ = DMAY

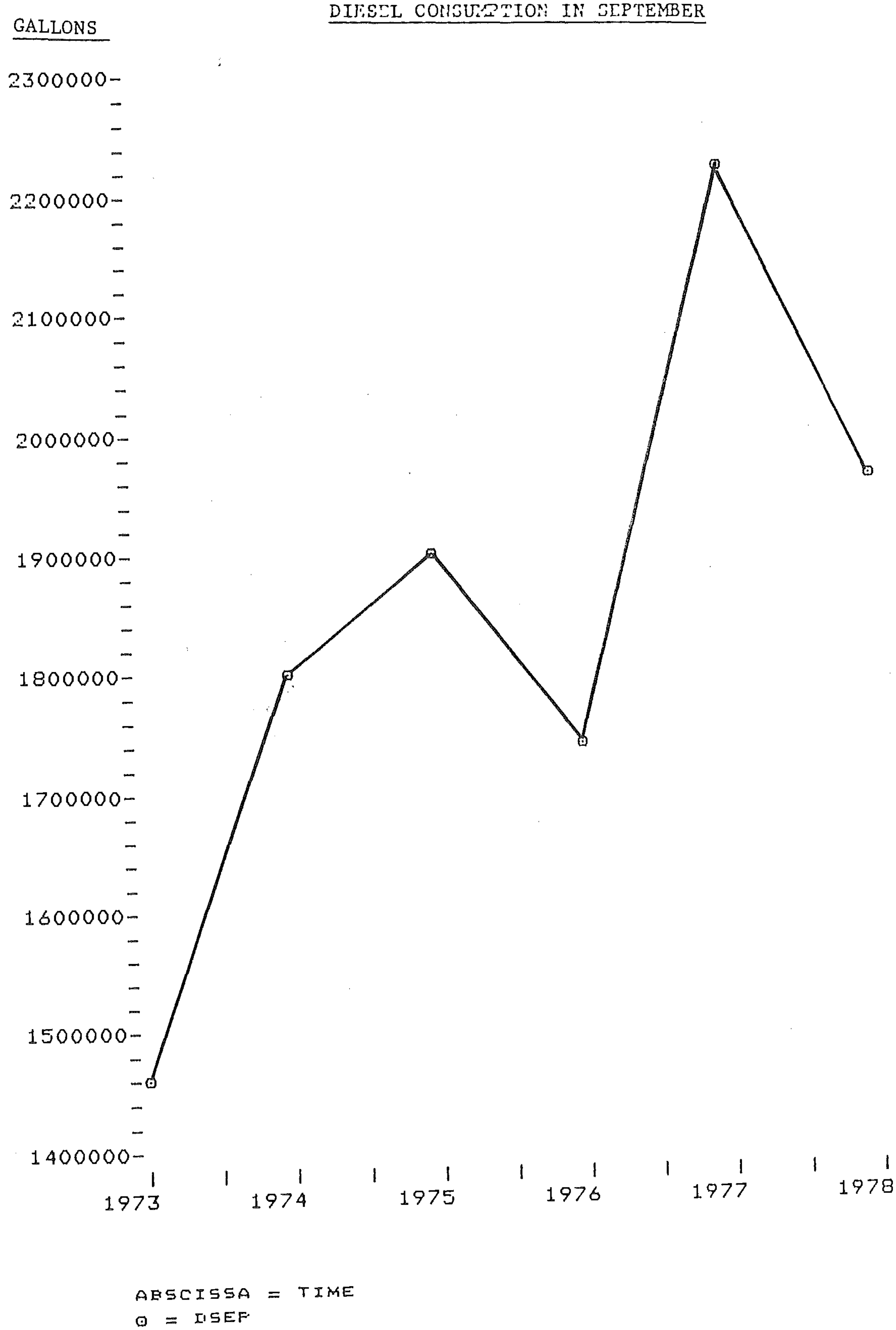

GALLONS
DIESEL CONSUMPTION IN JUNE
3000000
2800000
2600000
2400000
2200000
2000000
1800000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊙ = DJUN

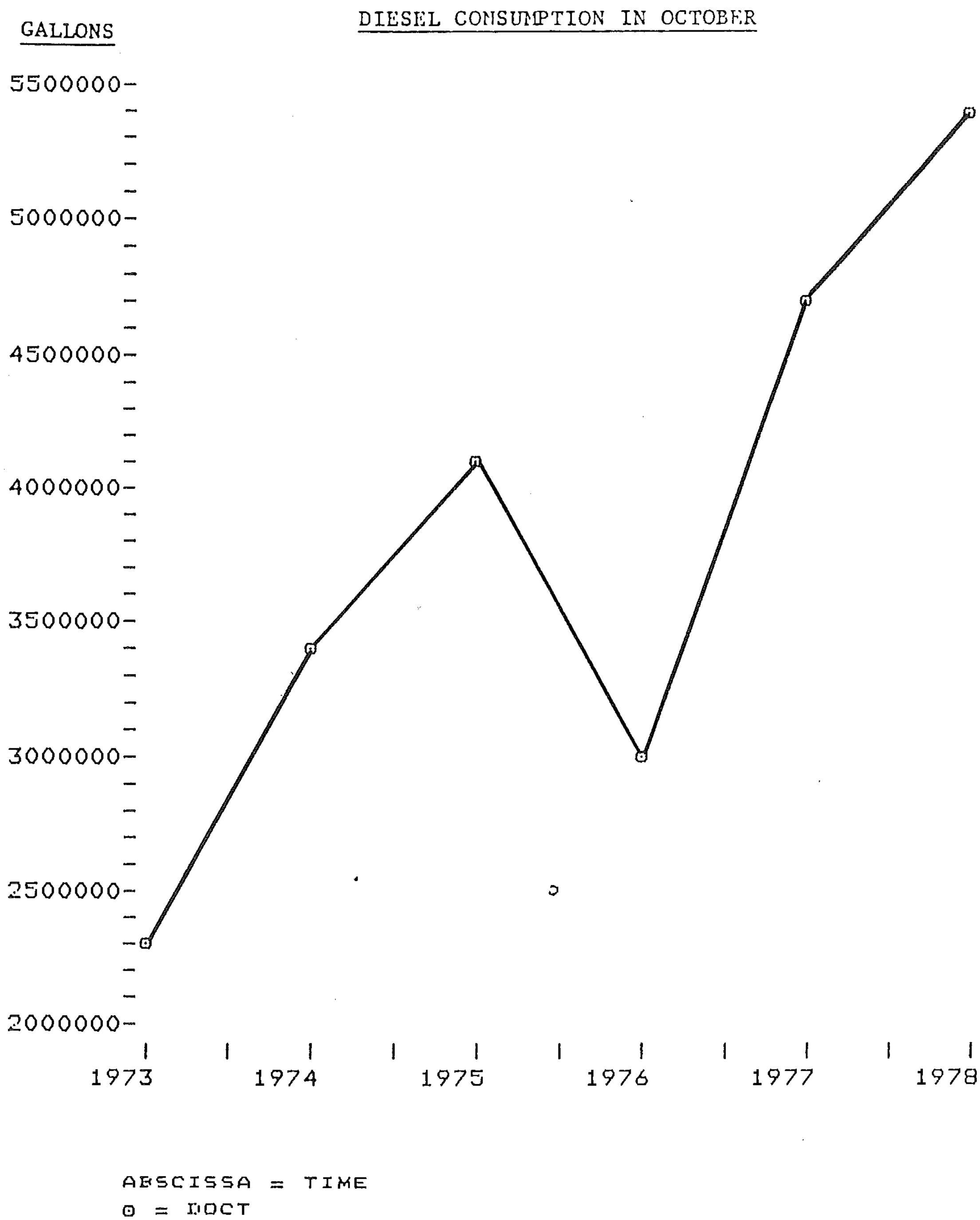

DIESEL CONSUMPTION IN JULY
GALLONS
4250000
4000000
3750000
3500000
3250000
3000000
2750000
2500000
2250000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊙ = DJUL

DIESEL CONSUMPTION IN AUGUST

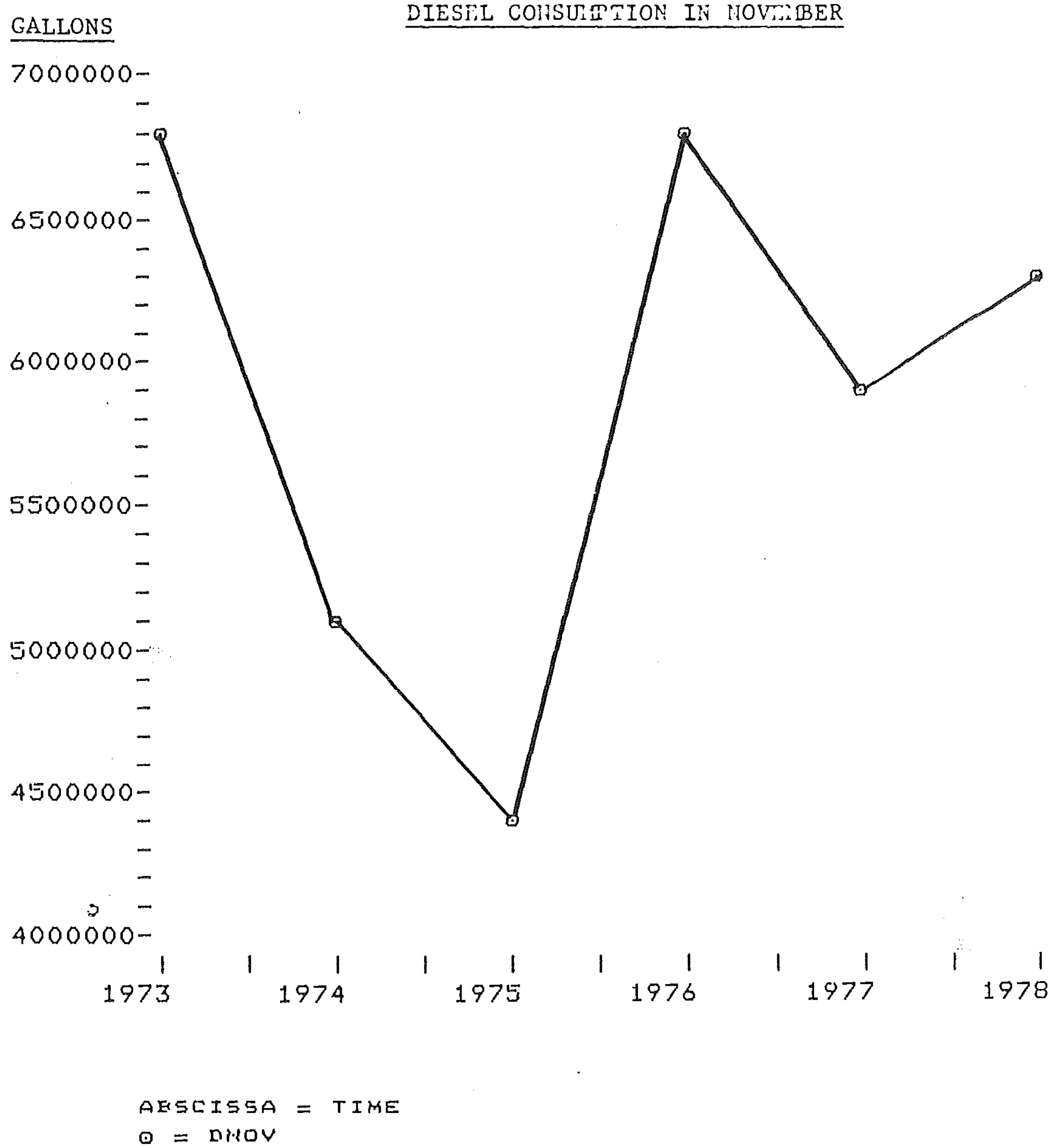


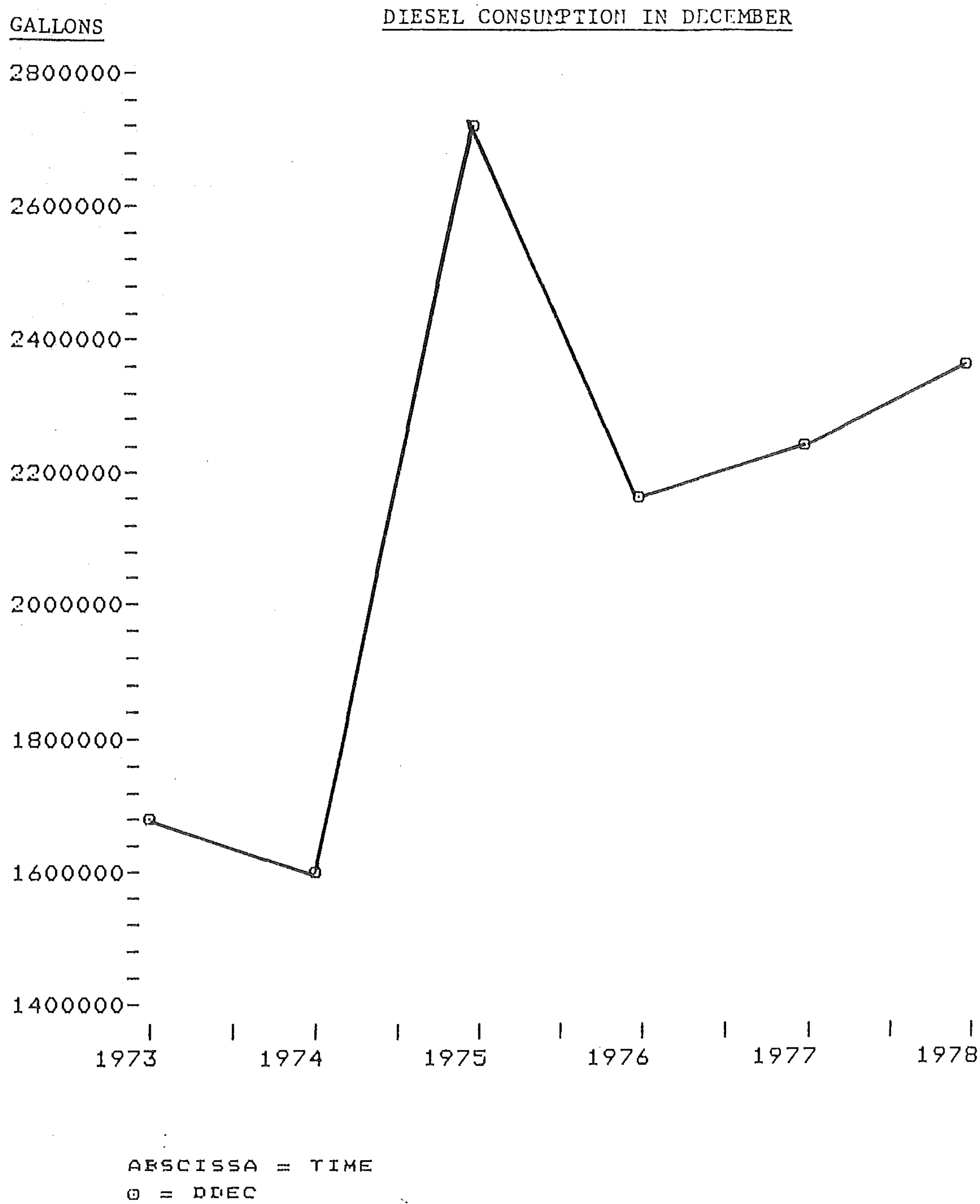
DIESEL CONSUMPTION IN SEPTEMBER




DIESEL CONSUMPTION IN OCTOBER
GALLONS
5500000
5000000
4500000
4000000
3500000
3000000
2500000
2000000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊙ = DOCT

DIESEL CONSUMPTION IN NOVEMBER

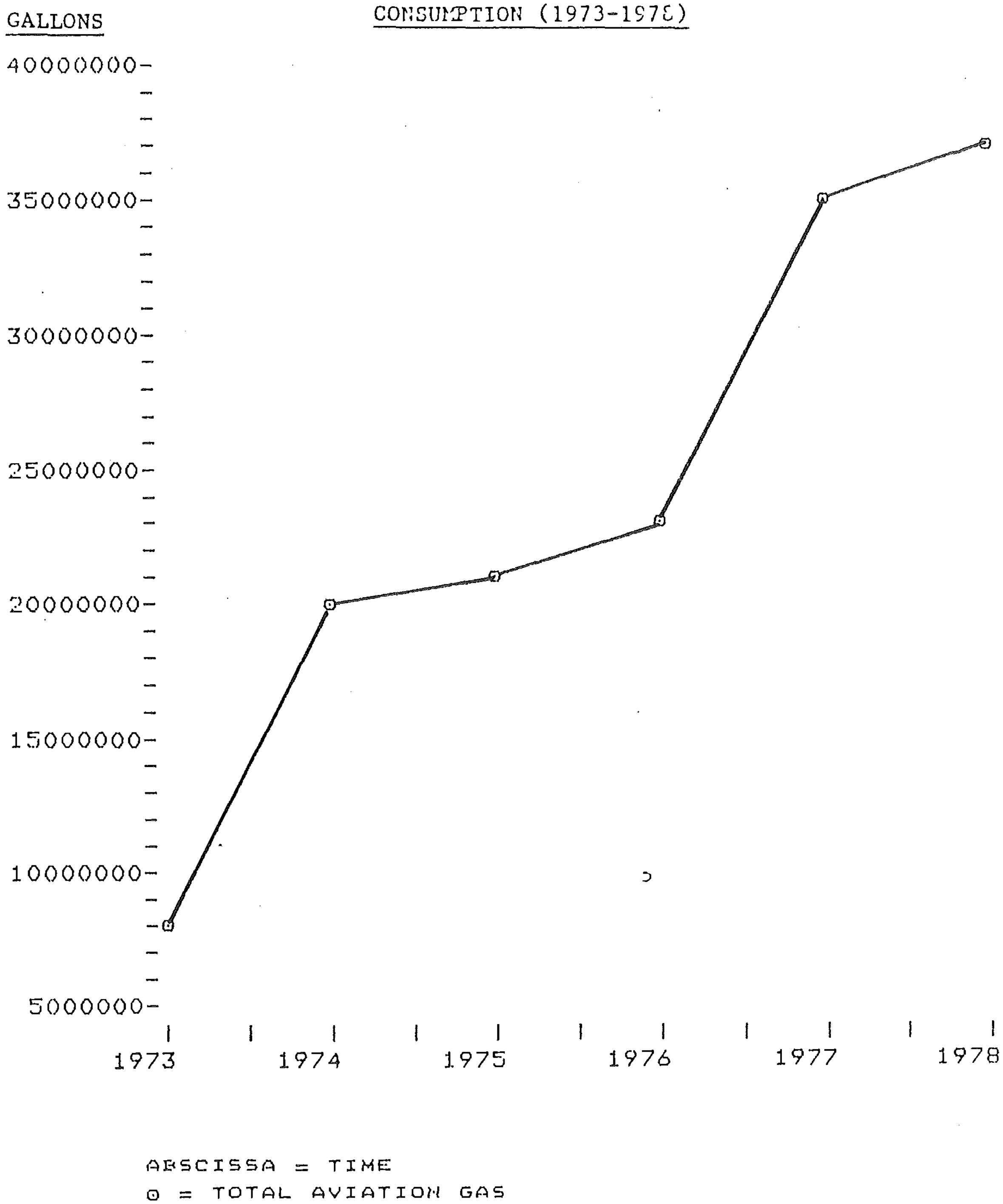



GALLONS
DIESEL CONSUMPTION IN DECEMBER
2800000
2600000
2400000
2200000
2000000
1800000
1600000
1400000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊡ = DDEC

YEARLY AVIATION GASOLINE CONSUMPTION PATTERN

Like diesel consumption aviation gasoline consumption has risen sharply since 1973. The most pronounced jumps occurred in 1974 and 1977 as shown on the page which follows.

TOTAL AVIATION GASOLINE CONSUMPTION (1973-1978)



	1974	1975	1976	1977	1978
TOTAL AVIATION GAS	19521529.00	20837396.00	23435595.00	34764774.00	37191901.00
PERCENT CHANGE	138.18	6.74	12.47	48.34	6.98

MONTHLY AVIATION GASOLINE CONSUMPTION PATTERNS

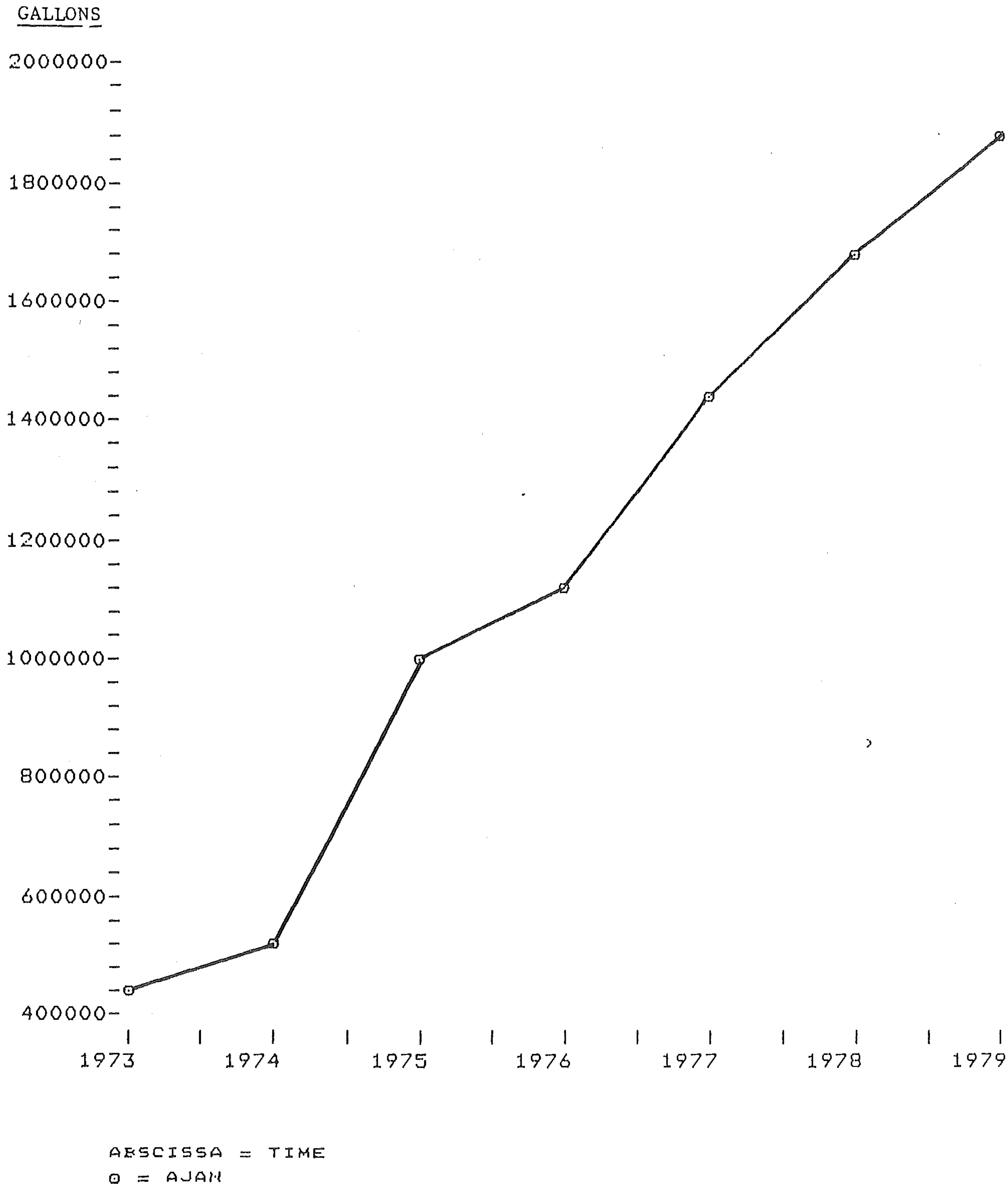
The monthly consumption patterns for January through May show a marked increase from year to year while the trends for June through September indicate a general increase from 1973-1977 with the 1978 figure below the 1978 level. Like January through May the data for October through December show a general upward trend.

TABULATION OF MONTHLY AVIATION GASOLINE CONSUMPTION IN MAINE (1974-1979)

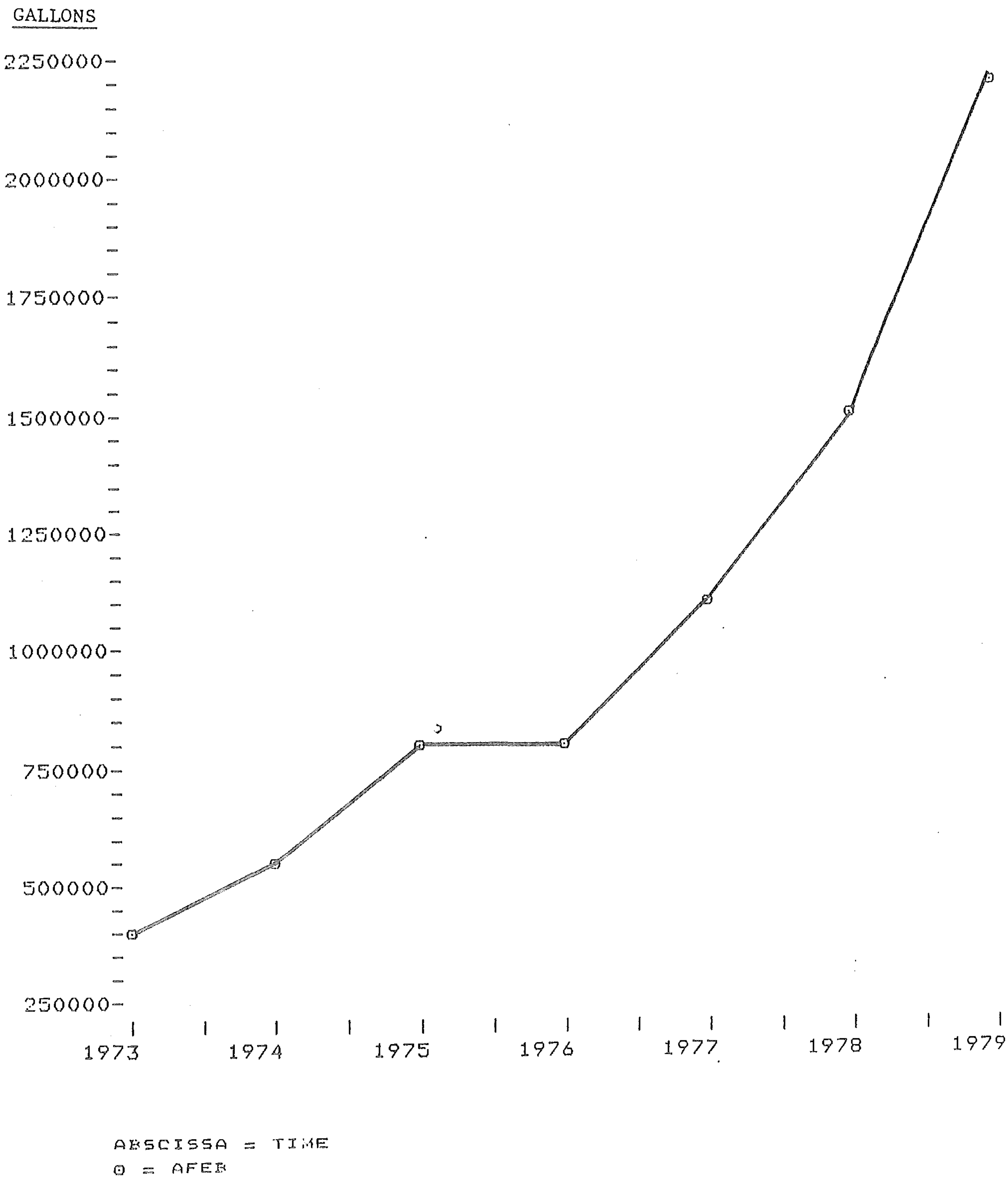
GALLONS

	1974	1975	1976	1977	1978	1979
AJAN	510073.00	980020.00	1105938.00	1438816.00	1671557.00	1866023.00
AJANPC	19.35	92.13	12.85	30.10	16.18	11.63
AFEB	538199.00	804711.00	781245.00	1087457.00	1500387.00	2192709.00
AFEBPC	33.22	49.52	¯2.92	39.20	37.97	46.14
AMAR	533635.00	971949.00	787600.00	1422687.00	2156605.00	2529767.00
AMARPC	¯14.25	82.14	¯18.97	80.64	51.59	17.30
AAPR	719308.00	1096660.00	1053962.00	1834505.00	2407458.00	.00
AAPRPC	26.60	52.46	¯3.89	74.06	31.23	¯100.00
AMAY	1470725.00	1666563.00	1454947.00	3048544.00	3102646.00	.00
AMAYPC	111.31	13.32	¯12.70	109.53	1.77	¯100.00
AJUN	2699810.00	2477425.00	3418852.00	4838308.00	4112287.00	.00
AJUNPC	195.42	¯8.24	38.00	41.52	¯15.01	¯100.00
AJUL	2819232.00	3028864.00	3960075.00	4996900.00	4921881.00	.00
AJULPC	219.36	7.44	30.74	26.18	¯1.50	¯100.00
AAUG	2955367.00	2962359.00	3231921.00	5670984.00	5052951.00	.00
AAUGPC	204.94	.24	9.10	75.47	¯10.90	¯100.00
ASEP	2532835.00	2302781.00	2743954.00	4020089.00	3948094.00	.00
ASEPPC	203.82	¯9.08	19.16	46.51	¯1.79	¯100.00
AOCT	2430146.00	2009557.00	2253453.00	2669568.00	3181594.00	.00
AOCTPC	215.82	¯17.31	12.14	18.47	19.18	¯100.00
ANOV	1244859.00	1427581.00	1508443.00	1870484.00	2971105.00	.00
ANOVPC	137.15	14.68	5.66	24.00	58.84	¯100.00
ADEC	1067340.00	1108926.00	1135205.00	1866432.00	2165336.00	.00
ADECPC	82.65	3.90	2.37	64.41	16.01	¯100.00

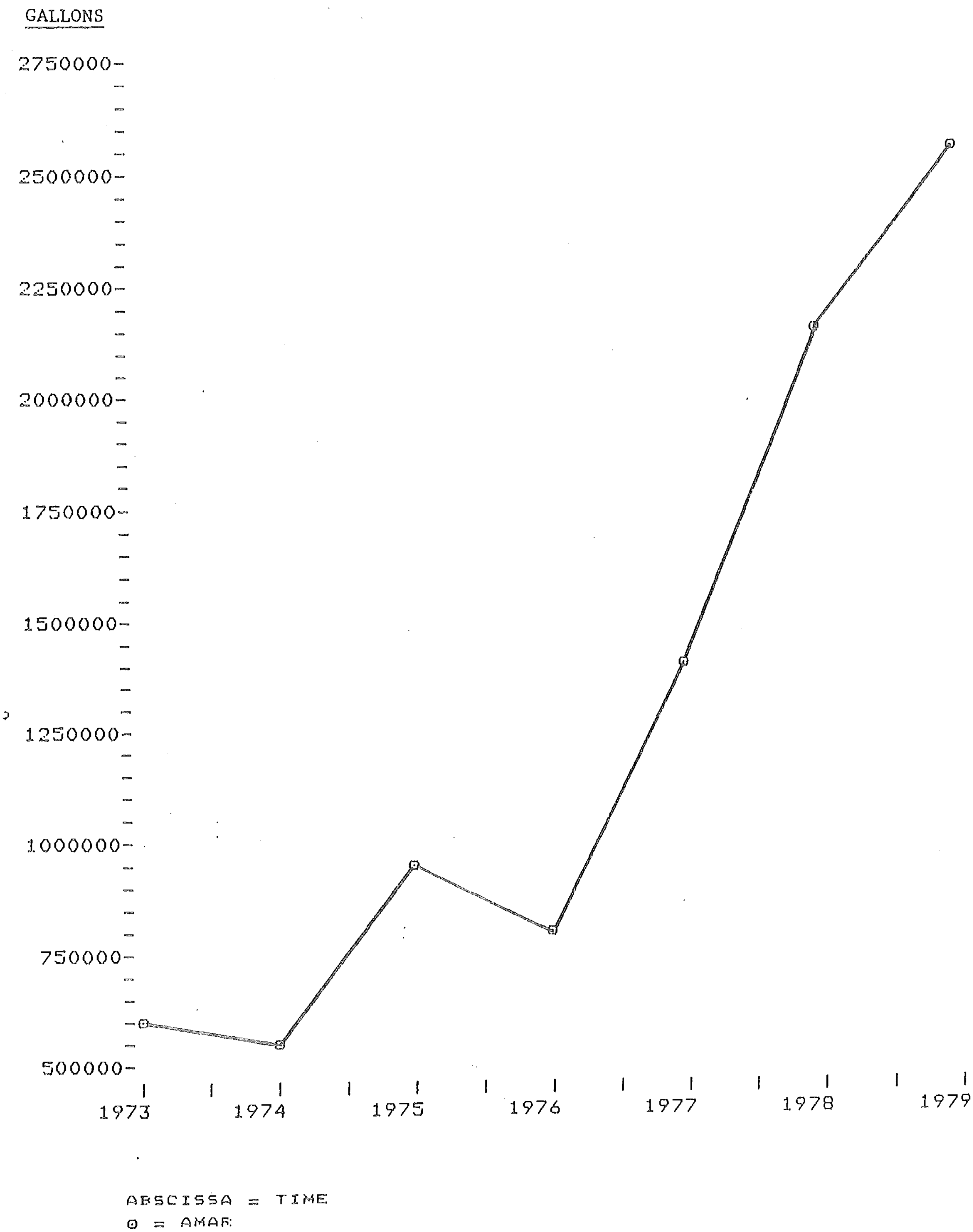
AVIATION GASOLINE CONSUMPTION IN JANUARY



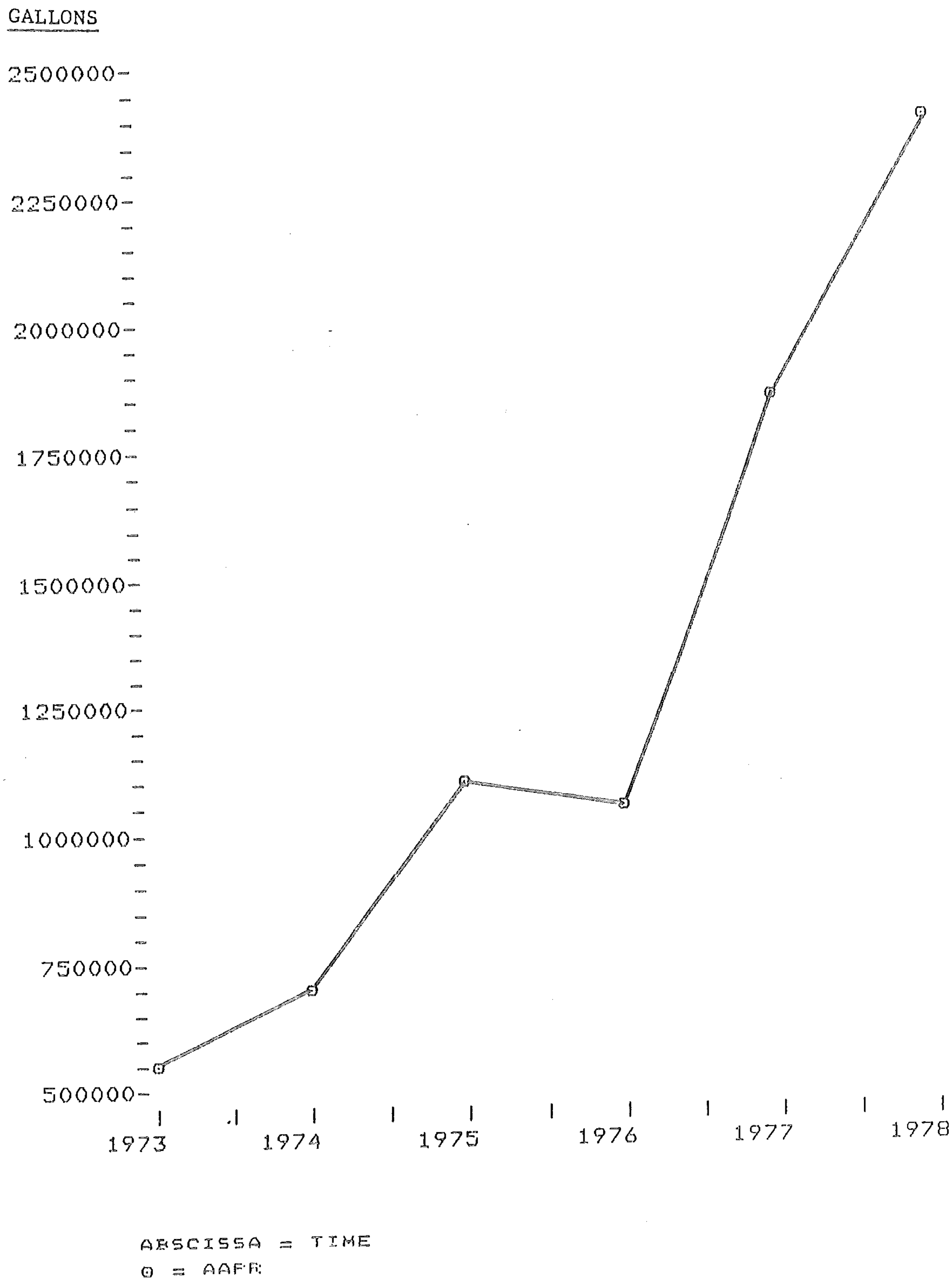
AVIATION GASOLINE CONSUMPTION IN FEBRUARY



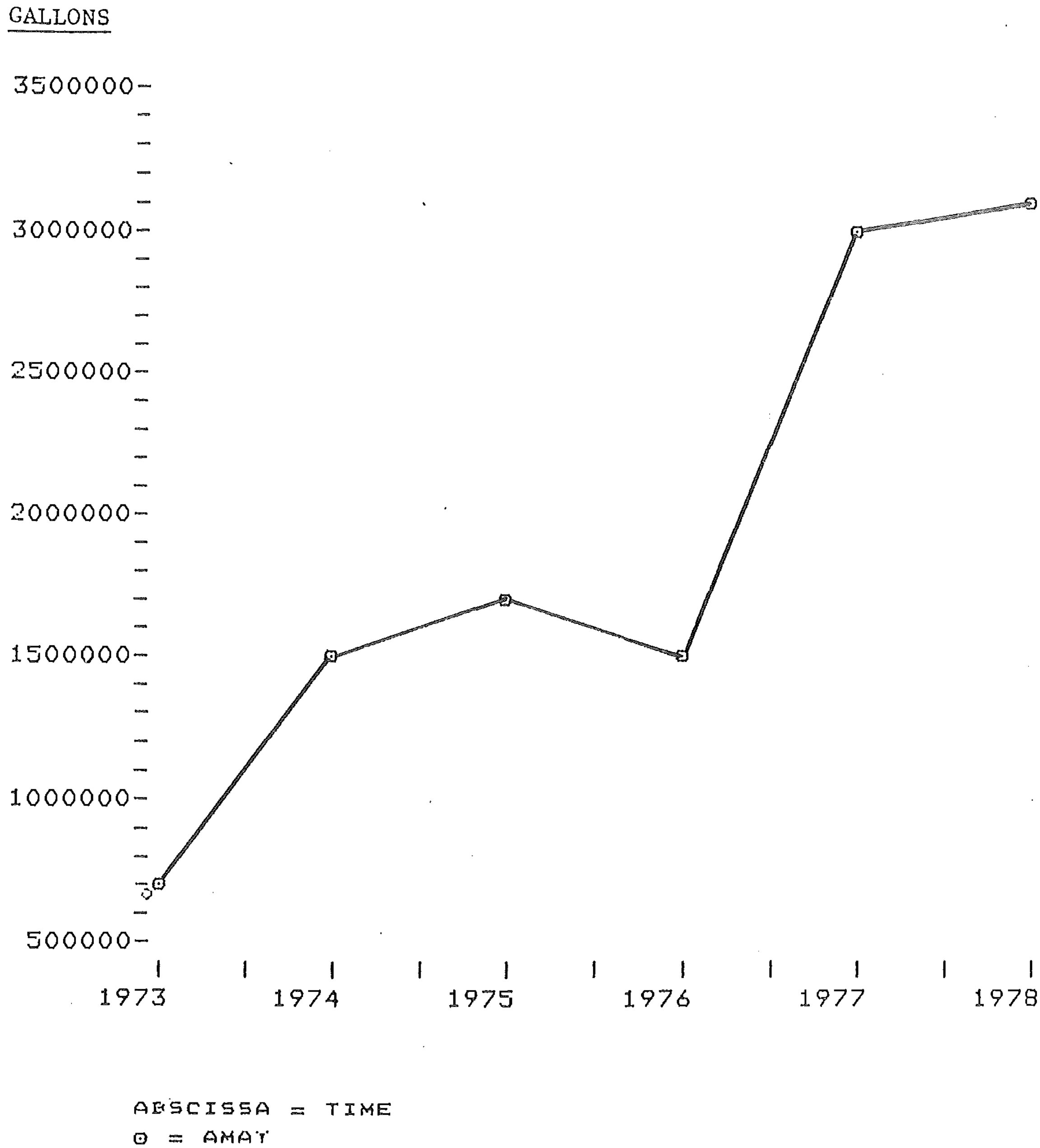
AVIATION GASOLINE CONSUMPTION IN MARCH

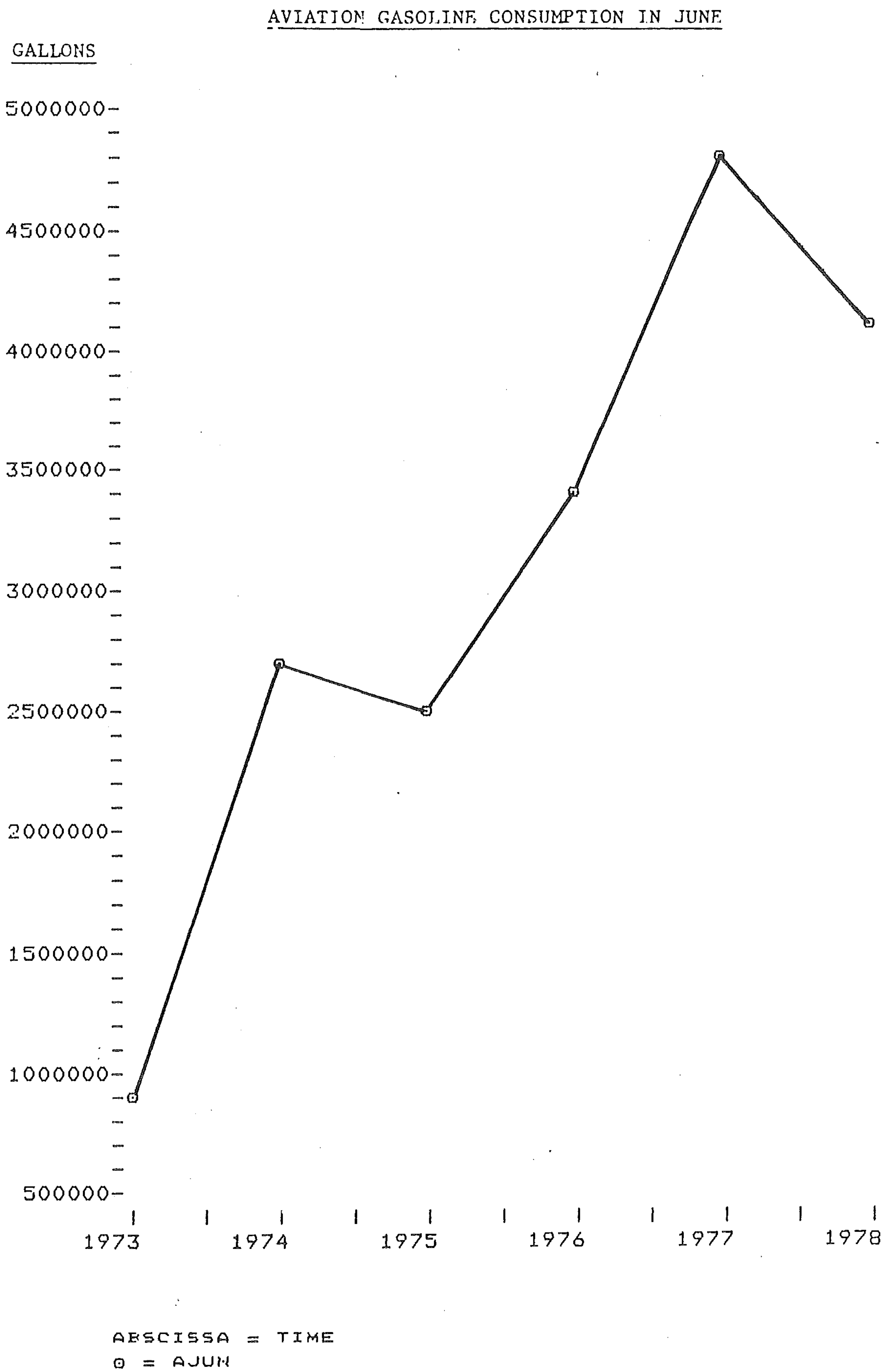


AVIATION GASOLINE CONSUMPTION IN APRIL

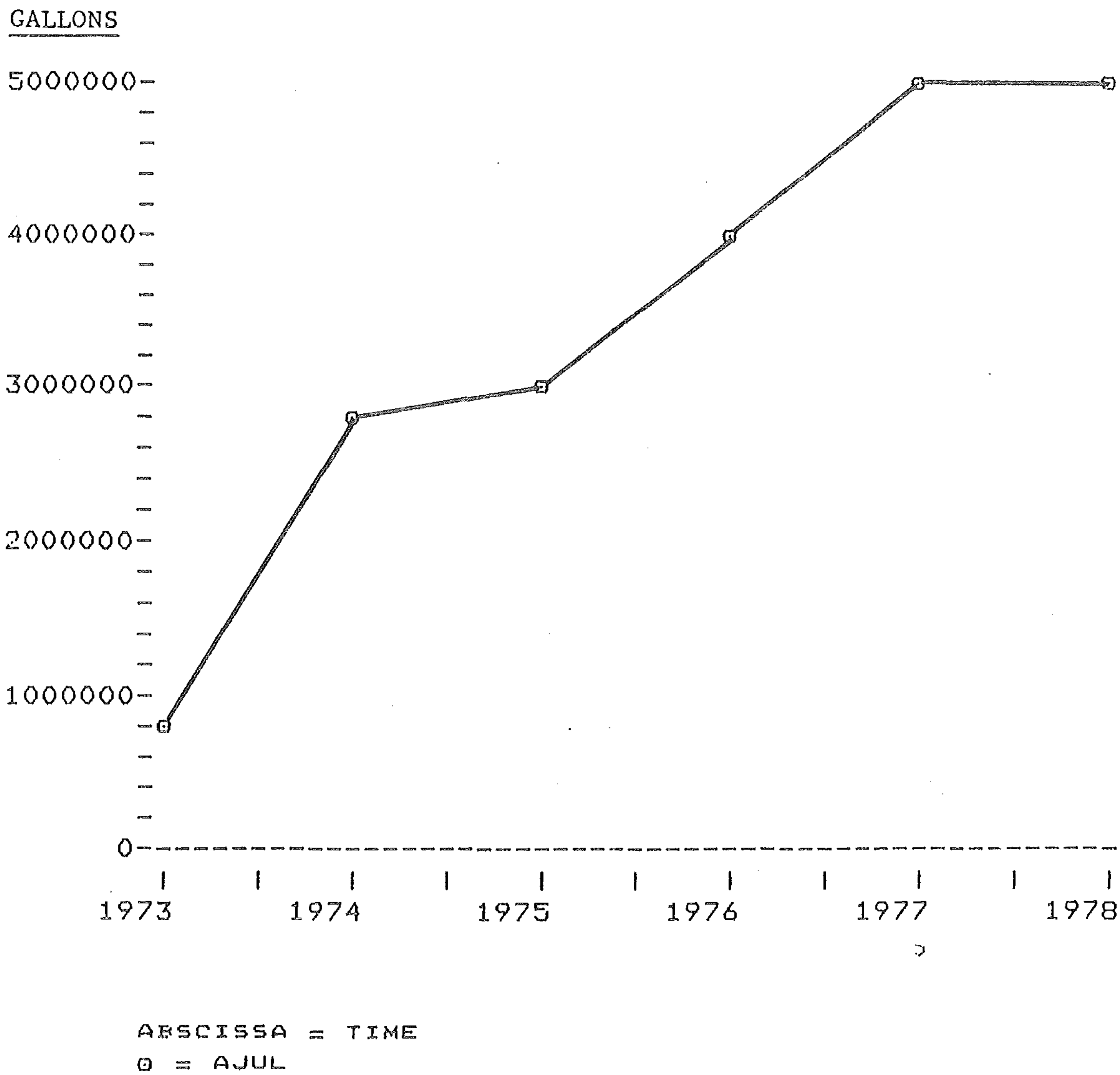


AVIATION GASOLINE CONSUMPTION IN MAY

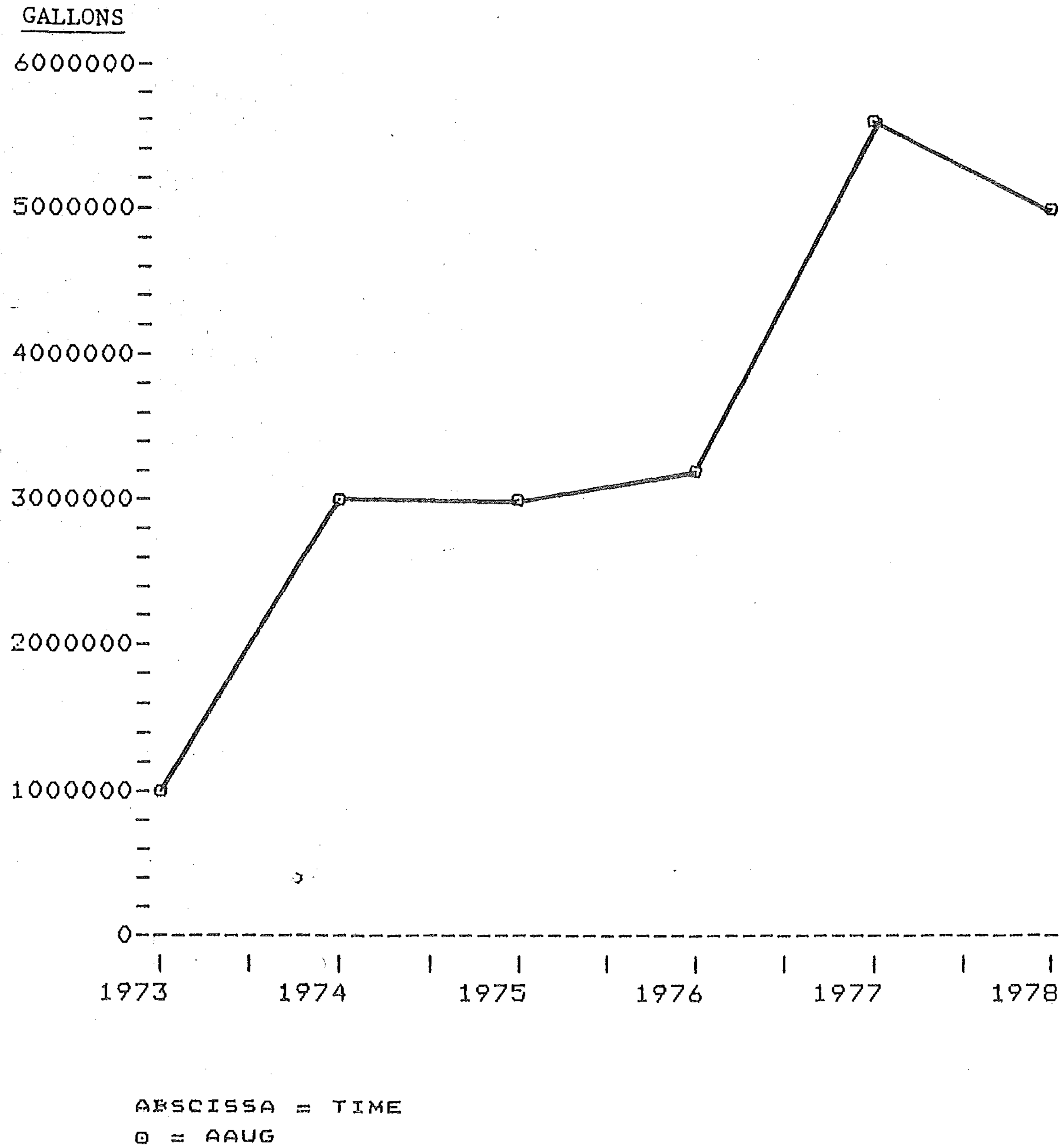


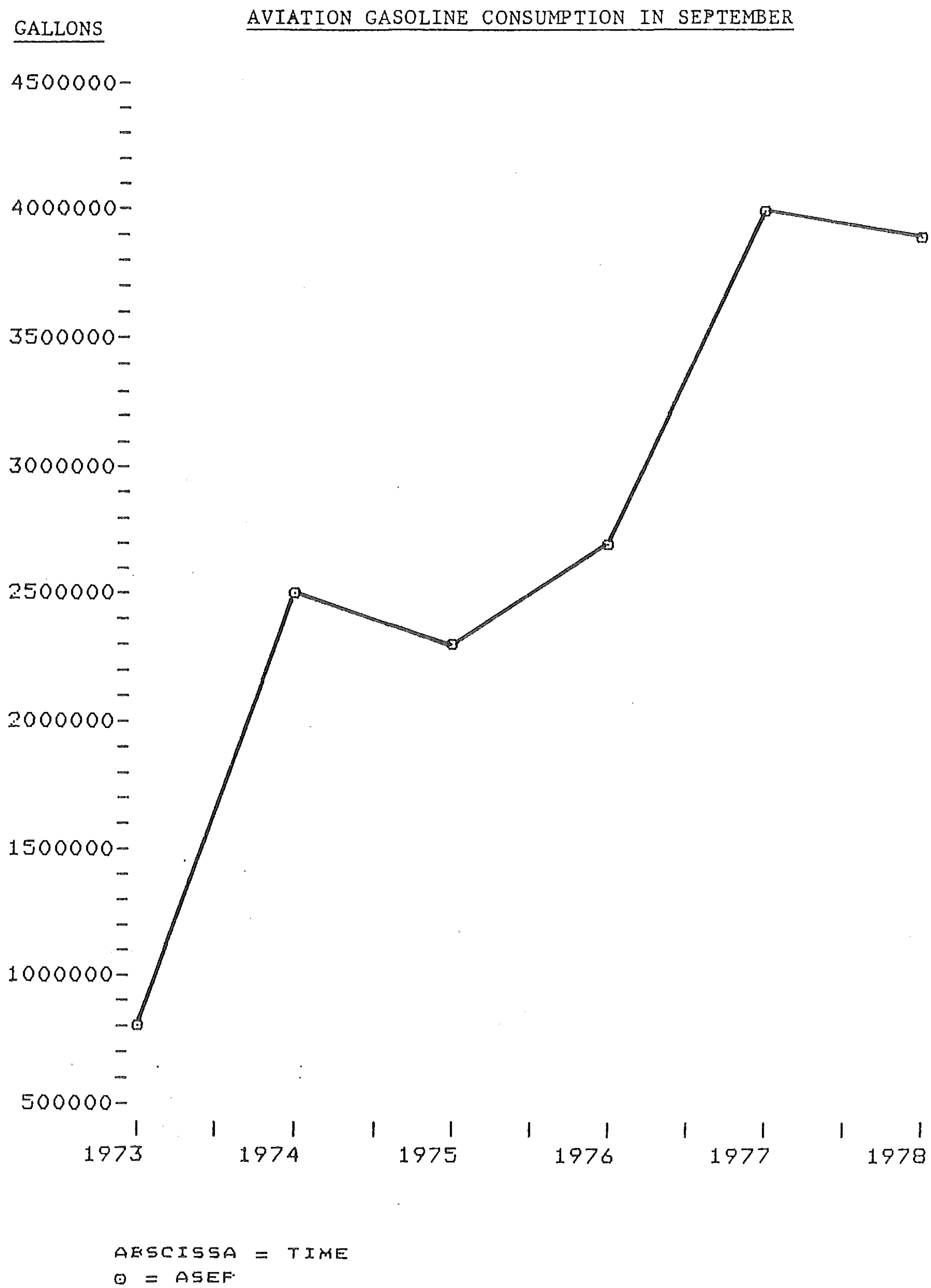

AVIATION GASOLINE CONSUMPTION IN JUNE
GALLONS
5000000
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊙ = AJUN

AVIATION GASOLINE CONSUMPTION IN JULY

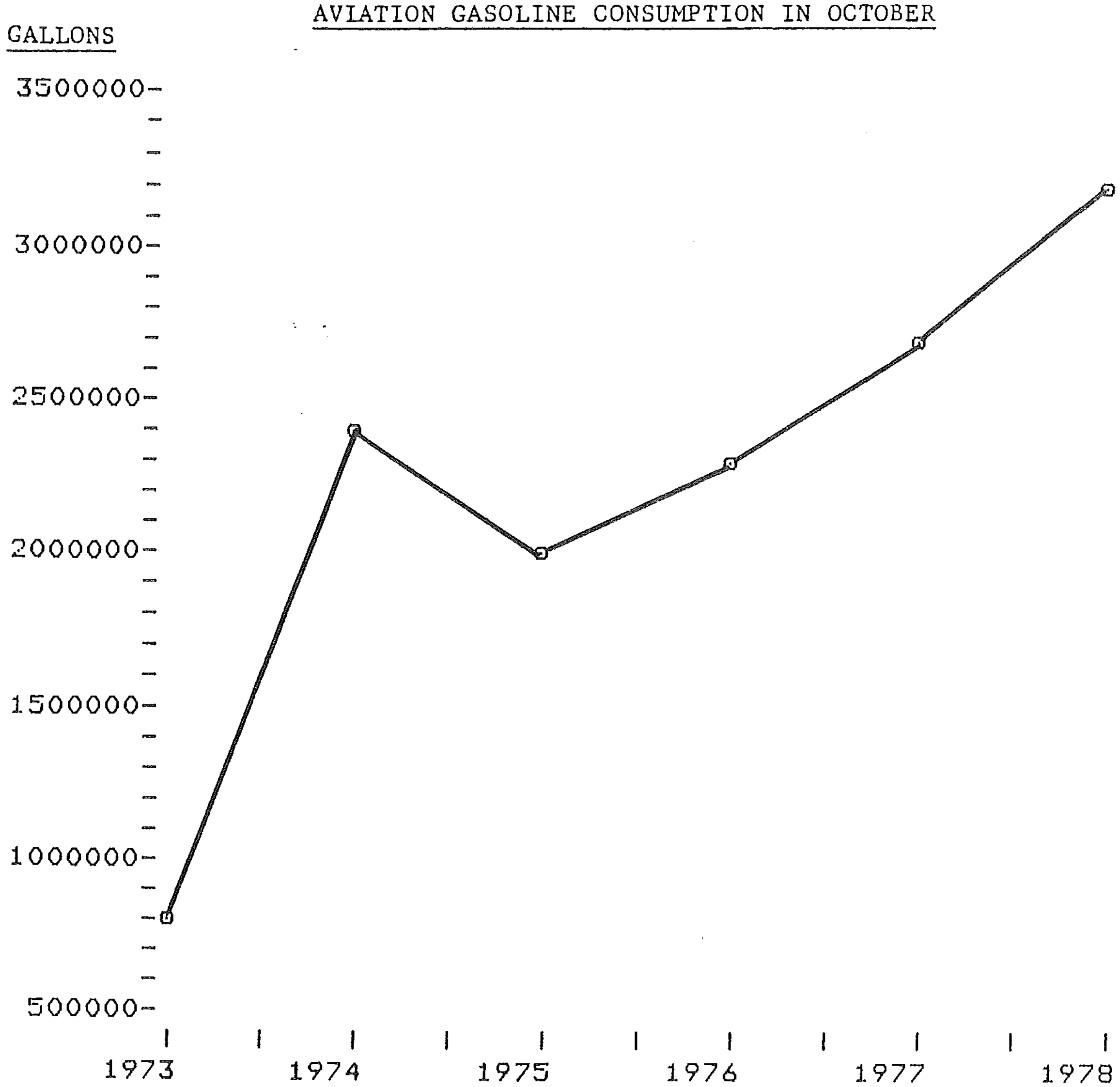


AVIATION GASOLINE CONSUMPTION IN AUGUST



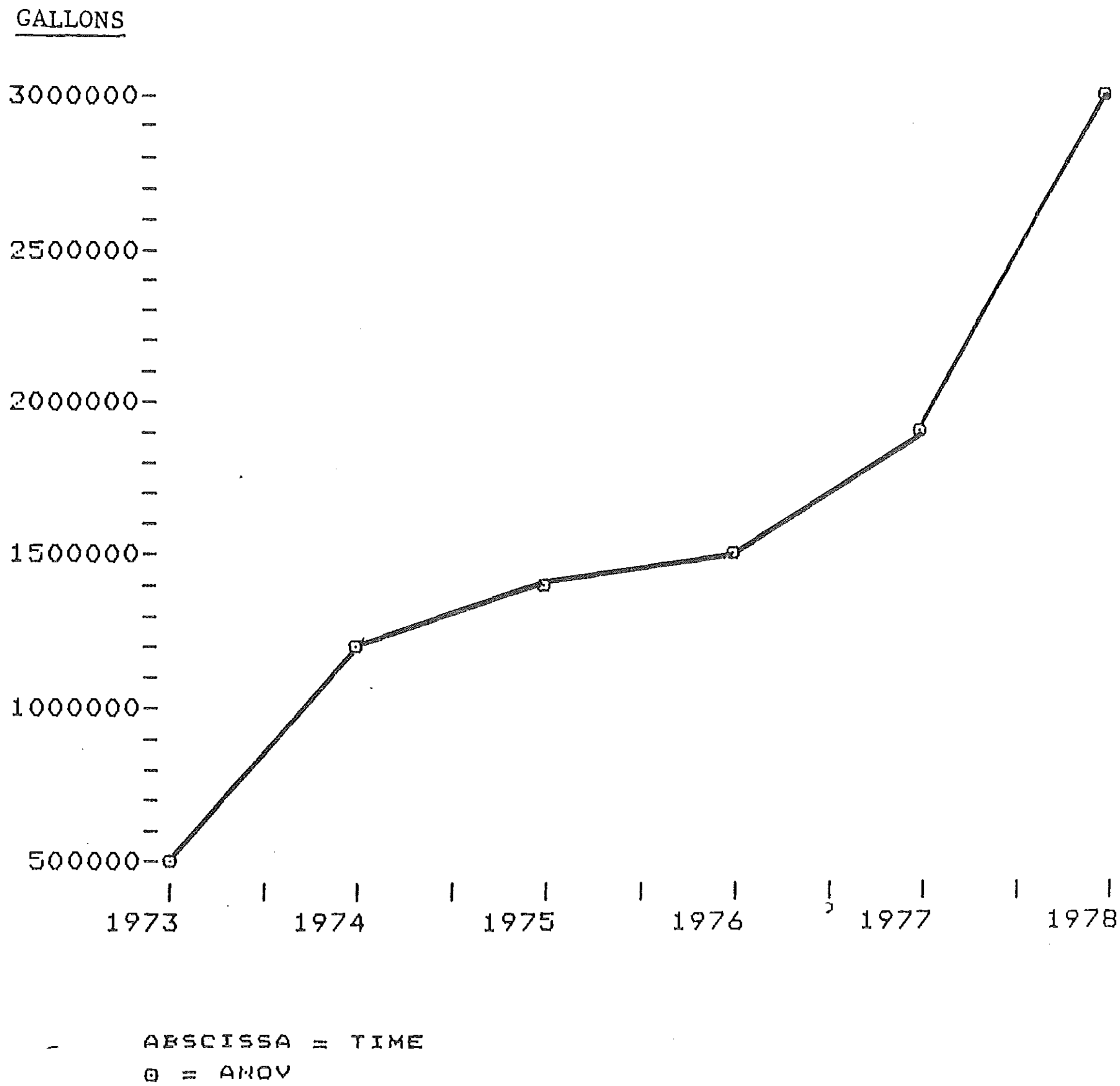

GALLONS
AVIATION GASOLINE CONSUMPTION IN SEPTEMBER
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
1973
1974
1975
1976
1977
1978
ABSCISSA = TIME
⊙ = ASEF

AVIATION GASOLINE CONSUMPTION IN OCTOBER

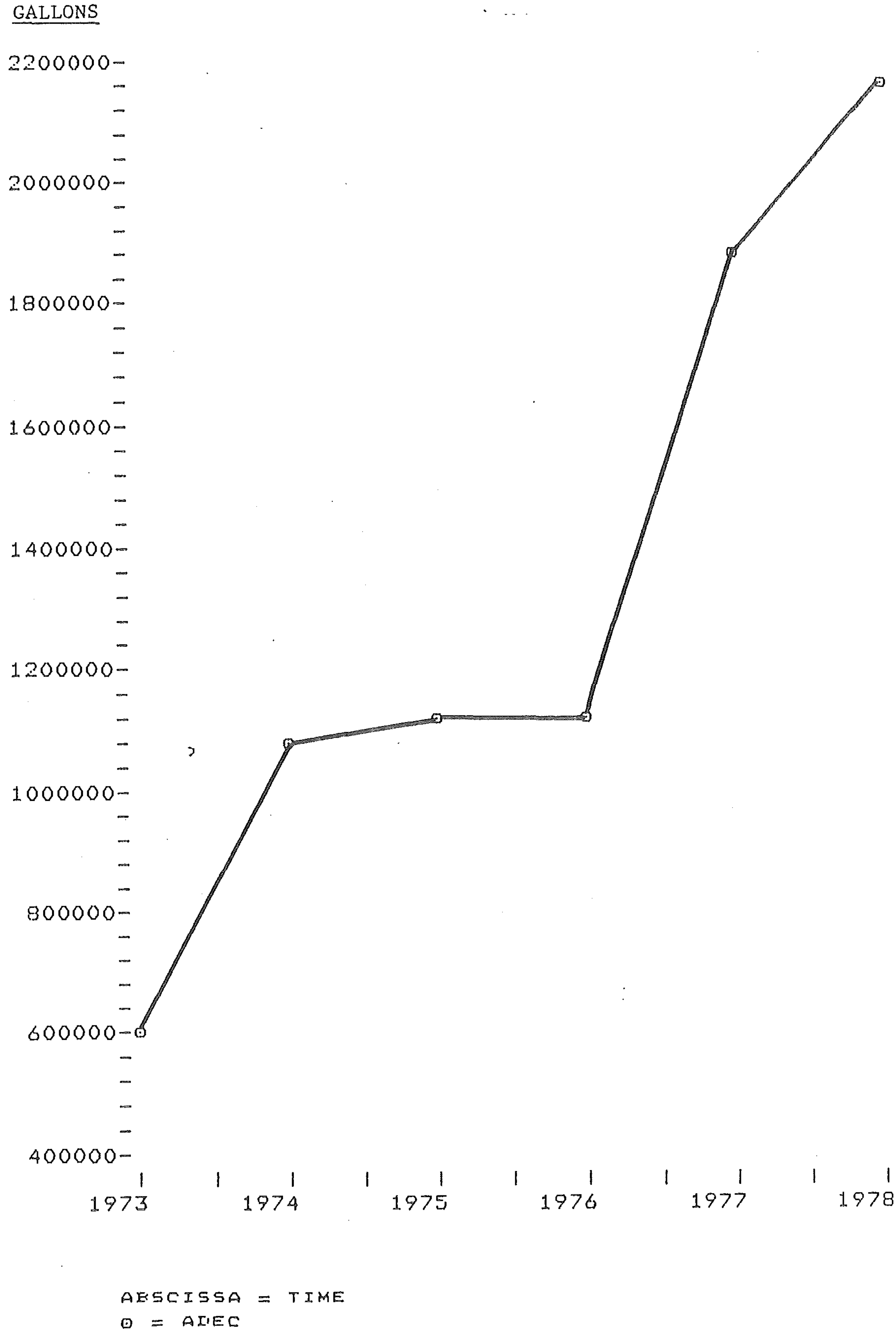


ABSCISSA = TIME
⊖ = AOCT

AVIATION GASOLINE CONSUMPTION IN NOVEMBER



AVIATION GASOLINE CONSUMPTION IN DECEMBER

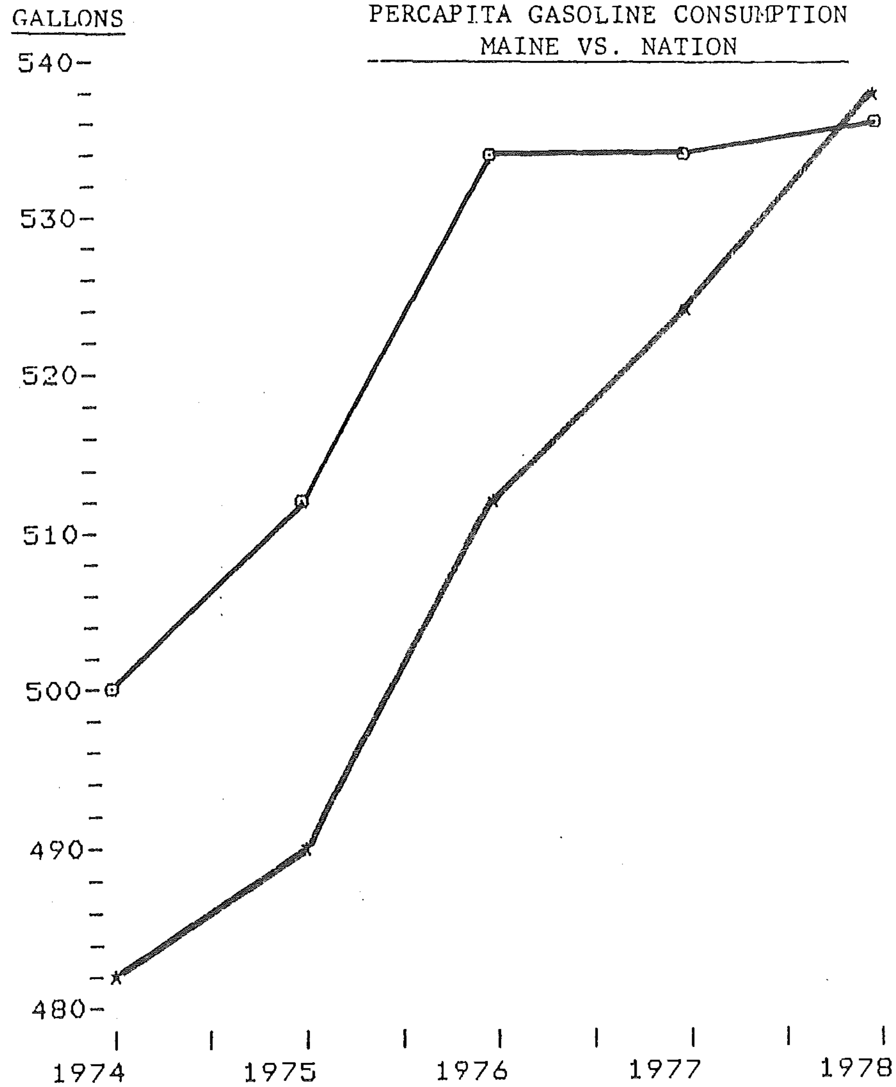


PERCAPITA GASOLINE, ELECTRICITY, DISTILLATE AND RESIDUAL OIL CONSUMPTION PATTERNS MAINE VS. NATION (1974-1978)

Percapita Gasoline Consumption

The gasoline consumption in Maine percapita has been above National consumption percapita until 1978. In 1976, 1977 and 1978 Maine's consumption percapita has been fairly constant while the national gasoline consumption percapita for this period has been rising. Also, in 1978 Maine's gasoline consumption percapita fell below the national figure by .52 gallons percapita. These trends indicate that Maine's conservation efforts have been more successful than the nation as a whole.

PERCAPITA GASOLINE CONSUMPTION
MAINE VS. NATION



ABSCISSA = TIME
O = GASOLINE ME PERCAPITA
* = GASOLINE US PERCAPITA

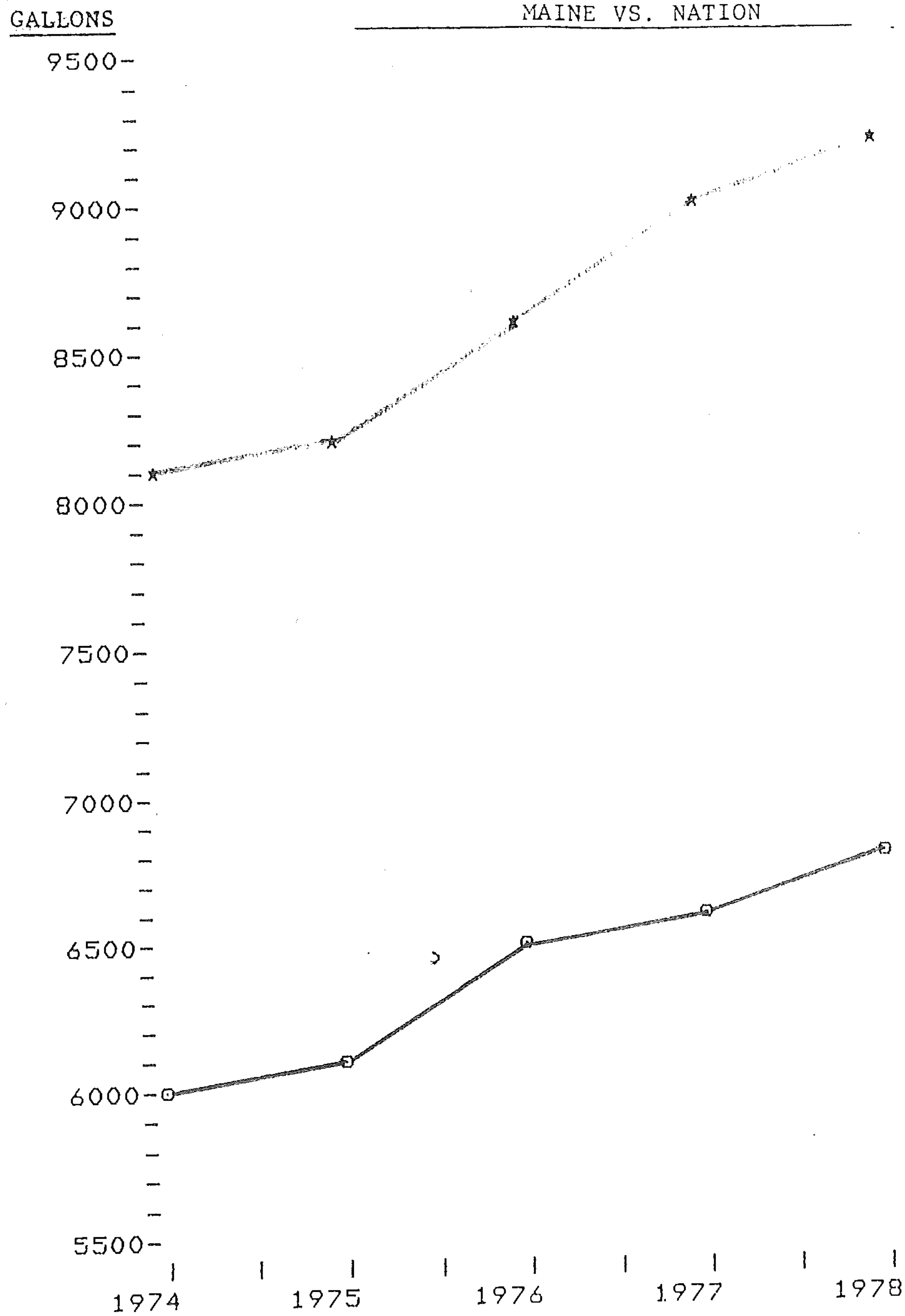
	1975	1976	1977	1978
GASOLINE ME PERCAPITA	511.66	534.80	533.92	536.67
GASOLINE ME PC	2.32	4.52	-.17	.52
GASOLINE US PERCAPITA	490.66	511.10	523.34	537.19
GASOLINE US PC	1.60	4.17	2.40	2.64

	1974	1975	1976	1977	1978
GASOLINE ME PERCAPITA	500.05	511.66	534.80	533.92	536.67
GASOLINE US PERCAPITA	482.94	490.66	511.10	523.34	537.19

PERCAPITA ELECTRICITY CONSUMPTION

Maine's electricity consumption percapita is significantly below National electricity consumption percapita. As the data on the following page shows Maine's consumption level percapita is approximately 25% below the national level, this equates to approximately 2000 kwh per year percapita, less than the national percapita figure.

PERCAPITA ELECTRICITY CONSUMPTION
MAINE VS. NATION



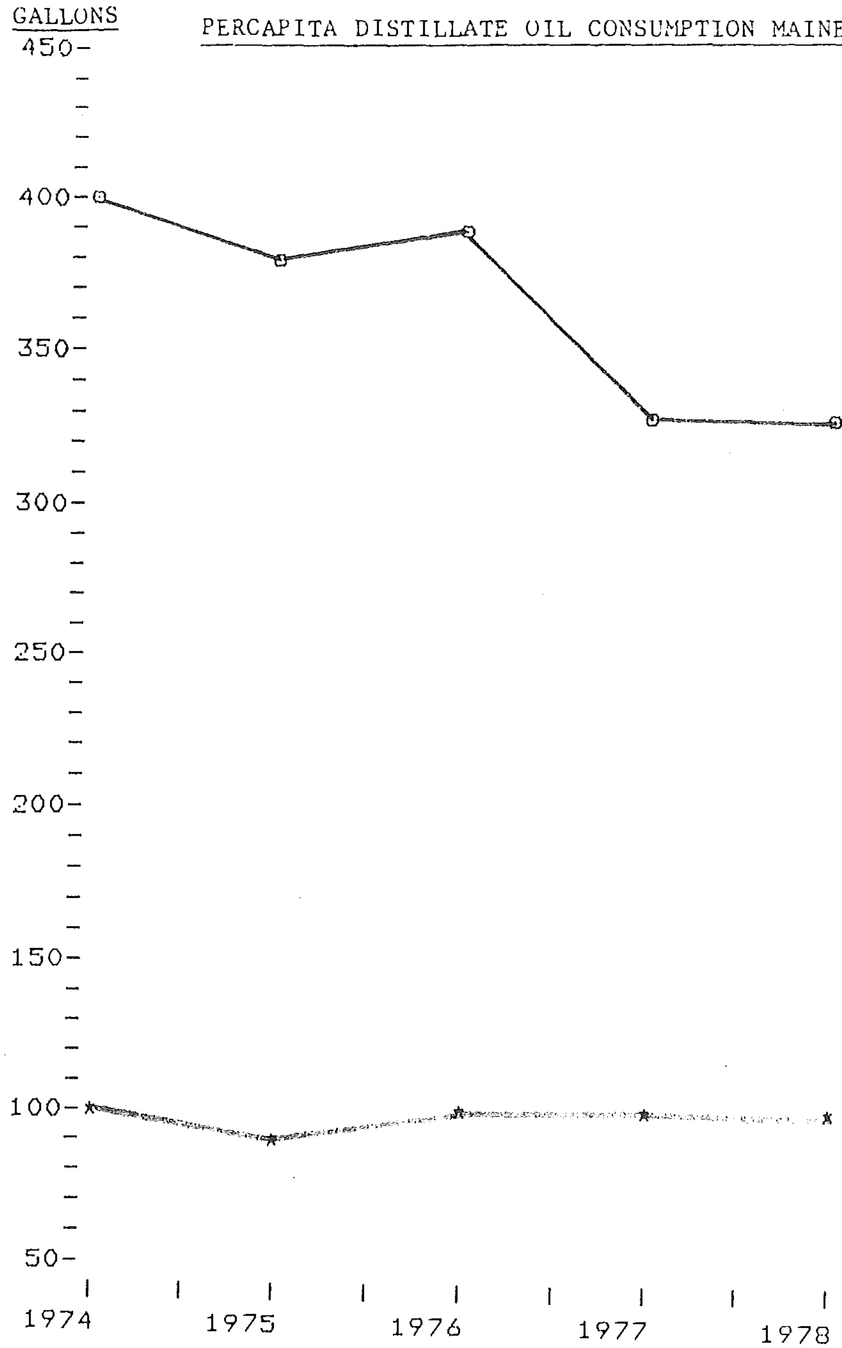
ABSCISSA = TIME
O = ELEC ME PERCAPITA
☆ = ELEC US PERCAPITA

	1974	1975	1976	1977	1978
ELEC ME PERCAPITA	5996.15	6053.84	6495.76	6586.61	6849.82
ELEC ME PERCAPITA PC	3.81	.96	7.30	1.40	4.00
ELEC US PERCAPITA	8064.17	8154.74	8620.95	9036.44	9223.90
ELEC US PERCAPITA PC	¯.83	1.12	5.72	4.82	2.07
PC BELOW US	¯25.64	¯25.76	¯24.65	¯27.11	¯25.74

PERCAPITA DISTILLATE OIL CONSUMPTION

Since we are geographically located in a cold region we would expect our dependence and consumption of distillate oils percapita to be greater than the national percapita consumption level. However, it is interesting to observe that while the national percapita figures are fairly constant, Maine's trend has been downward indicating conservation efforts have been made.

PERCAPITA DISTILLATE OIL CONSUMPTION MAINE VS. NATION



ABSCISSA = TIME
⊖ = DIST ME PERCAPITA
* = DIST US PERCAPITA

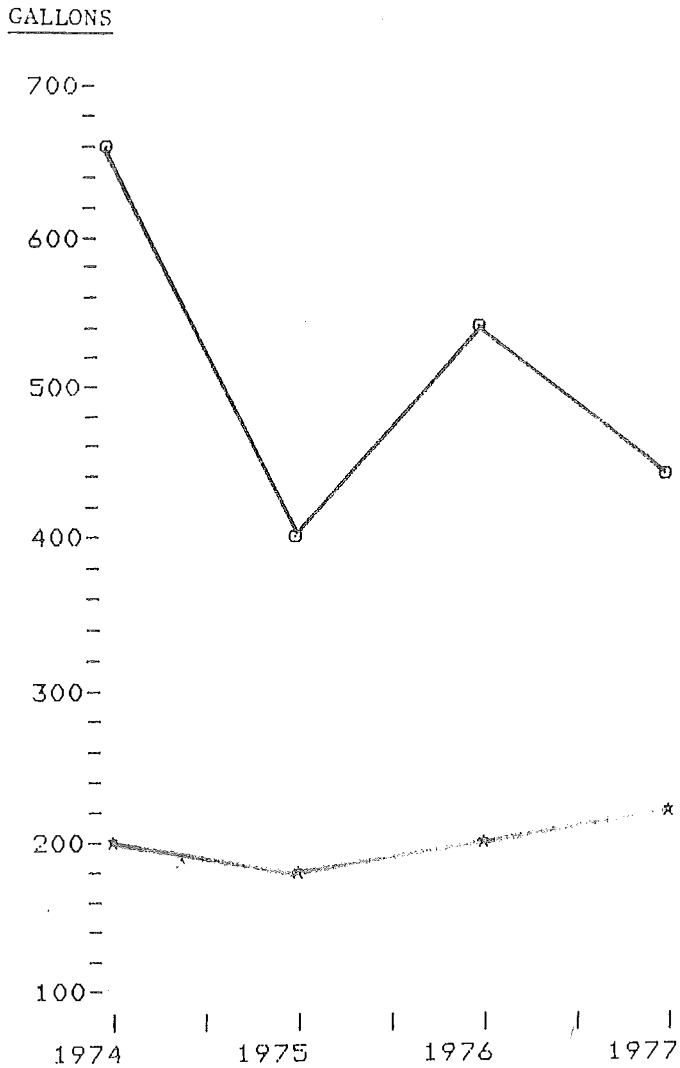
	1975	1976	1977	1978
DIST ME PERCAPITA	376.67	389.20	331.80	328.40
DIST ME PC	¯5.89	3.33	¯14.75	¯1.02
DIST US PERCAPITA	94.70	103.86	98.81	102.01
DIST US PC	¯1.40	9.67	¯4.86	3.24

	1974	1975	1976	1977	1978
DIST ME PERCAPITA	400.25	376.67	389.20	331.80	328.40
DIST US PERCAPITA	96.04	94.70	103.86	98.81	102.01

PERCAPITA RESIDUAL OIL CONSUMPTION

Like distillate oil, residual data shows a general downward trend while the nations percapita consumption data indicates a slight upward trend. It should be noted that Maine is more dependent on residual oil for industrial purposes and less dependent on natural gas. This is significant since our natural gas consumption is insignificant in comparison to the residual oil consumption.

PERCAPITA RESIDUAL OIL CONSUMPTION
MAINE VS. NATION



ABSCISSA = TIME
⊖ = RESID ME PERCAPITA
☆ = RESID US PERCAPITA

	1975	1976	1977
RESID ME PERCAPITA	396.23	534.73	433.63
PC1	¯40.68	34.96	¯18.91
RESID US PERCAPITA	177.59	200.68	217.92
PC2	¯7.42	13.01	8.59

	1974	1975	1976	1977
RESID ME PERCAPITA	667.96	396.23	534.73	433.63
RESID US PERCAPITA	191.81	177.59	200.68	217.92

Data Source for Main Body of Paper: State of Maine Bureau of Taxation

Data Sources for Pages 50 to end

Population: Sales and Marketing Management, Survey of Bying Power, Yearly Reports.

Gasoline Consumption: U. S. DOT, Monthly Motor Gasoline Reported by States, Year-End Reports.

Distillate Consumption: Ethyl Corp., Monthly Report of Heating Oil.

Residual Consumption: U.S. DOE, Energy Data Reports, November 1978. (U.S. BOM Data)

Electricity Consumption: Edison Electric Institute, Pocketbook of Electric Utility Industry In New England Statistical Bulletin 1977 for Maine data with a projection for 1978.

Electric data is reported in KWH percapita.

Petroleum Products are reported in gallons percapita.

COAL IN MAINE - OCTOBER 1,1979

A coursory investigation indicates that there are eight coal dealers serving the State of Maine at this time (see attached I). Seven are located in-state and one in New Hampshire. Six of the Maine based dealers stockpile coal and the other retails in bag lot quantities or jobs by the truck from another dealer. Geographic location range is from Caribou to Portland with market areas ranging from 15 to 50 mile radius (see attached II). Practically all customers are residential except for a few apartment houses, potato houses and foundries.

Anthracite coal from Pennsylvannia is the major grade carried by all dealers. Types of coal are Stove, Nut and Chestnut for hand shoveled kitchen, living room stoves and furnaces; and Rice, Buckwheat and Pea for automatic furnaces. The Stove type was the only one handled by all eight dealers; Chestnut next, stocked by five; Rice by four; Nut by three, Buckwheat and Pea by two. A type called Cannel is supplied by three for Franklin fireplaces although the supply is carried over from prior years and is not in great demand.

Bituminous coal is carried by two dealers, sized as Pea and Buckwheat for automatic consumption; also run-of-the-mine for manual operation. Bituminous is used for foundry or large commercial installation although there doesn't seem to be many customers.

Information pertaining to volumes of stockpiled coal and projected usage was not readily available by phone but data supplied indicated that Stove, Chestnut and Rice (anthricite) seem to be in the greatest demand. Coal supply did not seem to be as great a concern as availability of rail coal cars for transportation. Antiquity and non-replacement of cars was indicated as probable causes for coal transportation problem. It was noted that in past coal consumption eras, port facilities served a great portion of the demand.

Economically, coal is currently averaging at $95 per ton in Maine. Comparing this by the "useful heat delivered" in the home (see comparison total - attached III), coal costs about $6.60 per million BTU's. Wood at $75.00 per cord, is equally favorable at $6.66 per million BTU "useful". Oil is more expensive at $9.40 per million BTU "useful" computed at .85¢ per gallon present cost. Electricity and gas seem to be the most expensive at $11.50 per million BTU "useful"; computed respecitvely at .04¢ per KWH or .73¢ per gallon. Cost comparisons are based upon fuel only, assuming that the homeowner has a stove in place to burn either fuel. If the homeowner must include the cost of installing a stove to burn an alternate fuel, it could prove uneconomical.

Environmentally, David Tudor of the DEP in Augusta (289-2437) stated that sulfur and particular matter are the serious air quality implications to the use of coal but that both are testable and regulated to a tolerant limit at present. Anthrocite has a lower level of both substances than Bituminous. This fact coupled with the small consumption in the State, accounts for the non-monitoring of coal utilization by the DEP.

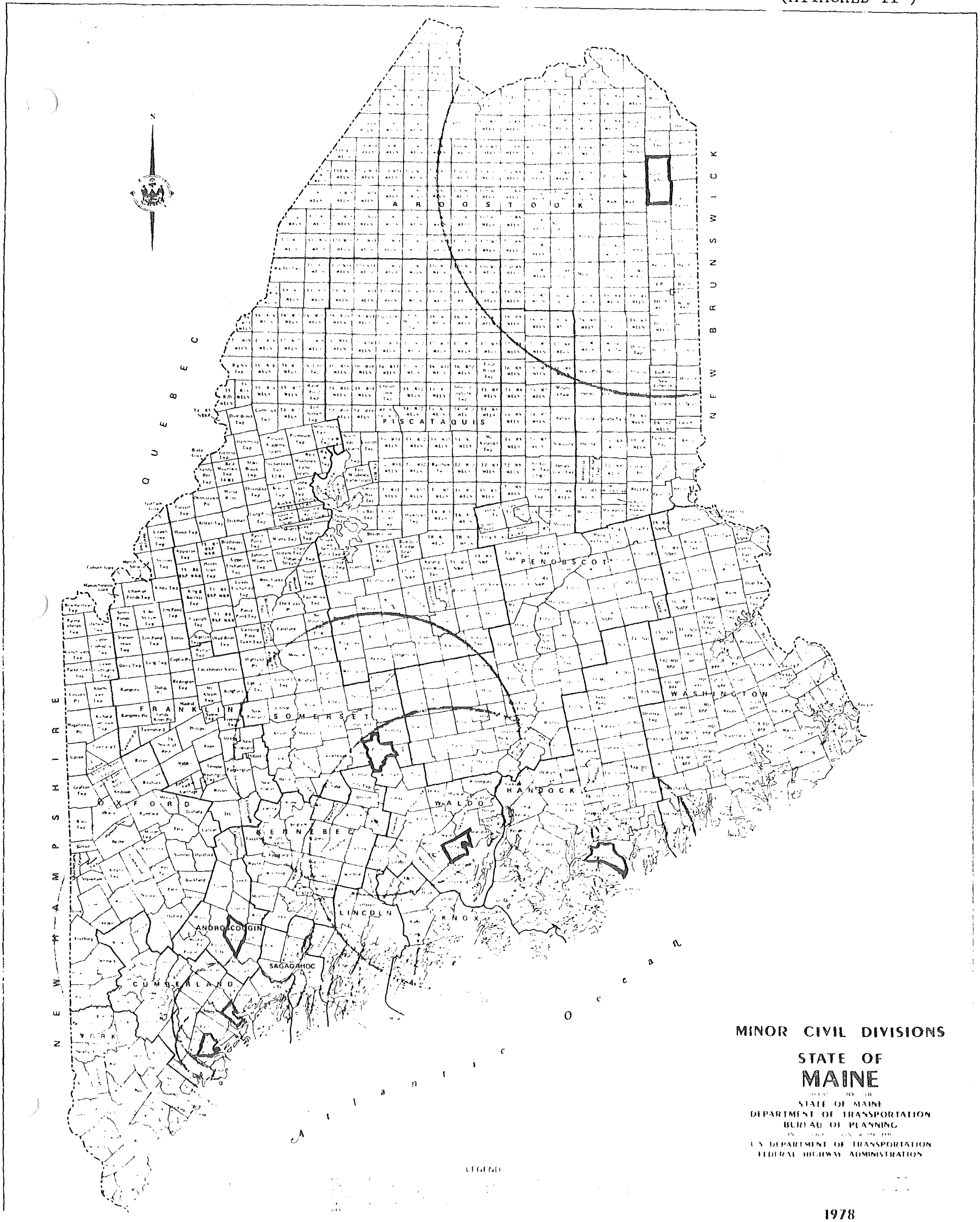
In summary, it appears that normal supply and demand is sustaining an adequate source of coal throughout the State to satisfy the current demand, which is mainly residential. There is some movement in both the supply and demand sector but not enough to either expand the current dealers or create new suppliers.

Current cost are favorable for coal as a substitute for oil, electricity or gas as a fuel; wood is on a par. However, if cost has to include installation of a stove, it becomes questionable but complex to analyze and therefore is not addressed in this review.

COAL DEALERS IN MAINE (ATTACHED I)

DEALER	AREA	TYPES
ELROY A. DeMERCHANT 7 Summer Street Caribou, Me 04736 496-2301	50 Mile radius	Anthracite - Stove, Nut, Rice, Cannel - (Franklin fireplace)
CLARK COAL CO. 53 Cottage Street Bar Harbor, Me 04609 288-3300	20 mile radius	Anthracite - Nut, Stove, Rice, Buckwheat
PITTSFIELD COAL & OIL CO., INC. 44 Hunnewell Ave. (Box 218) Pittsfield, Me 04967 487-2201 (George Moody)	40 mile radius	Anthracite - Rice, Pea, Stove, Chestnut, Bituminous - Pea, Stoker
CONSUMER FUEL CO. 39 Water Street Belfast, Me 04915 338-2000	40 mile radius	Anthracite - Stove, Nut, Pea
P & P FUEL CO. 25 Middle Street (Box 376) Lewiston, Me 04240 784-7359 (Norman Boulanger)	50 mile radius	Anthracite - Stove, Chestnut, Rice. Coke. Bituminous - Dale Ridge-Stoker. McIntire - run-of-the-mine
ELM ICE & OIL CO. 30 Washington Ave. Portland, Me 04101 773-5691 (Henry Lalumiere)	6-7 mile radius	Anthracite - Chestnut, Stove, Cannel (not much) for Franklin fireplace
RING GAS & HARDWARE CO. 49 Main Street Yarmouth, Me 04096 846-5503 (Ron Turner)	15 mile radius	Anthracite - Chestnut, Stove, Pea, Stoker, Buckwheat. Cannel for Franklin fireplace
VICTOR E. PAGE & SON 14 Spruce Street Rochester, N.H. 03867 (603) 332-0429	New Hampshire - Maine border towns	Anthracite - Chestnut, Stove

(ATTACHED II)


AROOSTOOK
PISCATAQUIS
PENOBSCOT
WASHINGTON
FRANKLIN
SOMERSET
HANCOCK
WALDO
OXFORD
KENNEBEC
LINCOLN
KNOX
ANDROSCOGGIN
SAGADAHOC
CUMBERLAND
YORK
QUEBEC
NEW BRUNSWICK
NEW HAMPSHIRE
Atlantic Ocean
MINOR CIVIL DIVISIONS
STATE OF
MAINE
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
LEGEND
1978

FUEL	BTU VALUE/UNIT	COST/UNIT	COST/MILLION BTU @ 100% EFFICIENCY	COST/MILLION BTU @ ANY STOVE EFFICIENCY
COAL	24 million BTU/ ton (useable @ 60%= 14.4 million/ton	$75 ton	$3.13	60% $ 5.21
		80	3.33	5.55
		85	3.54	5.90
		90	3.75	6.25
		95	3.96	6.60
		100	4.17	6.94
		110	4.58	7.64
		125	5.21	8.68
OIL	139,000 BTU/ gallon (useable @ 65%= 90,000 BTU gallon)	.80 gallon	5.70	65% 8.80
		.90	6.40	10.00
		1.00	7.10	11.10
WOOD	22.5 million BTU/ cord (useable @ 50%= 11.25 million/ cord)	$55 cord	2.44	50% 4.88
		65	2.88	5.78
		75	3.33	6.66
		100	4.44	8.88
		125	5.55	11.11
ELECTRICITY	3,415 BTU/KWH (useable @ 100%)	.03 KWH	8.70	100% 8.70
		.04	11.70	11.70
		.05	14.60	14.60
LP GAS	97,000 BTU/ gallon (useable @ 65%= 63,050 BTU/ gallon)	.73 gallon	7.50	65% 11.50
		.80	8.20	12.60
		.85	8.70	13.40

PRICE OF COAL PER TON - October 1, 1979

(ATTACHED IV)

	ANTHRACITE							BITUMINNOUS	
	STOVE	NUT	CHESTNUT	CANNEL	BUCKWHEAT	RICE	PEA	DALE RIDGE	RUN OF THE MILL
ELROY DeMERCHANT Caribou	$76.00	$76.00		$75.00		$73.00			
CLARK COAL CO. Bar Harbor	125.00	125.00			125.00	125.00			
PITTSFIELD COAL & OIL CO. Pittsfield	95.00		95.00			95.00	93.00/ /116.00		
CONSUMER FUEL Belfast	100.00	100.00					85.00/		
RINGS GAS Yarmouth	95.00		95.00		90.00		90.00/		
ELM ICE & OIL Portland	100.00		100.00 4.60/ 50 LB.	6.70/ 50 LB.					
PAGES New Hampshire	95.00/ 3 ton 100.00/ 2 ton 110.00/ 1 ton		95.00/ 3 ton 100.00/ 2 ton 110.00/ 1 ton						
P & P FUEL Lewiston	93.50		93.50			86.50		95.25	89.00

PART III

ELECTRICITY IN THE CENTRAL MAINE MARKETING AREA.

AN ECONOMETRIC FORECAST

OFFICE OF ENERGY RESOURCES

TECHNICAL REPORT

ELECTRICITY DEMAND IN THE CENTRAL MAINE MARKETING AREA: AN ECONOMETRIC FORECAST

BY:

T. H. Tietenberg
Department of Economics
Colby College
Waterville, ME 04901

AND

Michael Donihue
Colby College
Waterville, ME 04901

Al Maxwell
Office of Energy Resources
Augusta, ME 04330

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This report was written under a contract between the Office of Energy Resources and Colby College. The contract monitor for the Office of Energy Resources was Richard Darling. The principal investigator was Dr. Thomas H. Tietenberg, Associate Professor of Economics, who had the responsibility for designing and estimating the forecasting system and for writing the report. He was assisted by Alfred Maxwell, a member of the staff of the Office of Energy Resources, in sections III, IV, V and VI and by Michael Donihue, a Colby College student in section V.

The conservation scenario, section VIII, was devised and supervised by Richard Darling. The estimates of the impact of this scenario on energy demand were derived by Alfred Maxwell and Richard McGinley. All three are members of the Office of Energy Resources staff.

The typing of the manuscript was accomplished by Ms. Valarie Vashon.

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I. INTRODUCTION

The Genesis of the Report

On June 6, 1977 the Central Maine Power Company, (CMP) filed with the Maine Public Utilities Commission a petition for a Certificate of Public Convenience and Necessity to construct a 568 megawatt coal-fired power plant on Sears Island in Searsport, Maine. In support of that proposal a specific demand forecast was presented to justify the need for that plant by 1986 (subsequently changed to 1987).

Forecasting electricity demand is subject to a great deal of uncertainty. After steady growth at the national level of approximately 7%, the tremendous increase in oil prices which accompanied the Arab oil embargo in the last quarter of 1973 has reduced the growth in demand for energy, in general, and electricity, in particular, well below historic levels. A forecast of future demand levels has to be capable of separating out the individual influences of the level of economic activity, population, the price of electricity in general and the rate structure used to differentiate this price among the various consuming sectors.

One obvious technique to use in developing a forecast which is sensitive to these various factors is econometrics. This technique uses the historical experience as a basis for deriving specific structural relationships among the important variables. Statistical techniques are used to estimate the various parameters and to derive tests which allow the forecaster to assess the strength of the relationships underlying the forecast.

An Overview

The purpose of this report is to present one such econometric model which was developed during the first three months of 1979. This model is capable of generating forecasts of energy consumption and peak demand in the CMP marketing area. The forecasts of this model are therefore directly comparable to the CMP forecasts.[1/] No implication is intended that this forecast is "right" for no one has a proven crystal ball. Rather, since the methodology for this forecast is so different from that used by the CMP staff it provides a useful complement to their forecast; differences can be systematically explored.

1/ The industrial and commercial forecasts are not strictly comparable because CMP adopted a different classification system for 1976 and succeeding years. Because this change affects commercial and industrial individually, but does not affect their sum, the sum should be comparable.

II. BACKGROUND

Energy and the Economy

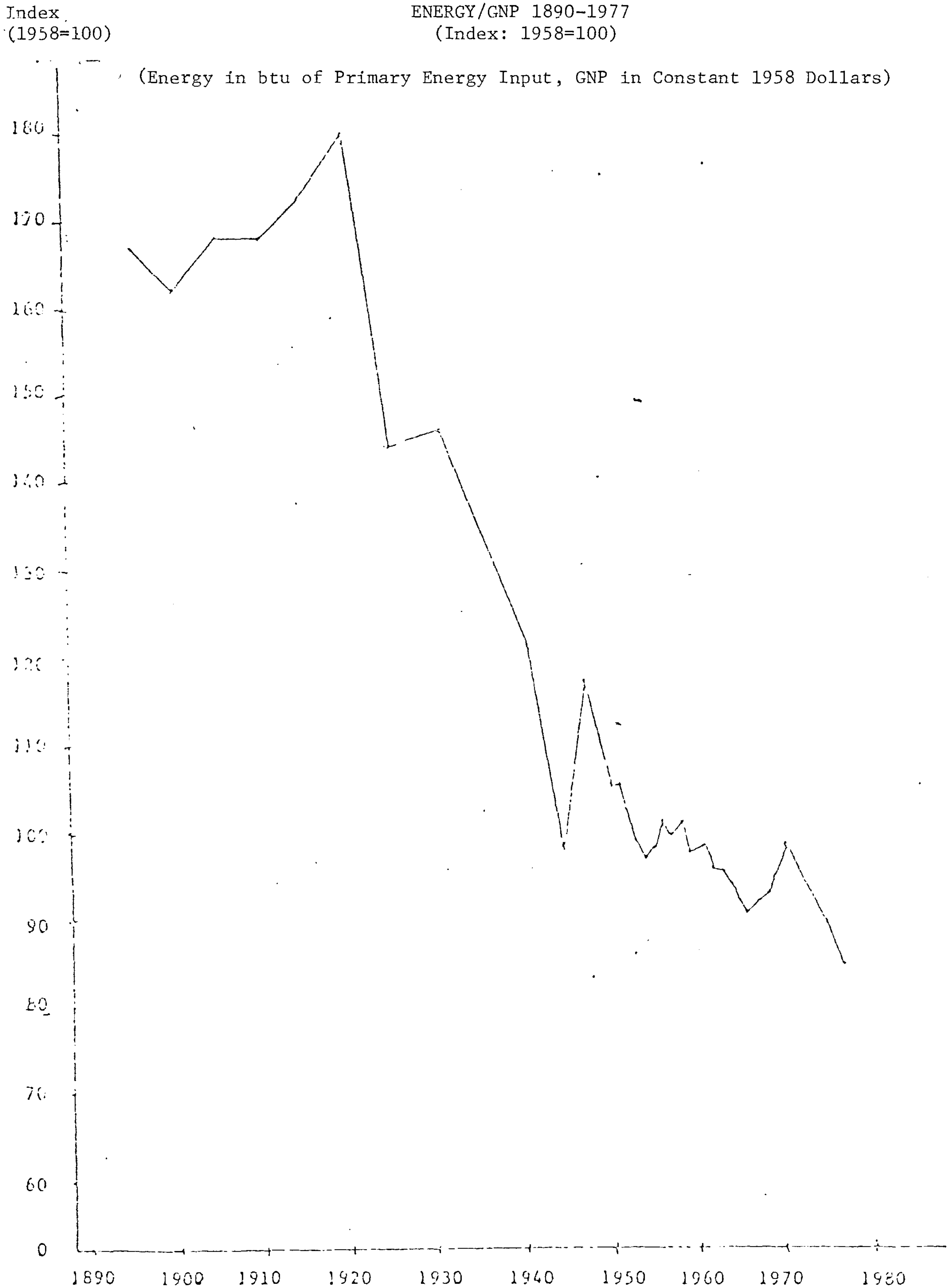
As noted in Figure 1 while there have been periods in which the amount of energy used per dollar of real GNP generated has risen, in general the long-term trend is distinctly downward. Since 1890 the general tendency has been for the production process to use less energy per unit output in producing goods and services. This decline results from increasing technical efficiency in the use of energy, the substitution of other factors of production for energy and shifts in the composition of demand toward less energy intensive commodities (e.g. services).

The presence of these trends is not fortuitous; they are rational responses to prices, incomes and other factors which influence human behavior. Energy is a factor of production and, like labor, capital and materials, the amount of energy used is a function of its costs. There have been a number of studies accomplished using aggregate national data which indicate that the energy/output ratio is indeed quite sensitive to the real cost of energy. Even international studies show that in Europe, where energy prices are much higher, the energy/output ratio is much lower.

There are, of course, several energy sources. Our concern here is with electricity. Electricity prices since 1965 have risen from approximately 3.1 cents per kilowatt hour to 3.5 cents per kilowatt hour in 1971. During this same period electricity's share of end use BTU's consumed increased from 5.7% to 7.2%.2/ While this may appear to violate the notion that higher prices cause demand to be lower than it otherwise would have, it does not. During the same period the real cost of electricity to the residential sector, when deflated by the cost of other fuels, actually declined from 3.2 cents per kilowatt hour in 1965 to 2.2 cents per kilowatt hour in 1967 dollars in 1975. The inter-

2/ Office of Energy Resources, Maine Comprehensive Energy Plan - 1978 Edition: Draft, p. 24.

ENERGY/GNP 1890-1977
(Index: 1958=100)



Source: Energy Economics Division
The Chase Manhattan Bank, N.A.

FIGURE 1

pretation of this is simply that electricity prices rose more slowly than other energy prices -- electricity became a better buy. In fact, electricity became a better buy in terms of all commodities, not merely energy commodities. In addition, during this period, real income rose substantially as well, giving another boost to the demand for electricity.

The effect of this on electricity consumption in the CMP market area was dramatic. Per capita residential consumption of electricity increased 112% between 1967 and 1975 while per capita commercial sales increased 119% during the same period. Industrial sales increased a more modest 33%. This has had quite an impact on the kind of demand that CMP is experiencing. In 1965 the industrial sector was the dominant consumer class using some 44.0% of the kilowatt hours sold. By 1975 this had declined to 35.5%. Simultaneously the commercial and residential sectors, which together accounted for 46.2% in 1965, by 1975 accounted for 61.1%.

Assessing the Future

In thinking systematically about the future it is clear that these trends will exercise considerable influence on future demands for CMP power, not only in terms of kilowatt hours consumed, but the load factors as well. Each of these sectors has a different impact on the peak and therefore shifts among them will cause changes in the load factor.

The central difficulty in forecasting the future demand for electricity stems from the realization that we are now in a different situation than we were in the earlier part of the 1965-1975 period. The days of marked declines in real electricity prices are over. Since the ground rules have changed, one would not expect the trends to remain constant. We know that demand will grow more slowly in the future, but how much more slowly is not at all obvious.

The algorithm for generating a forecast must contain the various price and income structural relationships which underlie demand behavior. If these can adequately be captured, then price and income sensitive forecasts which track the historical period very well and yet take explicit recognition of the linkages between the economy and the demand for kilowatt hours and peak power can be developed.

In the next several sections a forecasting model which incorporates these structural relationships is presented. By conventional criteria the model performs extremely well. In addition, the results are in accord with economic theory and common sense.

This model is then used to provide a baseline forecast, which is designed to portray what will happen to electricity demand in response to anticipated market forces.

An alternative scenario incorporating future trends which are expected aggressive policy initiatives designed to conserve energy is then developed. The implications of this scenario and the baseline scenario for electricity demand growth and the need for the magnitude of generating capacity represented by the Searsport plant are considered.

III. THE COMMERCIAL SECTOR

Introduction

The commercial sector is an important user of electricity in Maine. In 1975 it purchased approximately 26% of the electricity sold by CMP to ultimate customers and accounted for 31% of the revenue derived from ultimate consumers. It has in recent history been one of the more rapidly growing sectors.

The demand for electricity in the commercial sector will be influenced by a number of factors. The most important of these are:

The Level of Demand for Commercial Services - Since electricity is used in the commercial sector to increase output or sales, the demand for it is a derived demand. Therefore the demand for electricity will be affected by the demand for commercial services.

The Composition of Demand for Commercial Services - Some commercial services are energy intensive (e.g. hospitals) while others (e.g. bookstores) are not. This implies that shifts in the demands among these sectors will affect the demand for electricity even if the total level of sales remained constant.

The Real Cost of Electricity - Electricity has substitutes. Labor can be substituted for energy intensive computers. Oil can be substituted for electric space heat. Conservation can also reduce the demand. The degree to which the commercial sector undertakes to make these substitutions or to undertake conservation will depend on whether or not it can reduce its costs by doing so.

The Rate Structure - The State of Maine has recently moved to a flat rate structure for residential consumption and is likely to move to a flat rate structure for the commercial and industrial sectors. This is a significant deviation from the historical practice of pricing according to a declining block structure. The change in the rate structure should have an effect on electricity demand quite apart from its effect on the average cost of electricity.

The Model

The basic model employed in this sector was originally used by Houthakker and Taylor (1970) and subsequently by Houthakker, Verleger and Sheehan (1973). It is a flow adjustment model which recognizes that it takes time for adjustments to take place.

Let the ratio of actual demand for period t to the actual demand in period t-1 be proportioned to the ratio of desired demand in this period to actual demand in last period. In logarithms this becomes:

$$\ln q_t - \ln q_{t-1} = \emptyset\ (\ln q_t^* - \ln q_{t-1}) \tag{1}$$

where q_t is actual demand in year t

q_t^* is desired demand in year t.

Desired demand is assumed to be related to the variables discussed in the introductory section via a function of the form:

$$q_t^* = \chi_{1_t}^{\beta_1} \chi_{2_t}^{\beta_2} \chi_{3_t}^{\beta_3} \chi_{4_t}^{\beta_4} \tag{2}$$

The χ variables are defined below and the data used to generate these variables are described in the appendix to this section.

Converting (2) into a logarithmic form and substituting (2) into (1) yields:

$$\ln q_t = \alpha^*\emptyset + \beta_1\ \emptyset \ln \chi_{1t} + \beta_2\ \emptyset \ln \chi_{2t} + \beta_3\ \emptyset \ln \chi_{3t} + \beta_4\ \emptyset \ln \chi_{4t} + (1-\emptyset) \ln q_{t-1} \tag{3}$$

where $\alpha^* = \ln\alpha$. This formulation has the virtue that the short run and long-run elasticities can differ and are directly calculable. For an independent variable the short run elasticity is its estimated coefficient and the long run elasticity is that coefficient divided by 1.0 minus the coefficient on the lagged variable.

The Variables

Four variables were used to capture the effects described in the introductory section. The level and composition of demand for commercial services are represented, respectively, in the equations by non-manufacturing employees (E_t) and per capita real income (Y_t). The per capita income variable is intended to capture the shifts in the composition of demand for commercial services as Maine becomes a richer state. Both variables are defined for Maine and not specifically for the CMP marketing area. The relative cost of electricity and the rate structure are represented in the equation by the real average cost per kilowatt (A_t) to the average commercial consumer (which includes all charges) and the real energy price per kilowatt (M_t) in the block in which the average commercial consumer's consumption level fell. The consumer price index (1967 = 1.00) was used to convert nominal prices to real prices.

The Forecasting Equation

The resulting equation is:

$$\ln Q_t = -.442 + \underset{(6.72)}{2.386} \ln Y_t + \underset{(1.53)}{.576} \ln E_t \qquad (4)$$

$$- \underset{(2.08)}{.386} \ln A_t - \underset{(1.41)}{.070} \ln M_t \qquad \bar{R}^2 = .990 \quad \text{d.w.} = 2.01$$

where all variables are as previously defined and the t statistics are given in parentheses. The lagged dependent variable is not included because it's coefficient was slightly negative and extremely close to zero.[3/] A zero value for that coefficient implies Ø = 1.0 (i.e. all the adjustment takes place in a single year). In this case the lagged variable can be omitted as was done with the above equation. This implies that short-run and long run elasticities are the same in the commercial sector.

3/ An oil price variable was also deleted when it repeatedly was statistically insignificant and exhibited a perverse sign.

One way of validating our results is to compare them with previous studies. A recent survey by Taylor (1975) reveals, unfortunately, that very few studies of the commercial sector have been accomplished. Only one (Mount, Chapman & Tyrrell, 1973) is at all comparable and it does not use marginal prices so no direct comparison of that elasticity is possible. The main differences between this study and the Mount, Chapman & Tyrrell (hereafter referred to as MCT) study are:

- The estimated income elasticities in our study are higher than the MCT study by a factor of 3, although the estimates are not directly comparable because they use total income instead of a real per capita income[4/] variable.
- Our model indicates more price sensitivity in the short run and less in the long run than does the MCT study.

The implication of this finding is that our study will predict higher growth rates in the commercial sector in Maine than would the MCT study. This also indicates a rather strong sensitivity of the commercial sector in Maine to fluctuations in the business cycle.

Validation

The model used in this study comes from a class of models which use the same basic structure to recreate the past experience as is used to forecast the future experience. This imposes a discipline on the forecasting structure which is not imposed on structures which assume the future will be different than the past. Specifically, one method of validating a model of this type is to see how well it does recreate the past.

4/ The elasticity for per capita income should be higher because it grows much more slowly.

Selecting the "best" equation is not a precise science although there are a number of criteria which can apply. The tests used in this study in rough order of importance were:

- A signs test. The signs on the coefficients must be plausible (e.g. higher prices, all other things being equal, should not lead to higher consumption and colder weather should not reduce the demand for electricity).
- Statistical significance of the coefficients. Equations where a high degree of confidence in the coefficients is exhibited are preferrable to those with statistically insignificant coefficients.
- Goodness of fit. All other things being equal, equations which can replicate the past with low error rates are preferred to those which cannot.

This equation performs quite well by these criteria. The signs are plausible. The per capita income and average price variables are statistically significant with a 95% degree of confidence. The non-manufacturing employment and marginal price variables are statistically significant with a 90% degree of confidence. As confirmed by Table 1 the average absolute percentage errors are reasonable.

TABLE 1

ACTUAL VS. ESTIMATED COMMERCIAL SALES (MWH)

1961-1977

Year	Actual Value	Estimated Value	(%) Percent Error
1961	236,024	245,880	4.2
1962	261,263	264,089	1.1
1963	282,113	261,805	-7.2
1964	310,211	315,041	1.6
1965	340,509	373,693	9.7
1966	458,416	431,659	-5.8
1967	506,567	489,324	-3.4
1968	561,266	552,705	-1.5
1969	626,413	656,283	4.8
1970	708,385	730,215	3.1
1971	796,929	760,406	-4.6
1972	895,580	830,665	-7.2
1973	969,243	994,664	2.6
1974	968,951	968,105	-0.1
1975	1,024,561	953,057	-7.0
1976	1,093,551	1,141,735	4.4
1977	1,125,116	1,194,990	6.2

Average Absolute Percent Error 4.38%

The overprediction in the last two years is somewhat troubling. Nonetheless there are reasons for reassurance. CMP changed the classification scheme for commercial users for 1976 and 1977. It is therefore impossible (for either CMP or us) to be sure our estimates for those years are accurate. The Electric Council of New England[5/] has attempted a comparable series and estimates that commercial demand grew 17.7% and 5.1% in 1976 and 1977. Our backcast estimates growth at 19.8% and 4.7% for those two years. These are comfortingly close.

The Baseline Forecast

Once the structural equation has been estimated, the next step is to forecast the variables which will drive the forecast. The exact values of these projected variables and their sources are given in the second appendix to this section. For convenience, the growth rates of these variables are summarized below for two historical periods and the 1978-1990 period.

TABLE 2

HISTORICAL AND PROJECTED ANNUALIZED COMPOUND GROWTH RATES FOR THE EXOGENOUS VARIABLES IN THE COMMERCIAL SECTOR, SELECTED PERIODS

Variable	1965-73	1974-77	1978-90
Real per capita income	3.1	1.3	1.7
Non-manufacturing employment	3.7	3.2	1.9
Real average price	-5.1	-5.6	0.5
Real marginal price	-11.8	0.5	0.5

Source: See Commercial Sector, Appendix II

5/ CMP response to Maine Public Utilities Commission Data Request #2 Item-14.

It is worth noting from Table 2 that this forecast is based on lower expected growth rates in both employment and real per capita income than were experienced in the 1965-73 period. It is also based on a reversal of the historic declines in real electricity prices.

The price forecast, in this sector, and the others described in the following sections, is based on the CMP financial forecast of required revenue per kilowatt hour between now and 1990.[6/] This trend reflects the increases in the costs of generating electricity which are expected, including the increases resulting from the hypothetical construction of the Searsport plant in 1989.

The development of a price forecast from this variable requires two more steps, both of which are attempts to replicate the political process which determines the rate structure. The first step requires the identification of the relationship between the required revenue per kilowatt for the system as a whole and the average price in the commercial sector. Essentially this step requires a decision about allocating the responsibility for the system costs among the various sectors. In the recent past the average price in the commercial sector exceeded, by a considerable amount, the required revenue per kilowatt for the system as a whole,[7/] although the gap had been closing. Our baseline forecast assumes that the commercial sector average price will continue to be 55% higher than the required revenue per kilowatt.

The second step requires some judgement to be made about the future rate structure (in our equation this is captured by the marginal price). The baseline forecast assumes that a mild move toward flat rate pricing system was implemented by the end of 1978 in the residential sector and the commercial sector. The marginal price in the commercial sector is therefore assumed to be

6/ CMP response to MPUC Data Request #1, dated September 13, 1978, Item 13a.

7/ The ratio of the average price per kilowatt in the commercial sector to the required revenue per kilowatt for the system as a whole was 1.552 in 1977.

0.58 times the average price. The 0.58 reflects the relationship which currently exists between the average price and marginal price in the residential sector, the only sector currently under a flat rate system. The effect of this assumption, as can be seen in the second commercial sector appendix, is to increase the marginal price in one year while letting the average price change only a small amount. This accords with most moves to flat rate pricing by regulatory commissions and can be accomplished by reducing customer charges and/or demand charges while eliminating the declining block structure.

Once the future projections of these variables are accomplished, the forecast of electricity sales to the commercial sector is derived by using these values in the forecasting equation. The resulting forecast is given below as Table 3.

TABLE 3

FORECASTED SALES TO THE COMMERCIAL SECTOR, 1978-1990
(Thousands of kilowatt hours)

1978	1979	1980	1981	1982	1983	1984
1,300,408	1,268,464	1,295,231	1,418,882	1,523,942	1,636,389	1,771,670

1985	1986	1987	1988	1989	1990
1,855,576	1,924,664	2,001,173	2,074,555	2,151,846	2,312,950

Source: Computed using equation (4), Page 9 and the variables given in Appendix II. Because of different definitions these are not directly comparable to the CMP forecasted commercial sales.

The implied annualized growth rate for the 1978-88 period in the commercial sector is 4.78, which can be compared to the 5.3% growth rate forecasted by CMP for the same period. The NEPOOL model forecasts a growth rate of 6.5% for the 1979-89 period.[8/]

8/ Report of the NEPOOL Load Forecasting Task Force on the NEPOOL-MODEL-BASED Forecast of New England Energy and Peak Load, 1979-89. (March 1, 1979), p. 27.

APPENDIX I

COMMERCIAL SECTOR

HISTORICAL VALUES OF EXOGENOUS AND ENDOGENOUS VARIABLES

YEAR	SALES[a] MWH	REAL AVERAGE[b] PRICE/KWH ($1967)	MARGINAL[c] PRICE/KWH ($1967)	NON-MANUFACTURING[d] EMPLOYEES (THOUSANDS)	PER CAPITA[e] INCOME ($)	CPI[f] DEFLATOR
1960	220,119	.064	.017	173.0	1796	.887
1961	236,024	.050	.017	173.9	1815	.896
1962	261,263	.050	.017	175.2	1885	.906
1963	282,114	.049	.035	176.8	1932	.917
1964	310,211	.049	.034	181.1	2100	.929
1965	340,509	.049	.034	187.4	2274	.945
1966	458,415	.047	.033	194.2	2445	.972
1967	506,567	.045	.015	200.6	2559	1.000
1968	561,266	.043	.014	205.2	2768	1.042
1969	626,413	.035	.014	214.3	2995	1.098
1970	708,385	.033	.013	221.8	3250	1.163
1971	796,929	.032	.012	229.6	3396	1.213
1972	895,580	.034	.012	241.3	3636	1.253
1973	969,243	.032	.012	250.3	4085	1.331
1974	969,951	.034	.011	256.4	4493	1.477
1975	1,024,561	.031	.010	260.6	4766	1.612
1976	1,093,551	.030	.012	272.8	5367	1.705
1[illegible]	1,125,116	.029	.011	281.9	5734	[illegible].815

(a) FPC Form 1, Electric Operating Revenues. The 1976 and 1977 figures were generated by disaggregating the combined commercial and industrial sales by rate structures for 1975 and estimating the proportion of sales to commercial in each rate class. Commercial sales for 1976-77 were then estimated by assuming the 1975 proportions were valid for 1976-77 in each rate class. It should be noted that this produces a smaller commercial (and larger industrial) sales estimate than is used by CMP for these years.

(b) Federal Power Commission, Typical Electric Bills. The average were calculated using the consumption for the average commercial establishment to guide the decision as to which typical bill to consider. Then that bill was divided by the number of kilowatt hours included.

(c) Federal Power Commission, National Electric Rate Book (Maine), (Various years). The jump in 1963-66 was the result of a rate structure change which raised the marginal cost significantly in the range where the average firm was consuming.

(d) Maine Department of Manpower Affairs, Annual Average Wage and Salary Employment in Non-Farm Industries in Maine.

(e) U.S. Department of Commerce, Bureau of Economic Affairs, Survey of Current Business. (Various issues)

(f) Statistical Abstract of the United States, 1976. Consumer price index for all commodities.

APPENDIX II

COMMERCIAL SECTOR

PROJECTED VALUES OF THE EXOGENOUS VARIABLES

YEAR	AVERAGE PRICE[a] ($1967/kwh)	MARGINAL PRICE[b] ($1967/kwh)	NON-MANUFACTURING[c] EMPLOYEES (THOUSANDS)	PER CAPITA[d] INCOME ($)	CPI[e] DEFLATOR
1978	.026	.015	291.5	6288	1.953
1979	.030	.017	298.7	6883	2.119
1980	.028	.016	309.9	7405	2.300
1981	.027	.016	315.4	8171	2.477
1982	.027	.015	321.1	8986	2.662
1983	.026	.015	327.0	9856	2.857
1984	.025	.014	333.1	10770	3.060
1985	.026	.015	339.4	11750	3.273
1986	.026	.015	344.5	12760	3.494
1987	.027	.016	349.6	13850	3.723
1988	.028	.016	354.8	14990	3.960
1989	.029	.017	360.0	16210	4.205
1990	.028	.016	365.3	17490	4.457

(a) Average price was projected by assuming a constant average price per revenue ratio of 1.55 from 1979 to 1990. The actual 1977 ratio was 1.552. These values were translated to average price by multiplying by the revenue per kilowatt-hour as provided by the Central Maine Power Response to MPUC Data Request No. 1, Item 13a.

(b) Marginal price was assumed to be 0.58 times the average price for the projection.

(c) Non-manufacturing employees data were obtained from CMP's long range forecast for same using equivalent yearly growth rates as projected to calculate these state-wide non-manufacturing employment figures.

(d) Per capita income data for 1979 and 1980 were obtained from the Maine State Planning Office projections. The figures for 1980-90 were compiled using assumed growth rates of real per capita income of 2.46% decreasing yearly to 1.8% for 1981-85, and a constant 1.8% for 1986-90, a procedure recommended by the State Planning Office.

(e) The CPI deflator was calculated assuming a constantly-declining yearly growth rate which reaches 6% in 1990.

IV. THE INDUSTRIAL SECTOR

Introduction

In 1977 the industrial sector accounted for approximately one third of all electricity sales by CMP. Approximately one half of the industrial demand in 1977 came from the pulp and paper industry. The next two largest industries, food and kindred products and textile mill products, account for approximately 7% and 6% respectively of the industrial demand.

These sectors have historically exhibited quite different growth rates. From 1965-73 the sales to the pulp and paper industry grew at a compound growth rate of 2.4% whereas the comparable growth rates for the food and kindred products and textile mill products industries were 4.7% and 1.3% respectively. In light of this diverse growth pattern we have chosen to forecast the demand in each of these industries separately.

As in the commercial sector the demand for electricity in the industrial sector is a derived demand - it depends on the demand for the products in that industry. In the commercial sector we were forced to decompose the impact of this demand into two components - the level of the demand and the composition of demand. The consideration of the latter component was necessitated by the heterogeneity of the commercial class. Shifts in demand within this class could have potentially large effects on the demand for electricity by the class as a whole. Except for the conglomerate industrial demand group (discussed on succeeding pages) the industrial classifications are homogenous enough that this composition effect can be safely ignored. As in the commercial and residential sectors, the real cost of electricity and the rate structure are important determinants and in the industrial sector oil prices play a significant role.

The Model

In the industrial sector experimentation with the flow adjustment model used in the other sectors suggested strongly that the industrial sector reacted quickly to changes in prices and levels of demand for its products. Therefore, no lagged terms were incorporated. The basic demand function used was the constant elasticity demand function (known in economics as the Cobb-Douglas function because of its extensive use by Cobb and Douglas in estimating production relationships). Symbolically this equation takes on the form:

$$q_t = \alpha X_{1_t}^{\beta_1} X_{2_t}^{\beta_2} X_{3_t}^{\beta_3} X_{4_t}^{\beta_4} \qquad (1)$$

In practice this function is estimated by taking logs of both sides. The resulting equation, which is linear in logs, is amenable to estimation by standard multivariate regression computer packages. The chief restriction imposed by this functional form is the fact that the elasticities of demand are constant (i.e. are not affected by the level of demand).

The Variables

Average and marginal prices were computed in a similar manner as in the other sectors. The marginal price is the tail block cost of an additional kilowatt hour consumed. The average price was computed simply as the typical utility bill paid by that industry for the highest level of consumption class which was below its 1977 consumption level divided by the number of kilowatt hours involved.

Two measures of industrial economic activity were employed - earnings and employment. Conceptually these measures are inferior to alternatives such as value added, but since no forecasts of value added were available we were forced to rely on these closely related measures of industrial activity. Forecasts of earnings by industry were available from the Department of Commerce through the State Planning Office and therefore these were used.

In the other two sectors repeated attempts to include oil prices in the forecasting system failed. They did not add significantly to the explanatory power of the equations and for some equations their inclusion lead to very counterintuitive results. This was not true for the industrial sector. Oil prices turned out to be a powerful determinant in each industrial group's demand for electricity. The oil price data came from the Office of Energy Resources. The actual values used in this study and their sources can be found in the first industrial appendix.

The Forecasting Equations

The four equations which were estimated on historical data and subsequently used as the basis for the forecast are:

$$\ln \frac{Q26_t}{E26_t} = -.218 - \underset{(3.08)}{.195} \ln AP6_t - \underset{(3.50)}{.231} \ln MP_t + \underset{(6.78)}{.448} \ln ROP_t + \underset{(.442)}{.124} \ln DD_t \qquad (2)$$

$\bar{R}^2 = .907$
d.w.=2.01

$$\ln Q20_t = -4.197 - \underset{(2.39)}{.542} \ln APO_t - \underset{(.114)}{.014} \ln MP_t + \underset{(3.26)}{1.121} \ln E20_t + \underset{(7.5)}{.853} \ln RPO_t \qquad (3)$$

$\bar{R}^2 = .929$
d.w.=1.59

$$\ln Q22_t = -.253 - \underset{(2.46)}{.459} \ln AP2 - \underset{(.950)}{.078} \ln MP_t + \underset{(6.82)}{.910} \ln EMP2_t + \underset{(2.33)}{.255} \ln ROP_t \qquad (4)$$

$\bar{R}^2 = .837$
d.w.=2.83

$$\ln QOth_t = 1.76 - \underset{(4.26)}{1.11} \ln APOth_t - \underset{(.074)}{.011} \ln MP_t + \underset{(1.96)}{.277} \ln ROP_t + \underset{(.506)}{.080} \ln EOth_t \qquad (5)$$

$\bar{R}^2 = .871$
d.w.=1.61

The variables are defined for each year t as follows:

$\frac{Q26_t}{E26_t}$ = The electricity demanded per dollar of real earnings for the pulp and paper industry.

$AP6_t$, APO_t, and $APOth_t$ = respectively the real average prices for the paper, food, textile and "all other" industrial categories.

$Q20_t$, $Q22_t$ and $QOth_t$ = respectively the demand for electricity (kilowatt hours) by the food, textile and "all other" industrial categories.

MP_t = the real marginal price (which is the same for all industrial categories).

ROP_t = the real oil price.

$E20_t$ and $EOth_t$ = respectively the earnings in the food and "all other" industrial categories.

$EMP2_t$ = the employment in the textile industry.

Several characteristics of these equations are apparent. The effect of oil prices is pronounced and very statistically significant. Average prices have a pronounced effect, but marginal prices are important only in the pulp and paper industry. This is to be expected since the typical consumption levels in the other industry groups are significantly lower and are therefore much less influenced by the tail block price. Statistically speaking, the strongest equation is the one applying to the pulp and paper industry. Since the pulp and paper industry is the largest industrial sector consumer, that is reassuring.

Validation

The actual and estimated kilowatt hour sales for each of the four industrial sectors are given in Tables 4, 5, 6 and 7. The same data for the industrial sector as a whole is given in Table 8.

TABLE 4

ESTIMATED SALES, ACTUAL SALES (MWH) AND ERROR RATES

FOR THE PULP AND PAPER INDUSTRY

1963-1977

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1963	473,222	488,850	3.3
1964	511,011	498,332	-2.5
1965	597,971	559,983	-6.3
1966	607,670	601,241	-1.1
1967	594,094	633,441	6.6
1968	617,750	628,796	1.8
1969	645,653	645,453	0.0
1970	649,527	658,591	1.4
1971	654,203	644,448	-1.5
1972	682,906	673,366	-1.4
1973	724,915	729,095	0.6
1974	790,882	812,662	2.8
1975	773,399	745,943	-4.0
1976	852,417	877,448	2.9
1977	1,092,994	1,073,544	-1.8

Average Absolute Percent Error 2.63%

TABLE 5

ESTIMATED SALES, ACTUAL SALES (MWH) AND ERROR RATES

FOR THE TEXTILE MILL PRODUCTS INDUSTRY

1963-1977

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1963	114,542	117,002	2.1
1964	116,801	113,718	-2.6
1965	123,118	120,463	-2.2
1966	125,846	128,955	2.5
1967	123,137	126,460	2.7
1968	129,074	128,004	-0.8
1969	123,173	125,166	1.6
1970	122,584	119,109	-2.8
1971	90,220	99,347	10.1
1972	104,981	98,547	-6.1
1973	110,716	107,414	-3.0
1974	107,857	106,293	-1.4
1975	90,333	93,093	3.1
1976	105,733	102,963	-2.6
1977	116,615	117,260	0.6

Average Absolute Percent Error 2.95%

TABLE 6

ESTIMATED SALES, ACTUAL SALES (MWH) AND

ERROR RATES FOR THE FOOD PRODUCTION INDUSTRY

1963-1977

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1963	60,412	63,488	5.1
1964	63,896	61,895	-3.1
1965	72,172	68,743	-4.8
1966	82,032	78,418	-4.4
1967	90,803	86,995	-4.2
1968	90,436	94,243	4.2
1969	83,036	89,476	7.8
1970	88,186	92,365	4.7
1971	92,183	99,792	8.3
1972	100,971	99,098	-1.9
1973	104,569	94,239	-9.9
1974	105,656	107,633	1.9
1975	108,149	113,586	5.0
1976	137,745	130,014	-5.6
1977	144,737	141,413	-2.3

Average Absolute Percent Error 4.88%

TABLE 7

ESTIMATED SALES, ACTUAL SALES (MWH) AND

ERROR RATES FOR ALL OTHER INDUSTRIES

1963-1977

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1963	422,720	437,915	3.6
1964	454,881	441,662	-2.9
1965	477,391	494,842	3.7
1966	500,458	532,194	6.3
1967	546,651	553,536	1.3
1968	604,872	588,098	-2.8
1969	627,211	616,217	-1.8
1970	646,717	660,223	2.1
1971	675,968	684,079	1.2
1972	737,402	702,149	-4.8
1973	721,885	703,115	-2.6
1974	746,687	632,449	-15.3
1975	731,999	749,638	2.4
1976	715,768	731,760	2.2
1977	713,071	782,534	9.7

Average Absolute Percent Error 4.18%

TABLE 8

ESTIMATED SALES, ACTUAL SALES (MWH) AND

PERCENT ERROR RATES FOR ALL INDUSTRIES

1963-1977

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1963	1,070,896	1,107,255	3.4
1964	1,146,589	1,115,607	-2.7
1965	1,270,652	1,244,030	-2.1
1966	1,316,006	1,340,808	1.9
1967	1,354,685	1,400,433	3.4
1968	1,442,132	1,439,141	-0.2
1969	1,479,073	1,476,312	-0.2
1970	1,507,014	1,530,288	1.5
1971	1,512,574	1,527,666	1.0
1972	1,626,260	1,573,160	-3.3
1973	1,662,085	1,633,863	-1.7
1974	1,751,082	1,659,037	-5.3
1975	1,707,880	1,702,260	-0.3
1976	1,811,663	1,842,185	1.7
1977	2,067,417	2,114,751	2.3

Average Absolute Percent Error 2.07%

The Baseline Forecast

As in the other sectors the first step in developing the forecast is to develop a forecast of the exogenous variables. The exact values of these variables are given in the second industrial appendix. For comparative purposes, the historic and projected growth rates for these variables are given in Table 9.

TABLE 9

HISTORIC AND PROJECTED ANNUALIZED COMPOUND GROWTH RATES FOR THE EXOGENOUS VARIABLES IN THE COMMERCIAL SECTOR, SELECTED PERIODS

VARIABLES	1965-1973	1974-1977	1978-1990
Pulp and Paper			
Real Average Price	-3.4	-3.2	-.1
Real Marginal Price	-3.0	-12.0	-0.5
Real Earnings	2.0	4.5	1.9
Textile Mill Products			
Real Average Price	-3.3	0.9	-.1
Real Marginal Price	-3.0	-12.0	-.5
Employment	-3.5	1.4	0
Food and Kindred Products			
Real Average Price	-3.4	-4.4	-.1
Real Marginal Price	-3.0	-12.0	-.5
Real Earnings	1.6	4.0	1.3
All Other			
Real Average Price	-3.4	-4.4	-.1
Real Marginal Price	-3.0	-12.0	-.5
Real Earnings	6.2	17.5	2.8
Common Variables			
Real Oil Prices	.1	2.3	2.0
Degree Days	-1.0	2.2	0

Given these variables the forecast is generated using equations (2)-(5). The results of that forecast are given as Table 10.

TABLE 10

FORECASTED SALES TO THE INDUSTRIAL SECTOR, 1978-1990
(Megawatt-hours)

YEAR	SALES TO PAPER IND.	SALES TO TEXTILE IND.	SALES TO FOOD IND.	SALES TO OTHER IND.	TOTAL IND. SALES
1978	1,090,195	114,200	146,705	773,393	2,124,493
1979	1,112,073	110,715	147,276	730,879	2,100,943
1980	1,174,161	113,557	156,441	775,623	2,219,782
1981	1,234,717	116,627	166,072	827,564	2,344,980
1982	1,277,960	117,415	172,687	847,388	2,415,450
1983	1,326,155	118,592	180,176	872,322	2,497,245
1984	1,391,787	121,494	190,774	925,869	2,629,924
1985	1,416,697	119,763	194,097	906,377	2,636,935
1986	1,433,632	117,410	196,843	884,693	2,632,577
1987	1,449,819	115,020	199,162	862,028	2,626,028
1988	1,465,673	112,617	202,017	839,132	2,619,440
1989	1,479,903	110,097	204,283	814,243	2,608,525
1990	1,546,326	112,379	216,004	864,800	2,739,509

To facilitate the interpretation of these data the annualized compound growth rates are given as Table 11.

TABLE 11

HISTORIC AND PROJECTED ANNUALIZED COMPOUND GROWTH RATES
FOR THE INDUSTRIAL SALES CATEGORIES
SELECTED PERIODS

INDUSTRIAL CATEGORY	1965-1973	1974-1977	1978-1988	1978-1990
Pulp and Paper	2.4	11.3	3.0	3.0
Textile Mill Products	-1.3	2.6	-.1	-.1
Food and Kindred Products	4.7	11.1	3.3	3.3
All Other	5.3	-1.5	.8	.9
Total Industrial	3.4	5.7	2.1	2.1

The comparable CMP figure for our 2.1% growth rate until 1988 is 4.5%. Almost all of the differences between the forecasts is due to the treatment of the Boise-Cascade addition scheduled to come on line in 1980. CMP treated this addition as reflecting an increase over and above their forecasted sales and therefore simply added it to their forecast. This model treats it as part of the already-accounted-for increase in industrial sales.

One other characteristic is evident in this forecast - the importance of the price effect induced by the construction of the Searsport plant. By all reckoning the addition of the Searsport plant will increase the average system cost by more than 20% when operational. When this effect is translated into prices it stimulates quite a reduction in demand. The construction of Searsport, by virtue of its effect on prices, will dampen the demand, and hence, the need for the plant. Not building it, however, and holding down system costs encourages demand and hastens the need for it.

APPENDIX I

INDUSTRIAL SECTOR

PROJECTED VALUES OF THE EXOGENOUS VARIABLES

PULP AND PAPER INDUSTRY

YEAR	AVERAGE PRICE(i) ($1967/kwh)	MARGINAL PRICE(j) ($1967/kwh)	EARNINGS(k) (X1000(1967$))	OIL PRICES(m) (¢/GAL.)	HEATING(n) DEGREE DAYS	CPI(o) DEFLATOR
1978	.012	.0027	182,258	54.3	7498	1.953
1979	.013	.0027	187,123	60.1	7498	2.119
1980	.012	.0026	192,051	66.6	7498	2.300
1981	.012	.0025	195,896	73.1	7498	2.477
1982	.011	.0024	199,818	80.2	7498	2.662
1983	.011	.0024	203,818	87.8	7498	2.857
1984	.011	.0023	207,898	95.9	7498	3.060
1985	.011	.0023	212,070	104.6	7498	3.273
1986	.011	.0024	215,289	113.9	7498	3.494
1987	.012	.0025	218,557	123.8	7498	3.723
1988	.012	.0026	221,875	134.3	7498	3.960
1989	.012	.0027	225,243	145.4	7498	4.205
1990	.012	.0025	228,668	157.2	7498	4.457

PROJECTED VALUES OF THE EXOGENOUS VARIABLES

TEXTILE MILL PRODUCTS INDUSTRY

YEAR	AVERAGE PRICE(i) ($1967/kwh)	MARGINAL PRICE(j) ($1967/kwh)	EMPLOYMENT(l) (X1000)	OIL PRICES(m) (¢/GAL)	CPI(o) DEFLATOR
1978	.020	.0027	9.22	54.3	1.953
1979	.020	.0027	8.99	60.1	2.119
1980	.019	.0026	8.95	66.6	2.300
1981	.018	.0025	8.89	73.1	2.477
1982	.018	.0024	8.84	80.2	2.662
1983	.018	.0024	8.78	87.8	2.857
1984	.017	.0023	8.73	95.9	3.060
1985	.017	.0023	8.68	104.6	3.273
1986	.018	.0024	8.59	113.9	3.494
1987	.018	.0025	8.50	123.8	3.723
1988	.019	.0026	8.40	134.3	3.960
1989	.020	.0027	8.32	145.4	4.205
1990	.019	.0025	8.23	157.2	4.457

PROJECTED VALUES OF THE EXOGENOUS VARIABLES

FOOD PRODUCTS INDUSTRY

YEAR	AVERAGE PRICE(i) ($1967/kwh)	MARGINAL PRICES(j) ($1967/kwh)	EARNINGS(k) (X1000(1967$))	OIL PRICES(m) (¢/GAL)	CPI(o) DEFLATOR
1978	.020	.0027	66.4	54.3	1.953
1979	.021	.0027	67.5	60.1	2.119
1980	.020	.0026	68.6	66.6	2.300
1981	.019	.0025	69.5	73.1	2.477
1982	.019	.0024	70.4	80.2	2.662
1983	.018	.0024	71.3	87.8	2.857
1984	.017	.0023	72.2	95.9	3.060
1985	.018	.0023	73.2	104.6	3.273
1986	.018	.0024	74.0	113.9	3.494
1987	.019	.0025	74.8	123.8	3.723
1988	.020	.0026	75.8	134.3	3.960
1989	.020	.0027	76.6	145.4	4.205
1990	.019	.0025	77.5	157.2	4.457

PROJECTED VALUES OF THE EXOGENOUS VARIABLES

ALL OTHER INDUSTRIES

YEAR	AVERAGE PRICE(i) ($1967/kwh)	MARGINAL PRICE(j) ($1967/kwh)	EARNINGS(k) (X1000(1967$))	OIL PRICES(m) (¢/GAL)	CPI(o) DEFLATOR
1978	.020	.0027	477.3	54.3	1.953
1979	.021	.0027	491.3	60.1	2.119
1980	.020	.0026	506.8	66.6	2.300
1981	.019	.0025	521.5	73.1	2.477
1982	.019	.0024	541.6	80.2	2.662
1983	.018	.0024	552.0	87.8	2.857
1984	.017	.0023	567.8	95.9	3.060
1985	.018	.0023	584.0	104.6	3.273
1986	.018	.0024	599.6	113.9	3.494
1987	.019	.0025	615.6	123.8	3.723
1988	.020	.0026	631.7	134.3	3.960
1989	.020	.0027	648.3	145.4	4.205
1990	.019	.0025	665.3	157.2	4.457

APPENDIX II

INDUSTRIAL SECTOR

HISTORICAL VALUES OF EXOGENOUS AND ENDOGENOUS VARIABLES

PULP AND PAPER INDUSTRY

YEAR	SALES(a)	AVERAGE(b) PRICE($1967/kwh)	MARGINAL(c) PRICE($1967/kwh)	EARNINGS(d) (X1000(1967$))	OIL PRICES(f) (¢/GAL)	HEATING(g) DEGREE DAYS	CPI(h) DEFLATOR
1963	473,222	.019	.0056	126,876	16.7	7645	.917
1964	511,011	.019	.0055	130,760	16.3	7821	.929
1965	597,971	.013	.0053	135,781	16.7	7660	.945
1966	607,670	.012	.0051	143,491	17.1	7858	.972
1967	594,094	.012	.0050	148,828	17.7	7686	1.000
1968	617,750	.011	.0048	147,302	18.2	7169	1.042
1969	645,653	.011	.0046	149,748	18.6	7153	1.098
1970	649,527	.010	.0043	149,140	19.3	7705	1.163
1971	654,203	.010	.0041	144,536	20.5	7551	1.213
1972	682,906	.010	.0044	155,299	20.6	7418	1.253
1973	724,915	.010	.0041	158,926	23.8	7047	1.331
1974	790,882	.013	.0037	155,678	37.6	7248	1.477
1975	773,399	.012	.0052	150,975	40.7	7383	1.612
1976	852,417	.012	.0049	172,726	43.7	8127	1.705
1977	1,092,994	.012	.0025	177,462	49.5	7749	1.815

HISTORICAL VALUES OF EXOGENOUS AND

ENDOGENOUS VARIABLES

TEXTILE MILL PRODUCTS INDUSTRY

YEAR	SALES(a) (MWH)	AVERAGE(b) PRICE($1967/kwh)	MARGINAL(c) PRICE($1967/kwh)	EMPLOYMENT(e) (X1000)	OIL PRICES(f) (¢/GAL)	CPI(h) DEFLATOR
1963	114,542	.025	.0056	12.68	16.7	.917
1964	116,801	.025	.0055	12.40	16.3	.929
1965	123,118	.022	.0053	12.39	16.7	.945
1966	125,846	.021	.0051	13.11	17.1	.972
1967	123,137	.020	.0050	12.51	17.7	1.000
1968	129,074	.019	.0048	12.44	18.2	1.042
1969	123,173	.018	.0046	11.84	18.6	1.098
1970	122,584	.017	.0043	10.90	19.3	1.163
1971	90,220	.017	.0041	8.86	20.5	1.213
1972	104,981	.018	.0044	8.96	20.6	1.253
1973	110,716	.018	.0041	9.31	23.8	1.331
1974	107,857	.022	.0037	8.89	37.6	1.477
1975	90,333	.019	.0052	7.70	40.7	1.612
1976	105,733	.020	.0049	8.75	43.7	1.705
1977	116,615	.019	.0025	9.27	49.5	1.815

HISTORICAL VALUES OF EXOGENOUS AND

ENDOGENOUS VARIABLES

FOOD PRODUCTS INDUSTRY

YEAR	SALES(a) (MWH)	AVERAGE(b) PRICE($1967/kwh)	MARGINAL(c) PRICE($1967/kwh)	EARNINGS(d) (X1000(1967$))	OIL PRICES(f) (¢/GAL)	CPI(h) DEFLATOR
1963	60,412	.027	.0056	51,227	16.7	.917
1964	63,896	.027	.0055	51,382	16.3	.929
1965	72,172	.024	.0053	53,611	16.7	.945
1966	82,032	.023	.0051	58,491	17.1	.972
1967	90,803	.022	.0050	62,884	17.7	1.000
1968	90,436	.021	.0048	66,303	18.2	1.042
1969	83,036	.020	.0046	63,387	18.6	1.098
1970	88,186	.019	.0043	63,891	19.3	1.163
1971	92,183	.018	.0041	66,403	20.5	1.213
1972	100,971	.018	.0044	66,620	20.6	1.253
1973	104,569	.018	.0041	60,939	23.8	1.331
1974	105,656	.022	.0037	57,991	37.6	1.477
1975	108,149	.019	.0052	56,389	40.7	1.612
1976	137,745	.020	.0049	64,178	43.7	1.705
1977	144,737	.019	.0025	65,266	49.5	1.815

HISTORICAL VALUES OF EXOGENOUS AND

ENDOGENOUS VARIABLES

ALL OTHER INDUSTRIES

YEAR	SALES(a) (MWH)	AVERAGE(b) PRICE($1967/kwh)	MARGINAL(c) PRICE($1967/kwh)	EARNINGS(d) (X1000(1967$))	OIL PRICES(f) (¢/GAL)	CPI(h) DEFLATOR
1963	422,720	.027	.0056	133,330	16.7	.917
1964	454,881	.027	.0055	165,479	16.3	.929
1965	477,391	.024	.0053	185,145	16.7	.945
1966	500,458	.023	.0051	215,074	17.1	.972
1967	546,651	.022	.0050	233,188	17.7	1.000
1968	604,872	.021	.0048	270,528	18.2	1.042
1969	627,211	.020	.0046	275,577	18.6	1.098
1970	646,717	.019	.0043	259,090	19.3	1.163
1971	675,968	.018	.0041	252,413	20.5	1.213
1972	737,402	.018	.0044	280,970	20.6	1.253
1973	721,885	.018	.0041	300,291	23.8	1.331
1974	746,687	.022	.0037	289,172	37.6	1.477
1975	731,999	.019	.0052	264,412	40.7	1.612
1976	715,768	.020	.0049	373,975	43.7	1.705
1977	713,071	.019	.0025	469,157	49.5	1.815

(a) Federal Power Commission Form 1, Electric Operating Revenues. The 1976 and 1977 figures were generated by disaggregating the combined commercial and industrial sales by rate structures. Total industrial sales was singled out by recombining sales by rate structure according to historical proportions.

(b) Federal Power Commission, Typical Electric Bills. The average prices were calculated using the consumption levels for the three particular industries studied and for the average industrial establishment for the remainder to guide the decision as to which typical bill to consider. That bill was then divided by the number of kilowatt hours consumed on that (those) industry(ies). The typical bill categories were: SIC26-1000 kilowatts, 400,000 kilowatt hours; SIC22-500 kilowatts, 100,000 kilowatt hours; SIC20 and "all other" - 150 kilowatts, 300,000 kilowatt hours.

(c) Federal Power Commission, National Electric Rate Book (Maine) (Various Years).

(d) U.S. Department of Commerce, Bureau of Economic Affairs, (OBERS) Population, Personal Income, and Earnings by State Projection to 2000.

(e) Maine Employment Security Commission, Maine's Statewide Total Wage and Salary Employment in Selected Industries by Standard Industrial Class.

(f) Maine Office of Energy Resources, "Monthly Price Monitoring Program".

(g) U.S. Department of Commerce, Environmental Science Services Administration, Local Climatological Data - Portland, Maine. (Latest data).

(h) Statistical Abstract of the United States, 1976. Consumer price index for all commodities.

(i) Average price was projected by assuming a constant average price per revenue ratio of 1.05 over the forecast period. These values were translated to average price by multiplying by the revenue per kilowatt hour as provided by CMP response to MPUC Data Request No. 1, dated September 13, 1978 Item 13a.

(j) Marginal price is assumed to be:

0.214 times the average price (in 1967 dollars) for SIC26

0.135 times the average price (in 1967 dollars) for SIC22

0.132 times the average price (in 1967 dollars) for SIC20

0.132 times the average price (in 1967 dollars) for all other industries. These figures were derived by computing the average price/marginal price ratio in 1977 for each industrial class. Note that this computation implicitly assumes that a system of flat rate pricing is not instituted in the industrial sector.

(k) <u>OBERS Projections</u>. Figures were available for 1978, 1979, 1980, 1985, 1990. A constant annual compound growth rate was assumed to interpolate between 1980-85 and 1985-90.

(l) Data for employment was extrapolated by assuming that the yearly growth rates would be equal to the growth rates of real earnings in the Textile Mill Products Industry.

(m) An average annual growth rate of 2% for real oil prices, using the CPI deflator, was assumed.

(n) Average yearly heating degree days was used for Portland, Maine.

(o) The CPI deflator was calculated assuming a constantly-declining yearly growth rate which reaches 6% in 1990.

V. THE RESIDENTIAL SECTOR

Introduction

The residential sector currently uses approximately 40% of all electricity sold by Central Maine Power and therefore this sector exercises a great deal of influence over the total demand for electricity. The major uncertainties in forecasting the behavior of this sector over the next decade and a half are the role which electric space heat will play in the future and the effect that flat rate pricing will have on the demand for electricity.

Sales to electrically heated homes is the fastest growing sector in residential demand. Although it currently comprises only approximately 4.7% of residential demand, the fact that it is growing so rapidly suggests that it could be a much more important component of electricity demand in the future.

As confirmed below by the econometric analysis, the demand for electricity by electrically heated homes is subject to much different influences than the demand for electricity by homes not electrically heated. Insulation plays much more of a role in these homes as does the use of wood heating to complement the electricity. Electric homes are much more sensitive to the marginal (tail block) price than are other homes simply because so much more of the electricity they consume is subject to that price. In the following sections, specific means of estimating the effects of these influences on the residential demand for electricity are presented.

The Model

The general approach taken in developing the model was to segment the residential sector into two categories - the demand by those non-seasonal homes which use electricity for space heat as well as for other purposes (the CMP customer class categories space heating and space heating plus water heating) and the demand by all other homes (henceforth called general use homes). For each category the emphasis was placed on estimating the average use per customer as a function of prices, income, etc.

The model for the general use homes is the flow adjustment model originally used by Houthakker and Taylor (1970). Since this model was described in the commercial sector portion of this report, let it suffice to say that the appropriate functional form is:

$$\ln q_t = \alpha^*\emptyset + \beta_1\emptyset \ln\chi_{1t} + \ldots\beta_\kappa\emptyset\ln \chi_{\kappa t} + (1-\emptyset) \ln q_{t-1} \quad (1)$$

The virtue of this form is that it allows the short run and long run elasticities to differ and both are calculable.

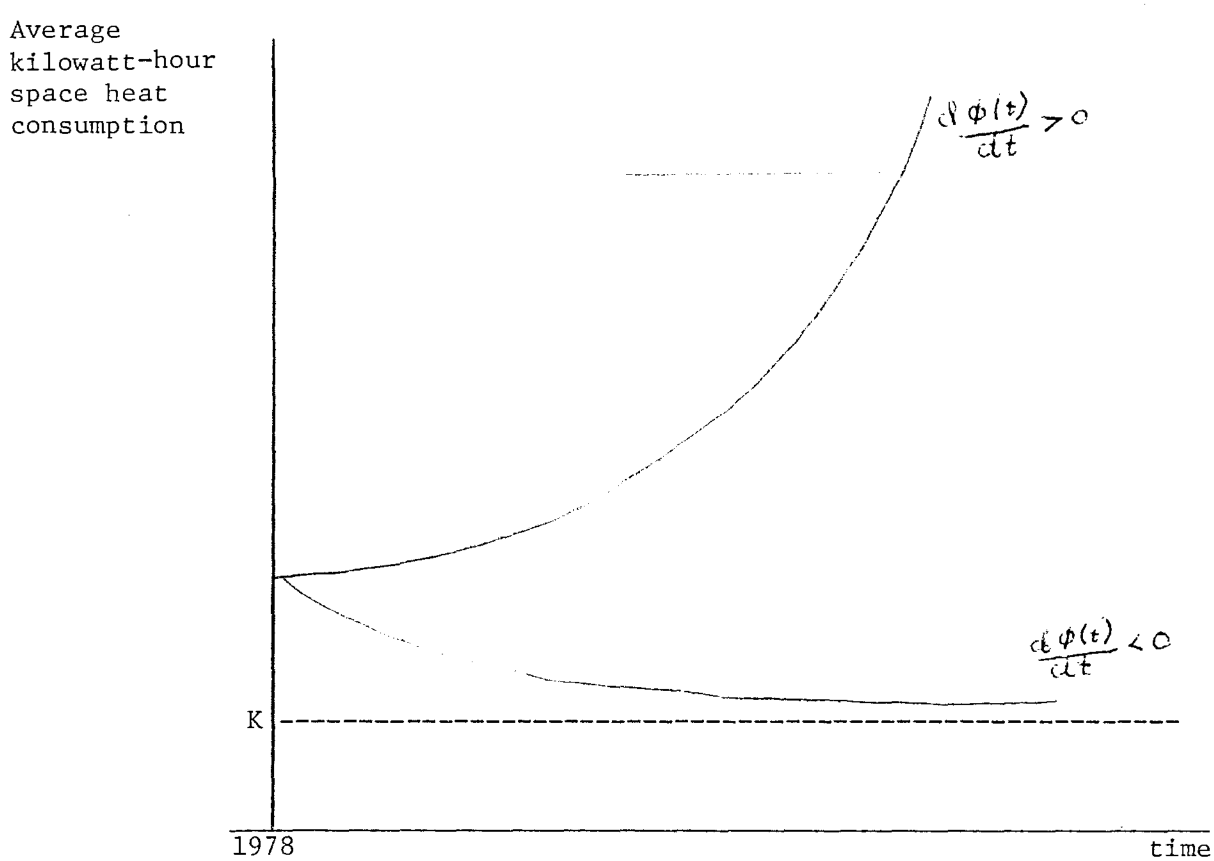
The model used for the electric space heated homes differed significantly from that used to forecast the consumption by general use homes. An examination of the data revealed that for electric homes the average consumption level had been declining for the last few years reflecting a variety of conservation activities by the homeowners and the use of wood burning stoves. Clearly the speed with which this would occur and the degree to which it would occur would be related to prices, incomes, etc. Yet equally clearly there are limits to how much conservation can be achieved in the planning horizon under investigation.

These considerations suggest the existence of a potentially binding theoretical lower limit on the average consumption of electricity for space heating. Therefore, the electric home model was further broken down into the general use portion and the space heat portion. The general use portion of the electricity consumed by electric homes was forecasted using equation (1). The space heat portion was forecasted with a function of the form:

$$q_t = K + e^{(\alpha+\beta_1 \chi_{1t}+ \ldots\beta_\kappa\chi_{\kappa t})} \quad (2)$$

where q_t is the amount of electricity consumed by the average electric home for space heating in year t.

The flexibility of this functional form is illustrated below in Figure 2. When the exponent (denoted collectively as $\emptyset(t)$) increases over time, average consumption will rise. When the exponent becomes progressively more negative over time, average consumption will fall toward the assimptote. The trend of the exponent can be estimated from historical data, as is described in the next section. Whether it will become progressively more positive or negative will depend on the estimated coefficients and the future behavior of the conditioning variables. In general, one would expect income increases to put upward pressure on consumption (e.g. larger homes) while prices would tend to retard consumption increases. The ultimate effect would depend on the strength of these two offsetting trends.



POSSIBLE PROJECTIONS FROM THE SPACE HEAT
FUNCTIONAL FORM

FIGURE 2

The Variables

The historical variables used to estimate the forecasting equation are given in the first residential sector appendix and the projected variables are given in the second residential sector appendix. The chief difficulty in defining the variables arises because the data base does not permit direct segmentation of the space heating electricity consumed by electrically heated homes. The data provide total electricity consumption by these homes which, of course, includes general use electricity consumed, in addition to space heating electricity consumed. To obtain a separate estimate for space heating in electrically heated homes, the average consumption of the general use customer was subtracted from the average consumption by the electric homes. The residual is the estimate of kilowatt hours used for space heating in electrically heated homes. This estimate will be correct if the general use demand in electric homes is identical to the general use demand in general use homes.

The second difficulty arises in calculating the value of K in equation (2). The form of the equation does not permit K to be directly estimated by linear regression programs by transformation of the variables. The equation can be estimated by conventional programs if K is known. This estimating equation then becomes:

$$\ln(q_t-K) = \alpha+\beta_1 X_{1t}t + \ldots+\beta_\kappa X_{\kappa t} \qquad (2)$$

Our estimate of K came from the REAP model developed and used by the Office of Energy Resources.9/ Intuitively K is a temperature sensitive lower limit for average space heat consumption for the period to 1990. It depends on conservation opportunities, the possible penetration of wood heat and the number of new (better insulated) homes added each year.

9/ Richard E. Dow and Richard E. Darling, "The REAP Residential Building Energy Conservation Analysis Computer Program," (Augusta, Maine Office of Energy Resources, April 1978). A description of the assumptions used to generate K can be found in the third appendix to this section.

The value of K used for a 7500 heating degree day year was 7397 kilowatt hours. The value of K for any other degree day year is found by multiplying the number of degree days in that year by .98.[10/]

The Forecasting Equations

The forecasting equation for the general use customers is:

$$\ln \frac{RSALE_t}{CUST_t} = \underset{}{1.320} + \underset{(.607)}{.132} \ln RIPCAP_t \tag{3}$$

$$- \underset{(1.17)}{.132} \ln AP_t - \underset{(1.01)}{.041} \ln MP_t$$

$$+ \underset{(1.81)}{.493} \ln \frac{RSALE_{t-1}}{CUST_{t-1}}$$

$\bar{R}^2 = .864$
d.w. = 2.83

where

$\frac{RSALE_t}{CUST_t}$ = the average sales per customer to general use customers in year t.

$RIPCAP_t$ = real income per capita in year t.

MP_t = the marginal price in year t.

The price terms are small in magnitude.

The space heating equation for all electric homes was:

$$\ln \left(\frac{RSH_t - K_t}{CUST_t}\right) = 2.827 + \underset{(1.17)}{.658} \; RIPCAP_t \tag{4}$$

$$- \underset{(1.42)}{.368} AP_t - \underset{(2.88)}{.630} MP_t - \underset{(3.16)}{.108} t$$

$\bar{R}^2 = .857$
d.w. = 2.29

where

$\frac{RSH_t}{CUST_t}$ = is the estimated average space heating demand per customer for all customers having electric heat and t is an integer variable taking on the value of 1 for 1963, 2 for 1964, etc.

10/Equations were also estimated with higher and lower values of K (8100 kilowatt hours and 6600 kilowatt hours). Neither the goodness of fit nor the projections were very much affected in this range, but to the extent there were differences the lowest value of K produced the lowest goodness of fit. This corroborates the concept that some non-zero threshold is operable.

There are several characteristics of these equations worth noting. First of all, general use consumption is not particularly sensitive to electricity prices, even in the long run. Space heating, however, is quite price sensitive, particularly for the marginal price. This is precisely as would be expected since electric homes consume large amounts of electricity for which they pay the marginal price. In addition, increases in per capita income, as expected, tend to increase both the average general use and average space heat consumption.

Validation

The actual historical data and the model estimates are presented below in Tables 12, 13, 14, and 15 along with the associated error rates. The error rates for these equations are small in comparison to those in the other sectors. To a large extent this is due to the fact that the residential sector is composed primarily of small customers while the other sectors have large customers. The latter is more difficult to forecast on a year to year basis because the expansions tend to take place infrequently and in large discrete jumps.

TABLE 12

ESTIMATED SALES, ACTUAL SALES (MWH) AND ERROR RATES
FOR THE RESIDENTIAL SECTOR

1965-1978

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1965	846,066	847,809	+0.2
1966	895,438	917,519	+2.5
1967	993,553	977,728	-1.6
1968	1,075,661	1,074,900	-0.1
1969	1,163,593	1,168,041	+0.4
1970	1,280,220	1,280,246	+0.0
1971	1,405,887	1,393,844	-0.9
1972	1,593,423	1,521,239	-4.5
1973	1,700,278	1,749,399	+2.9
1974	1,819,947	1,817,124	-0.2
1975	1,915,633	1,921,369	+0.2
1976	2,143,942	2,113,621	-1.4
1977	2,213,823	2,295,508	+3.7
1978	2,313,862	2,291,772	+0.3

Average Absolute Percent Error 1.4

TABLE 13

AVERAGE ELECTRIC HOME SPACE HEAT CONSUMPTION (KWH/CUST)

ACTUAL VS. ESTIMATED

1965-1978

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1965	16,039	17,030	+6.2
1966	17,432	17,683	+1.4
1967	18,747	18,784	+0.1
1968	19,391	19,287	-0.6
1969	19,308	19,424	+0.6
1970	19,821	20,287	+2.3
1971	19,760	19,412	-1.8
1972	20,505	17,676	-13.8
1973	17,715	18,383	+3.8
1974	17,172	16,515	-3.8
1975	15,185	15,077	-0.8
1976	16,086	16,124	+0.2
1977	14,374	15,747	+9.6
1978	11,932	11,789	-1.2

Average Absolute Percent Error 3.3

TABLE 14

TOTAL ELECTRICITY CONSUMPTION BY ELECTRIC HOMES[11/] (MWH)

ACTUAL VS. ESTIMATED

1965-1978

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1965	16,794	17,647	+5.1
1966	19,822	20,142	+1.6
1967	27,601	27,569	-0.1
1968	39,029	38,852	-0.5
1969	53,882	54,184	+0.5
1970	78,475	79,959	+1.9
1971	114,271	112,477	-1.6
1972	181,411	160,081	-12.0
1973	234,305	242,611	+3.5
1974	312,986	304,125	-2.8
1975	377,262	375,739	-0.5
1976	485,402	484,067	-0.3
1977	541,136	581,981	+7.5
1978	554,235	548,083	-1.1

Average Absolute Percent Error 2.8

11/ For the purposes of this report, electric homes are those non-seasonal homes which are equipped to use electricity as the chief source of space heating.

TABLE 15

ELECTRICITY CONSUMPTION BY NON-ELECTRIC HOMES[12/] (MWH)

ACTUAL VS. ESTIMATED

1965-1978

YEAR	ACTUAL VALUE	ESTIMATED VALUE	PERCENT ERROR
1965	829,272	830,162	+0.1
1966	875,616	897,377	+2.5
1967	965,952	950,159	-1.7
1968	1,036,632	1,036,047	-0.1
1969	1,109,711	1,113,857	+0.3
1970	1,201,745	1,200,288	-0.1
1971	1,291,616	1,281,366	-0.8
1972	1,412,012	1,361,159	-3.6
1973	1,465,973	1,506,788	+2.8
1974	1,506,961	1,512,998	+0.4
1975	1,538,370	1,545,629	+0.5
1976	1,658,539	1,629,554	-1.7
1977	1,672,687	1,713,527	+2.4
1978	1,759,627	1,743,689	-0.9

Average Absolute Percent Error 1.28%

12/ For the purposes of this report, non-electric homes are all thos residential customers not classified as electric homes. For the definition of electric homes, see fn 11 in Table 14 on the preceeding page.

The Baseline Forecast

The development of the residential forecast requires a number of separate steps.

1. The exogenous variables have to be forecasted. The forecasted values and the methods used to derive them are described in the second appendix to this section. For comparative purposes some summary growth rates are presented as Table 16.
2. The next step is to use these variables in combination with the general use and electric home space heat equations to generate the per customer forecasts.
3. The non-electric home forecast is generated by multiplying the general use per customer forecast by the customer forecast.
4. The electric home forecast is generated by adding the general use per customer forecast to the space heat per customer forecast and multiplying this estimate of total electricity consumption per electric home customer by the forecast of the number of electric home customers.
5. The total residential sector forecast is then computed by adding the electric and non-electric home forecasts.

TABLE 16

GROWTH RATES FOR THE EXOGENOUS VARIABLES IN THE RESIDENTIAL SECTOR, SELECTED PERIODS

VARIABLE	1965-1973	1974-1977	1978-1990
Real Income per Capita	3.1	1.4	1.7
Real Average Price Space Heat	-3.9	-4.1	0.5
Real Marginal Price Space Heat	-5.4	-0.9	0.5
Real Average Price General	-3.6	-4.6	0.5
Real Marginal Price General	-3.2	2.6	0.5

In this model for the baseline forecast, we used the same forecast of the number of customers as was used in the CMP model. There were several reasons for this, but the most important was that this forecast was entirely consistent with the approach taken in the Office of Energy Resources model. Conceptually the total number of customers should be determined primarily by demographic phenonema (e.g. migration, household formation, age structure of the population, etc.), but the percentage of those customers choosing electric heat should be a function of the relative cost of electric space heating and oil space heating. The CMP forecast is fully in accord with this conceptualization and is based on an econometric equation which captures this relationship. For the purposes of the baseline forecast, the CMP and OER residential customer forecasts are identical.

TABLE 17

TOTAL RESIDENTIAL SALES FORECAST

1979-1990

YEAR	GENERAL (MWH)	SPACE HEAT (MWH/CUST)	ALL-ELECTRIC (MWH)	TOTAL SALES (MWH)
1979	1,764,628	10,497	572,576	2,337,204
1980	1,782,219	10,392	640,076	2,422,295
1981	1,833,494	10,521	706,456	2,539,950
1982	1,896,319	10,420	768,935	2,665,254
1983	1,969,174	10,348	836,240	2,805,415
1984	2,055,947	10,407	917,523	2,973,470
1985	2,129,657	10,098	982,218	3,111,875
1986	2,190,019	9,793	1,042,185	3,232,204
1987	2,249,245	9,522	1,088,829	3,338,074
1988	2,309,424	9,272	1,119,897	3,429,321
1989	2,367,075	9,043	1,149,013	3,516,087
1990	2,452,968	9,092	1,201,901	3,654,869

To facilitate the interpretation of this forecast, Table 18 below presents the historical and projected growth rates for each of the two main residential sectors and the total residential demand.

TABLE 18

HISTORICAL AND PROJECTED GROWTH RATES
FOR DEMAND IN THE RESIDENTIAL SECTOR

VARIABLES	1965-1973	1974-1977	1978-1990
General KWH Sales	7.4	3.5	2.9
All-electric KWH Sales	39.0	20.0	6.8
Total Residential KWH Sales	9.1	6.8	4.0

The expected growth rate of 4.0% is lower than historical experience by quite a bit. As is shown in Table 18 our forecast expects the sales to all-electric homes to grow by 6.8 in spite of a rather large reduction in the use per customer in that sector due to the penetration of wood heat and higher numbers of well insulated homes. The consumption in non-electric homes is expected to grow at a 2.9% rate which is somewhat lower than the growth rate experienced in the 1974-1977 period. The overall 4.0% growth rate in the residential sector is higher than the 3.7% forecasted by CMP.

APPENDIX I

RESIDENTIAL SECTOR

HISTORICAL VALUES OF EXOGENOUS AND ENDOGENOUS VARIABLES

YEAR	SALES (MWH)[a]	SPACE HEAT[e] AV. PRICE ($1967/kwh)	SPACE HEAT[f] MGL. PRICE ($1967/kwh)	OTHER[e] AV. PRICE ($1967/kwh)	OTHER[g] MGL. PRICE ($1967/kwh)
1964	810,714	.022	.019	.038	.013
1965	846,065	.022	.018	.039	.013
1966	895,437	.020	.017	.037	.012
1967	993,553	.019	.015	.035	.012
1968	1,075,661	.018	.013	.033	.012
1969	1,163,592	.018	.013	.032	.012
1970	1,280,220	.016	.012	.029	.010
1971	1,405,886	.016	.012	.029	.010
1972	1,593,423	.017	.012	.031	.011
1973	1,700,278	.016	.012	.029	.010
1974	1,819,947	.020	.010	.031	.015
1975	1,915,632	.017	.012	.027	.016
1976	2,143,941	.018	.012	.028	.016
1977	2,213,822	.018	.010	.027	.016

APPENDIX I

RESIDENTIAL SECTOR

HISTORICAL VALUES

YEAR	DEGREE DAYS(h)	PER CAPITA(i) INCOME($)	CPI(j) DEFLATOR	ALL-ELECTRIC(k) CUSTOMERS	OTHER(l) CUST	TOTAL(m) CUSTOMERS
1964	7,821	2,100	.929	698	231,653	232,351
1965	7,660	2,274	.945	858	234,706	235,564
1966	7,858	2,445	.972	942	242,582	243,524
1967	7,686	2,559	1.000	1,220	249,207	250,427
1968	7,169	2,768	1.042	1,662	253,336	254,998
1969	7,153	2,995	1.098	2,282	257,855	260,137
1970	7,705	3,250	1.163	3,218	263,222	266,440
1971	7,551	3,396	1.213	4,652	268,845	273,497
1972	7,418	3,636	1.253	7,076	275,128	282,204
1973	7,047	4,085	1.331	10,219	281,190	291,409
1974	7,248	4,493	1.477	13,942	285,551	299,493
1975	7,383	4,766	1.612	18,382	288,187	306,569
1976	8,127	5,367	1.705	22,344	294,143	316,487
1977	7,749	5,734	1.815	27,036	296,526	323,562

(a) Calculated from FPC reports: Annual Report for CMP-Form and Typical Electric Bills.

(b) Calculated as sum of Space Heating and Space and Water Heating per customer consumption classes less non-all-electric consumption per customer. Source: 1968 to present from CMP. Prior to 1968 sales were calculated by back forecasting along growth rates from partial data in FPC report All-Electric Homes in the U.S.

(c) Calculated as sum of per customer Space Heating sales and per customer non-all-electric sales multiplied by sum of customers in Space Heating and Space and Water Heating consumption classes.

(d) Calculated as sum of General, Water Heating and Seasonal Customer Classes.

(e) Federal Power Commission, Typical Electric Bills. Prices calculated by dividing typical bill by KWH of block preceeding that in which consumption falls.

(f) Calculated from rate schedules in FPC/DOE report, National Electric Rate Book.

(g) Calculated as ratio of difference between typical bills of block consumed in and preceeding block to the difference between the KWH consumption levels of those blocks. FPC, Typical Electric Bills.

(h) Source, National Weather Service.

(i) U.S. Dept. of Commerce, Bureau of Economic Affairs, Survey of Current Business (Various Issues).

(j) Statistical Abstract of the U.S., 1976. CPI for all commodities.

(k) CMP. Sum of no. of customers in Space Heating and Space and Water Heating Classes.

(l) CMP. Difference between total customers and all-electric customers.

(m) CMP.

APPENDIX II

RESIDENTIAL SECTOR

PROJECTED VALUES OF EXOGENOUS VARIABLES

YEAR	SPACE HEAT[n] AV. PRICE($1967/kwh)	SPACE HEAT[o] MGL. PRICE($1967/kwh)	OTHER[n] AV. PRICE($1967/kwh)	OTHER[o] MGL. PRICE($1967/kwh)
1978	.021	.017	.029	.017
1979	.024	.019	.033	.019
1980	.023	.018	.032	.018
1981	.022	.018	.030	.018
1982	.021	.017	.030	.017
1983	.021	.017	.029	.017
1984	.020	.016	.028	.016
1985	.021	.017	.029	.017
1986	.021	.017	.029	.017
1987	.022	.018	.030	.018
1988	.024	.018	.031	.018
1989	.023	.019	.032	.019
1990	.022	.018	.031	.018

APPENDIX II

RESIDENTIAL SECTOR

PROJECTED VALUES OF EXOGENOUS VARIABLES

YEAR	DEGREE DAYS(p)	PER CAPITA(q) INCOME($)	CPI(h) DEFLATOR	ALL-ELEC(i) CUSTOMERS	OTHER(i) CUSTOMERS	TOTAL(i) CUST
1978	7,548	6,288	1.953	31,867	302,469	334,336
1979		6,883	2.119	36,151	304,685	340,836
1980		7,405	2.300	39,552	307,782	347,334
1981		8,171	2.477	43,025	310,823	353,848
1982		8,986	2.662	46,701	313,685	360,386
1983		9,856	2.857	50,467	316,502	366,969
1984		10,770	3.060	54,455	319,146	373,601
1985		11,750	3.273	58,742	321,555	380,297
1986		12,760	3.494	62,934	323,639	386,573
1987		13,850	3.723	66,350	326,523	392,873
1988		14,990	3.960	68,863	330,337	399,200
1989		16,210	4.205	71,262	334,290	405,552
1990	7,548	17,490	4.457	73,549	338,385	411,934

(n) The projected average system revenues were taken from CMP data response. The average price for general use homes was projected as 1.52 times the projected average system revenue. The average price for electric homes was assumed to differ only because the fixed customer charge is spread over more kilowatt hours.

(o) Assumed to be 0.58 times the general use average price for projection. Since flat rate pricing was assumed the marginal price is the same for both electric and non-electric homes.

(p) Historical mean for period 1963-1977.

(q) Maine State Planning Office projection. The figures for 1980-1990 were compiled using assumed growth rates of real per capita income of 2.46% decreasing yearly to 1.8% for 1981-85, and a constant 1.8% for 1986-90.

(h) Calculated assuming a constantly declining growth rate which reaches 6% in 1990.

(i) CMP Forecast.

APPENDIX III

COMPUTATION OF SPACE HEATING THRESHOLD VALUE FOR RESIDENTIAL ELECTRIC HEAT EQUATIONS

The K value was computed by calculating the estimated amount of electric energy needed to heat a "typical" well insulated home in the Central Maine Power Company service area and estimating the affects of wood heating on the total electric consumption. In summary, the electric heating need for the "typical" home was calculated to be 12673 kwh per year. The methods utilized to determine this value are described in this appendix. The contribution from wood heat was estimated to be equivalent to 5276 kwh/year. The methods used to calculate this figure are also described herein. The final value for the Space Heating Threshold or "K" value is than computed to be 7397.

<u>Calculation of Electric Heat Requirements for a "Typical" Home</u>

The "typical" home was defined as a single story, three bedroom ranch-style home built to meet the Minimum Property Standards of the U.S. Department of Housing and Urban Development. The specifications for the home are as follows:

Length: 44 feet

Width: 28 feet

Area of Double Glazing: 126 square feet

Area of Doors: 34 square feet

Ceiling Area: 1232 square feet

Floor Area: 1232 square feet

Total Opaque Wall Area: 992 square feet

Volume: 9856 cubic feet.

R Values (computed on attached sheets)

Floor: 19.23	Windows: 1.79
Ceiling: 30.46	Doors: 5.26
Walls: 21.28	

The total kwh heating requirement was calculated using the Residential Energy Analysis Program developed by Richard Darling and Richard Dow of the Maine Office of Energy Resources. A summary of the formulae used in the model and a copy of the results of the model are attached. As previously noted, the model predicts a heating energy use requirement for the home as 12673 kwh.

Wood Heating Contribution

The amount of energy contributed by wood heat was calculated by using data reported in the Final Report Maine Firewood Study compiled by the Maine Audubon Society in 1978. From the data available in that study, the following table was prepared:

WOOD HEATING DEVICE	CORDS OF WOOD USED (1)	EFFICIENCY (2)	AVERAGE KWH DISPLACED (3)
Fireplace	2.75	10%	1272*
Air-Tight Stove	4.25	60%	11813*
Franklin Stove	2.42	30%	3361*
Other	3.48	35%	5641*

*Numbers shown may not compute exactly due to rounding errors.

WOOD HEATING DEVICE	AVERAGE KWH DISPLACED (ABOVE)	PENETRATION	AVERAGE KWH CONTRIBUTED
Fireplace	1272	28.7%	365
Air-Tight Stove	11813	19.3%	2281
Franklin Stove	3361	13.3%	447
Other	5641	38.7%	2183
		AVERAGE KWH DISPLACED BY WOOD HEAT	5276

Notes: 1) Calculated from data tables shown on Page 47 and Page 57 of the Maine Firewood Study.

2) Average efficiency figures were taken from Heating With Wood, a publication of the New England Regional Commission.

3) These figures were calculated assuming 15.7 x 10^6 BTU available energy per cord of wood.

4) These figures were calculated from data contained in the Maine Audubon Society Heating With Wood Report.

U_0 CALCULATIONS FOR WALLS

WALLS HEATING	R VALUES FRAMING	R VALUES CAVITY
1 AIR FILM OUTSIDE	.17	.17
2 OUTER SURFACE	1.05	1.05
3 OUTER SHEATHING	0.62	0.62
4 FRAMING	6.88	X
5 CAVITY a) INSULATION	X	19.0
6 b) AIR SPACE	X	
7 INSIDE SURFACE	0.45	0.45
8 AIR FILM INSIDE	0.68	0.68
9 OTHER a)		
10 (Specify) b)		
11 R_T = TOTAL LINES 1-10	9.85	21.97
12 U = 1/R TOTAL	0.102	0.046

WALLS HEATING	AREA s.f.	GROSS AREA RATIO 1)	U VALUE	UxRATIO
13 GROSS WALL	1152	X	X	X
14 WINDOW	126	0.109	0.56	0.061
15 DOOR	34	0.030	0.19	0.006
16 OTHER (Specify)				
17 OTHER (Specify)				
18 OPAQUE WALL	2) 992	X	X	X
19 FRAMING	3) 149	0.129	5) 0.102	0.013
20 CAVITY	4) 843	0.732	6) 0.046	0.034
21 U_0 = TOTAL LINES 14, 15, 16, 17, 19, 20				0.114

TABLE A - STUD FRAMING RATIO

STUD SPACING	12"	16"	24"
RATIO	0.17	0.15	0.10

THESE FOOTNOTES APPLICABLE TO ALL PAGES

1) GROSS AREA RATIO equals ratio of individual areas to gross area. This ratio may be obtained by dividing each individual line area by the gross area. For example, the ratio of line 19 -

$$\text{FRAMING} = \frac{\text{Framing Area - line 19}}{\text{Gross Area - line 13}}$$

2) Line 18 OPAQUE AREA, equals line 13 AREA minus 14, 15, 16, and 17 AREA.
3) FRAMING AREA equals line 18 AREA times appropriate FRAMING RATIO TABLE A.
4) CAVITY AREA equals line 18 minus line 19 AREA.
5) Line 12 U VALUE for FRAMING.
6) Line 12 U VALUE for CAVITY.
7) GROSS AREA RATIO equals ratio of individual areas to gross area. This ratio may be obtained by dividing each individual line area by the gross area.
8) The U VALUES obtained from Table 5-1 or 5-2.
9) This U VALUE is the value indicated on line 21 page 1.
10) This U VALUE is the value indicated on line 21 page 2 for floors.
11) This U VALUE is the value indicated on line 21 page 2 for ceiling-roof.
12) U x Ratio Allowed total must be greater than U x Ratio Actual Total.
13) TABLE A RATIO.
14) TABLE B RATIO.

U_0 CALCULATIONS FOR FLOORS AND ROOF-CEILING

FLOOR HEATING	R VALUES FRAMING	R VALUES CAVITY
1 AIR FILM OUTSIDE	0.17	0.17
2 OUTER SURFACE		
3 OUTER SHEATHING		
4 FRAMING	6.88	
5 CAVITY a) INSULATION		19.0
6 b) AIR SPACE		
7 INSIDE SURFACE	0.82	0.82
8 AIR FILM INSIDE	0.61	0.61
9 OTHER a) Flooring	1.23	1.23
10 (Specify) b)		
11 R_T = TOTAL LINES 1-10	9.71	21.83
12 U = 1/R TOTAL	0.103	0.046

FLOOR HEATING	AREA (s.f.)	GROSS AREA RATIO 1)	U VALUE	UxRATIO
13 GROSS FLOOR	1232			
14 OTHER (Specify)				
15 OTHER (Specify)				
16 OTHER (Specify)				
17 OTHER (Specify)				
18 OPAQUE FLOOR	2) 1232			
19 FRAMING	3) 123	.10	5) 0.103	0.010
20 CAVITY	4) 1109	.90	6) 0.046	0.041
21 U_0 = TOTAL LINES 14, 15, 16, 17, 19, 20				0.052

JOIST OR RAFTER SPACING	12"	16"	24"
RATIO	0.13	0.10	0.06

TABLE A - JOIST OR RAFTER FRAMING RATIO

ROOF - CEILING HEATING	R VALUES FRAMING	R VALUES CAVITY
1 AIR FILM OUTSIDE	.68	.68
2 OUTER SURFACE		
3 OUTER SHEATHING	19.0	
4 FRAMING	6.88	
5 CAVITY a) INSULATION		38.0
6 b) AIR SPACE		
7 INSIDE SURFACE	0.45	0.45
8 AIR FILM INSIDE	0.61	0.61
9 OTHER a)		
10 (Specify) b)		
11 R_T = TOTAL LINES 1-10	27.62	39.74
12 U = 1/R TOTAL	0.036	0.025

ROOF - CEILING HEATING	AREA (s.f.)	GROSS AREA RATIO 1)	U VALUE	UxRATIO
13 GROSS ROOF-CEIL.	1232			
14 SKYLIGHT				
15 ROOF SCUPPER				
16 OTHER (Specify)				
17 OTHER (Specify)				
18 OPAQUE ROOF-CEIL.	2) 1232			
19 FRAMING	3) 123	0.1	5) 0.036	0.003
20 CAVITY	4) 1109	0.9	6) 0.025	0.023
21 U_0 = TOTAL LINES 14, 15, 16, 17, 19, 20				0.026

ENERGY AUDIT FOR THE HOME OF: ELECTRIC HOME 1990

DIMENSIONS OF THE BUILDING ARE:

FLOOR AREA	1232.00 SQUARE FEET	CEILING AREA	1232.00 SQUARE FEET
ROOF SECTION AREA	0. SQUARE FEET	NET WALL AREA	992.00 SQUARE FEET
SINGLE GLAZING AREA	0. SQUARE FEET	DOUBLE GLAZING AREA	126.00 SQUARE FEET
DOOR AREA	34.00 SQUARE FEET	VOLUME	9856.00 CUBIC FEET

NUMBER OF OCCUPANTS: 3 THERMOSTAT SETTINGS: DAYTIME 60. NIGHTTIME 65.

THE CALCULATED FUEL USE FOR HEATING THIS BUILDING IS : 12673. KWH OF ELECTRICITY.
THE CALCULATED FUEL USE FOR HEATING DOMESTIC HOT WATER IS: 4050. KWH OF ELECTRICITY.
THE ACTUAL FUEL USE FOR HEATING THIS BUILDING IS : 17000. KWH OF ELECTRICITY.

THE FOLLOWING FIGURES INDICATE HEAT LOST THROUGH THE VARIOUS PARTS OF THE BUILDING IN KWH OF ELECTRICITY.

	FUEL USE	PCT		FUEL USE	PCT
INFILTRATION LOSSES	5854.	46.19	CEILING CONDUCTION LOSSES	1119.	8.83
FLOOR CONDUCTION LOSSES	1632.	12.88	ROOF SECTION CONDUCTION LOSSES	0.	0.
WINDOW AND DOOR CONDUCTION LOSSES	2439.	19.24	WALL CONDUCTION LOSSES	1629.	12.85

ESTIMATED ENERGY SAVINGS AND PAYBACK PERIOD FOR ENERGY CONSERVATION OPTIONS.
ALL FUEL UNITS ARE REPORTED IN KWH OF ELECTRICITY.

BY SETTING YOUR THERMOSTAT AT 60 DEGREES DURING THE DAY AND 60 AT NIGHT YOU COULD SAVE UP TO 1148. KWH PER YEAR.

BY HAVING CAULKED AND WEATHERSTRIPPED AROUND YOUR DOORS AND WINDOWS, YOU ARE ALREADY SAVING ENERGY AND MONEY.

SINCE VERY LITTLE OF THE BASEMENT PERIMETER IS EXPOSED TO THE OUTSIDE YOU ARE LOSING VERY LITTLE HEAT THROUGH THE FOUNDATION.

YOU HAVE ALREADY INSULATED YOUR CEILINGS TO THE LEVEL RECOMMENDED FOR THIS AREA. YOU ARE HELPING TO CONSERVE ENERGY AND DOLLARS.

BY INSTALLING STORM WINDOWS AT A COST OF $ 0. YOU COULD SAVE UP TO 1. KWH PER YEAR.
THIS WILL PAY BACK YOUR INVESTMENT IN ABOUT 0. YEARS.

THE WALLS IN YOUR HOME ARE ALREADY INSULATED TO THE LEVEL RECOMMENDED FOR THIS AREA. YOU ARE CONSERVING ENERGY AND DOLLARS.

BY CARRYING OUT ALL OF THESE OPTIONS AT A COST OF $ 0.
YOU COULD SAVE UP TO 1. KWH PER YEAR.
THIS WILL PAY BACK YOUR INVESTMENT IN ABOUT 0. YEARS.

BY DECREASING THE TEMPERATURE OF YOUR DOMESTIC HOT WATER BY 20 DEGREES YOU COULD SAVE 810. KWH OF ELECTRICITY PER YEAR.

*** DISCLAIMER ***

THE FIGURES SHOWN ABOVE WERE COMPUTED USING INFORMATION SUPPLIED BY THE HOMEOWNER OR HIS/HER AGENT AND EQUATIONS SUPPLIED BY THE U.S. DEPARTMENT OF ENERGY. THESE FIGURES ARE SUPPLIED TO THE HOMEOWNER FOR INFORMATIONAL PURPOSES ONLY. NO GUARANTEE OF ENERGY SAVINGS IS MADE OR IMPLIED BY THE MAINE OFFICE OF ENERGY RESOURCES OR BY THE U.S. DEPARTMENT OF ENERGY.

I. Wall, Ceiling Roof Section, Window and Door Conduction Losses are calculated using the "Modified Degree Day" formula.[2]

$$Q = \frac{HDD_a \times 24 \times A}{R \times E_s \times FV} \times C_D \times C_F$$

where

Q = Heat loss in Fuel Units of the particular fuel.
HDD_a = Adjusted Heating Degree Days.[1]
24 = Hours per Day.
Area = Surface Area.
R = R value of the Surface
E_s = Steady State Efficiency of the Unit.
FV = Fuel value in BTU's/fuel unit.
C_D = Degree Day Correction Factor[2] = .941 - (.000038 x HDD).
C_F = Oversize Correction Factor.(2)

(1) Heating Degree Days are adjusted for thermostat setting using the following formula:

0.625 x 0.02 x (68.0 - Thermday) + 0.375 x 0.036 x (68.0 - Thermnite)

where

Thermday = Daytime thermostat setting.
Thermnite = Night time thermostat setting.
0.625 = Approximate number of hours of daytime thermostat setting.
0.02 = Percent savings per degree. Setback during the day (calculated from hourly temperature data).
0.375 = Average number of hours which thermostat is set on night setting.
0.036 = Percent savings per degree setback during the night (calculated from hourly temperature data).

(2) The "Modified Degree Day" formula and the coefficients:

C_D and C_F are taken from the ASHRAE Handbook and Product Directory, Systems Volume, 1976 Chapter 43.

C_D is a factor which relates to the fraction of degree days which are close to 65°F and is always less than 1.0.

C_F is a factor which relates to standby losses of fuel-fired heating equipment, and is always greater than 1.0 for fuel-fired equipment.

C_F is 1.0, by definition, for electric resistance and wood heating systems.

Fuel values of the various fuels are defined as

Oil	=	140,000 BTU/gallon
Electricity	=	3,413 BTU/kwh
Natural Gas	=	100,000 BTU/MLF
Coal	=	22,000,000 BTU/Ton
Wood	=	20,000,000 BTU/Cord

Steady State Efficiency is defined for fuels as follows:

Oil	0.70
Electricity	0.95
Natural Gas	0.80
Coal	0.50
Wood	0.50

II. Heat Loss by Infiltration is calculated using the formula:

$$Q = 0.017 \times HDD_a \times V \times DI \times CEP$$

where

Q = Heat loss in BTU's.
0.017 = BTU/cubic foot air/farenheit degree.
V = Volume of heated space.
DI = Draft Index = number of air changes per hour.
CEP = Coefficient of Effective Performance = $(C_D \times C_F)/(E_s \times FV)$.

III. Conduction losses through the floor or through the basement walls are calculated by various formulae depending on the characteristics of the house.

A. For heated basements with less than 2 feet of wall exposed above grade:

$$Q = HDD_a \times ((4 \times \sqrt{FA} \times 1.375) + (0.025 \times FA)) \times \frac{70 - (65 - HDD/365)}{32.4 + 0.006\ HDD} \times CEP$$

where

HDD_a = Adjusted Heating Degree Days.
FA = Floor Area.
1.375 = Average composite U value for basement walls.
0.025 = U value for basement floors.
70-(65-HDD/365) = Basement design temperature difference.(3)
32.4 + 0.006 HDD = Design temperature difference.(4)

(3) This factor is based on a 70° Indoor Design Temperature and an average outdoor temperature which can be represented by inverting the formula for calculating Heating Degree Days.

(4) This formula was calculated for Maine based on a linear regression of design temperature differentials (70°F - Outdoor Design Temperatures) against Degree Days. The formula should be re-calculated for other states to ensure accuracy.

B. For Basement walls with more than 2 feet exposed above grade level:

$$Q = HDD_a \times ((4 \times \sqrt{FA} \times 2.50) + (0.025 \times FA)) \times \frac{70-(65-HDD/365)}{32.4 \times 0.006\ HDD} \times CEP$$

This is the same as equation A except for the composite U value of the basement wall which is 2.50.

These formulae are based on the following assumptions:

A) The actual temperature of the ground outside the basement walls will not vary significantly from the Annual Average Outdoor Temperature. This fact has been documented in several technical journals.

B) Since the Basement walls "see" a design temperature differential equal to the difference between the indoor temperature and the ground temperature, this differential is the proper temperature differential to use in calculating the annual heat loss through the basement walls.

C. For unheated basements with less than 2 feet of wall area exposed above grade:

$$Q = NT - \frac{\frac{FA}{FR} \times AVT + 39\ ((4 \times \sqrt{FA} \times 1.375) + (0.025 \times FA))}{\frac{FA}{FR} + ((4 \times \sqrt{FA} \times 1.375) + (0.025 \times FA))} \times 6000 \times \frac{FA}{FR} \times CEP$$

where

AVT = Average temperature in the heated space.
FA = Floor area.
FR = Floor R value.
39 = Average ambient outdoor winter temperature in Maine*.
1.375 = Composite foundation wall U value.
0.025 = Composite foundation floor U value.
6000 = Average number of heating hours in Maine*.

*Note: Should be recalculated for other areas.

D. For unheated cellars with more than 2 feet of wall exposed above grade line.

The same formula as C except the composite wall U value equals 2.5.

These formulae are based on the following assumptions:

A) The heat loss through the floor to the basement must equal the heat loss from the basement to the ground.

B) The Temperature Differential between the house and the "unheated" basement can be calculated using assumption (A).

C) This temperature differential, multiplied by the number of heating hours in a heating season, will give an approximation of the "Degree Days" which should be used to calculate the heat loss from the heated space into the basement.

E. For insulated slabs:

$$Q = \frac{HDD_a \times 24 \times (4 \times \sqrt{FA}) \times 0.7 \times 65}{DT \times FR} \times CEP$$

where

HDD_a = Adjusted Heating Degree Days.
24 = Hours per day.
4 x FA = Approximation for the perimeter length.
0.7 = ASHRAE factor for slab insulation.
65 = Heat loss per linear foot of slab perimeter*.
DT = Design temperature (See III.A.).
FR = Floor R Value.

F. For uninsulated slabs:

The formula is the same as equation (E) except the Insulation Factor is 1.0 instead of 0.7.

*Taken from ASHRAE Handbook and Product Directory Fundamentals Volume 1977, Page 24.5.

G. For Crawl Spaces which are not skirted:

$$Q = \frac{HDD_a \times 24 \times FA}{RF} \times CEP$$

H. For Crawl Spaces which are skirted:

$$Q = \frac{HDD_a \times 24 \times FA \times 0.75}{RF} \times CEP$$

These values were taken from the "Project Retro-Tech" Booklet.

VI. THE PEAK DEMAND

Introduction

One of the crucial dimensions in deciding to add capacity to an electrical generating system is the growth in the peak demand because the utility is required to have enough capacity to supply the demand at all times. By definition the peak is the maximum hourly demand during the year.

The peak in any particular year is a function of weather (particularly temperature and wind), the normal level of demand during the year and the mix of demands among the various sectors. The weather is important in predicting the peak in any particular year, but is not very important in predicting a secular trend because weather patterns do not exhibit an annual secular trend. Furthermore, since weather presumably is not correlated with the other variables, its absence in a forecasting equation will not bias the remaining coefficient.[13/] The level of demand in any year is important because it suggests the scale of operations in effect when the peak occurs. As the total energy demand grows, so will the peak. The final influences on the peak is the mix of demands among the sectors. This mix is important because the various sectors have very different influences on the peak, as will be demonstrated below.

The Model

Since the load factors vary among sectors, one way to model the growth in peak demand is to relate this growth directly to the growth in each of the sectors. This approach directly captures both the scale effect and the effect of the mix on peak growth.

In this model this functional relationship is assumed to be linear. The implication is that for each sector the number of megawatts of peak power demand for each megawatt-hour consumed remains constant over time. Thus the

13/ It will, however, make the historical error rates higher than they otherwise would have been.

equation assumes that the changes in the system load factor are due entirely to shifts in demand among sectors with different load factors.

The Forecasting Equation

The equation used in forecasting the peak demand is:

$$\text{Peak}_t = \underset{(4.66)}{.261}\ \text{RSales}_t + \underset{(3.8)}{.164}\ \text{C + I Sales}_t + \underset{(0.93)}{.239}\ \text{OSales}_t$$

$\bar{R}^2 = .998$
d.w. = 1.68

where

Peak_t = the annual peak one hour demand in year t.

RSales_t = residential sales in year t.

C + I Sales_t = commercial and industrial sales in year t.

OSales_t = "other" sales including sales for resale and municipal lighting.

The implication of this equation is that the peak is rather more sensitive to residential sales than to sales in the commercial and industrial sector. Given the low load factors in the residential sector this is exactly as should be expected. Somewhat more surprising is the apparently low load factor in the "other sales" category. While this is an interesting result it is not very important for the forecast because it is such a small sector.

Validation

A comparison of the actual peak demands for the 1964-77 period with those obtained using the forecasting equation are presented as Table 19.

TABLE 19

ACTUAL VS. ESTIMATED PEAK DEMANDS (MW)
AND ERROR RATES

1965-1977

YEAR	ACTUAL	ESTIMATED	PERCENT ERROR
1965	545	534	-2.0
1966	556	549	-1.3
1967	598	585	-2.2
1968	631	632	0.2
1969	679	674	-0.7
1970	712	726	2.0
1971	794	776	-2.3
1972	836	864	3.3
1973	899	912	1.4
1974	942	958	1.7
1975	1009	985	-2.4
1976	1083	1065	-1.7
1977	1120	1131	+1.0

Average Absolute Error 1.70%

The Baseline Forecast

Using the forecasts of sectoral energy demand presented in the previous sections and the peak forecasting equation in this section, the forecast of peak demand can be generated. The results of this forecast are presented in Table 20.

TABLE 20

THE OER BASELINE FORECAST
OF PEAK DEMAND (MW)

1978-1990

1978	1979	1980	1981	1982	1983	1984	1985
1185	1192	1240	1312	1374	1443	1533	1585

1986	1987	1988	1989	1990
1628	1668	1704	1738	1823

This forecast implies a 3.7% annual growth in the peak demand. This is quite a bit lower than the 4.4% growth rate forecasted by CMP, but higher than the 3.5% OER baseline forecast of total system energy demand. Thus the OER baseline forecast envisions some deterioration of the load factor due to the relatively high expected growth rate in the residential sector which has a low load factor.

VII. A CONSERVATION SCENARIO

Introduction

Projections of future consumption and demand levels have thus far been assumed to grow according to the trends in historically significant variables in a steady state manner. However, due to the advent of recent and anticipated future energy conservation codes and incentives, and practical solar and other alternative technologies, an assumption can be made that future forecast levels of electric consumption and demand will be effectively lowered in the residential and commercial sectors by some derivably predictable amounts. Conservation-stimulated reductions can be calculated by disaggregating the significant factors within the two sectors and applying calculable consumption-reducing measures to them.

A Description of the Scenario

The residential and commercial sectors were considered separately to provide two independent sub-scenarios. The potential for electricity conservation in the residential sector was evaluated on the basis of expected saturation levels of solar heating equipment, both domestic hot water and space heat systems, on existing and new residential structures over the next few years through 1993. The potential for electricity conservation in the commercial sector was similarly evaluated on the basis of expected levels of electricity conservation on existing and new commercial structures over the next few years through 1990.

Solar Sub-Scenario

The following scenario reflects the electrical load displacement potential for existing solar technology in the CMP service area by 1993. To most accurately reflect actual potential, the study is limited to solar technologies which are practical and cost effective today in single family residential applications. The residential sector comprises only 40% of the overall electrical load. However, it appears to be the most likely area for significant solar market penetration in the near future, and the performance data on which the study is based is generally limited to applications requiring low grade heat (i.e. water heating and space heating). There are a number of commercial and industrial functions which could utilize the same low grade heat, but they have been excluded in the interest of accuracy and clarity.

The basic data for the study was generated by the Tennessee Valley Authority (TVA) in association with their 1000 system solar hot water loan program in Memphis. Several alternatives are considered separately to give an insight into each area. Certain applications hold greater potential for the type of widespread utilization needed to significantly decrease the demand for more electrical generating capacity. The separate cases assessed include both passive and active space heating and solar water heating, looking at both the new and retrofit potential in each case.

One important aspect should be noted when assessing the impact of solar energy on the utility load. Currently the utilities argue that while a solar system reduces their average daily demand, the potential still exists for all the solar owners to demand power at the same time during long cold cloudy periods; so it does little to reduce their annual peak demand. In recognition of this, the TVA installed timers on their systems to limit the use of auxiliary energy to off-peak hours. By doing so, they have implemented an excellent load management tool, which actually serves to give them greater control over their annual peak demand than they would have if their customers were using conventional water heaters. It would be a simple matter to modify existing solar tanks to accommodate this type of device. If the solar industry felt that it would increase their sales exponentially they would certainly take advantage of the opportunity. Much the same effect could be derived from an off-peak rate structure.

Solar Water Heating for Existing Customers

Note: The specifications for all hot water systems are considered to be identical. Previous studies indicate that this system most closely represents the average size, cost, and performance parameters. The typical features include 75 sq. ft. of collector area, 120 gallon storage tank, and $2,000 installed cost. The hot water load of the typical CMP customer (2.4 persons) was determined to be 48 gallons per day of 140°F water. The system described previously would provide 70% of that load on an annual basis. The TVA has estimated that each solar water heater, with a control on the auxiliary element, displaces the need for one (1) kilowatt of generating capacity.

According to the CMP forecast, there were 85,597 existing non-seasonal water heat only customers and 28,992 water and space heating customers in the CMP service area totaling 114,589 customers using electric hot water. More than 50% of those homes would not be potential solar retrofits due to excessive shading and improper orientation. So the potential exists to install 50,000 solar water heaters for existing hot water customers.

Solar Water Heating for New Construction

According to the CMP forecast, there will be 38,881 additional hot water customers in the CMP service area by 1988. With adequate site planning the problems of shading and improper installations can be virtually eliminated, resulting in the potential participation of 90% of all new housing. This translates to 35,000 potential hot water customers in new residential construction.

Solar Space Heating in Residential Retrofits

According to the CMP forecast there were 2875 existing non-seasonal space heating only customers and 28,992 water and space heating customers in the CMP service area in 1978, totaling 31,867 customers using electric heat. The potential exists to cost-effectively derive over 60% of a building's heat load from a solar space heating system. Active solar space heating is one of the most adaptable solar retrofits but the initial cost is relatively high in comparison with other solar alternatives. As industries improve active solar economics, these systems will become cost-competitive, and therefore, more highly used for retrofit systems. The most cost effective solar space heating retrofit, the attached solar greenhouse, is primarily a food producer with the capability to provide 10% or more of the typical home space heating load.

About 60% of existing customers' homes would not be potential solar retrofits due to excessive shading and improper orientation. So the potential exists to retrofit 30,000 solar space heating systems onto existing buildings. The assumption is made that two-thirds of these systems would be solar greenhouses or porches contributing 0.5 kilowatt for 20,000 potential customers and that one-third of these would be space heat systems contributing 3 kilowatts for 10,000 potential customers.

Solar Space Heating in New Construction

Solar space heating in new homes currently poses the greatest impact on the load demand on a per unit basis. Passive solar space heating and site-built active air systems are presently one of the simplest and most cost effective solar technologies, and are adaptable for use in any new homes. There are two possible levels of implementation in this area. The first alternative is the more sophisticated system using a site built active air collector or a state-of-the-art passive home. Those would require somewhat unconventional building techniques, but they would meet between 60-70% of the building's space heating needs.

The second possibility, and the most realistic for immediate application, but perhaps not as desirable as a solar designed home in the near future, is the sun-tempered conventional house. These buildings are merely well-insulated conventional homes oriented on an east west axis, and the windows are sized and arranged so as to maximize the impact of the southern exposure. These homes look nearly identical to conventional style homes and can be built at no additional cost to the builder. With these minimal adjustments the house can obtain over 30% of its space heating load from the sun, displacing 1.5 kilowatts of generating capacity per unit. For the sake of comparison, and for a conservative approach, this type of system will be compared to the solar greenhouse which provides only 0.5 kilowatts of demand.

According to the CMP forecast, there will be 36,996 additional space heat customers in the CMP service area by 1988. With adequate site planning the problems of shading and improper orientation encountered in retrofit installations can be nearly eliminated resulting in the potential participation of 80% of all new housing. Due to the increased use of wood heat systems to supply space heat, the above conservation approach is taken in considering the beneficial effects of solar technology applied to residential buildings. Appendix VII shows the results of the solar scenario and the effect on electric consumption and peak demand on the residential sector.

Summary

If solar energy were utilized according to the expected levels indicated above in the CMP service area, a reduction of 26 megawatts of peak demand would be realized. If policies and technology result in a concentrated effort to maximize the benefits of solar energy as a space and water heating fuel, it is conceivable that, for the residential sector alone, the peak demand could be reduced by 75 to 100 megawatts below previously predicted values by, and after, 1988.

Commercial Conservation Sub-Scenario

To consider the potential for electricity conservation, the commercial sector must be disaggregated by building function to account for differing lighting, power, heating, cooling and other ratios, operating schedules, and building saturations. Assuming the Central Maine Power Company marketing area to be not significantly different in commercial composition to New England as a whole, Appendix I Table 1 indicates type use ratios of total electric consumption for the disaggregated commercial sector in 1977. A cross section of the demand for electricity in the one year 1977 is sufficient for estimating conservation levels since the impact of newly-initiated conservation methods will affect present, not past, conditions. Appendix I Table 2 gives an example of electric consumption by building function and end use in megawatt-hours using Table 1 for the CMP marketing area in 1977.

New conservation-oriented programs are beginning to attack excessive and wasteful energy use on the basis of economics. Public schools, hospitals, and municipal buildings, audited for energy consumption with accompanying cost-effective recommendations and supplemental funding, are already showing reductions on energy (and more appropriately, electricity) consumption. Offices and retail stores will comply with lighting codes and respond to energy audits which are becoming easily available. Appropriate insulation, more effective controls for heating and cooling systems, lighting reductions, and solar technology applications will reduce electric consumption as a result of careful energy design for new construction.

The percentages of electricity savings which are expected by encorporating the lighting code retroactively into existing buildings are summarized in Appendix II.

The percentages of electricity savings which are expected with normal conservation measures applied by a building code are also given in Appendix II for new construction.

Lighting standards for existing commercial buildings and overall energy standards for new commercial buildings are expected to be introduced entirely in 1981. Therefore, all reductions in energy consumption as a result of the conservation code are estimated beginning in 1981 and are continued through 1990.

New Construction

The rate of new construction of offices, retail stores, and miscellaneous buildings was arrived at through manipulation of employment data and average square feet of building area per employee for SIC codes which correspond to non-manufacturing employment data for those SIC codes. The years 1967 and 1977 were used as sample years to project the average annual growth rates of new building area as shown in Appendix III. School construction was assumed to grow with school enrollment data over the same period of time. In year 1977 data for total school building area provided a base year from which to calculate new construction. Total 1977 electric consumption by hospitals, from Appendix I Table 2, was used with 1977-78 data for kilowatt-hours per square foot from a representative sample of hospitals. This provides a 1977 basis for hospital area. Appendix IV provides 1967 and 1977 base year data for total floor space and average yearly growth rates by building type, and subsequent yearly total floor space and percent of total floor space data through 1990. Floor space is growing slower than the forecast for electric sales to the commercial sector. This is not surprising since the construction of more energy-intensive structures have been the rule in recent years.

The Effect of Conservation

To remain conservative, the ratio of each year's new floor space to the total previous year's floor space determines the percentage of relative sales attributed to new construction by the original OER forecast. Electric sales attributed to old structures and new construction are then derived and are shown in Appendix V. Using these figures and percent savings data from Appendix II, the conservation forecast for electric consumption by the commercial sector are given in Appendices V and VI.

The Forecast

The commercial conservation scenario predicts a 1978-1988 average annual growth rate of 4.0 compared to the original OER forecast of 4.8 and CMP's forecast of 5.3. As time increases, the percent reduction in electric consumption due to conservation increases. The cause of this is the increasing percentages of new structures adhering to building energy standards. The solar scenario predicts a 1978-1988 average annual growth rate of 3.7 compared to the original OER forecast of 4.1 and CMP's forecast of 3.7. As time increases, the percent reduction in electric consumption due to solar energy utilization increases. The cause of this is the increasing percentages of new and existing structures installing solar energy equipment. The combined effect of the two sub-scenarios on the peak demand are tabulated in Appendix VIII.

APPENDIX I

TABLE 1

PERCENTAGE OF ELECTRIC CONSUMPTION BY BUILDING FUNCTION AND END USE (%) [(a)]

	Office	Retail	Hospital	School	Other
Space Heat	0.9	0.5	0.1	0.6	0.2
Air Conditioning	2.2	2.9	0.4	1.4	1.3
Light and Power	8.9	27.9	3.1	9.7	3.5
Auxiliary	8.1	14.4	0.8	6.2	6.9

TOTAL = 100%

TABLE 2

ELECTRIC CONSUMPTION BY BUILDING FUNCTION AND END USE (MWH) IN 1977

	Office	Retail	Hospital	School	Other
Space Heat	10,126	5,626	1,125	6,751	2,250
Air Conditioning	24,753	32,628	4,500	15,752	14,627
Light and Power	100,135	313,907	34,879	109,136	39,379
Auxiliary	91,134	162,017	9,001	69,757	77,633
TOTAL	226,148	514,178	49,505	201,396	133,889

a) These percentages were derived from a table by Energy Systems Research Group, Inc. in Electric Power Measures During an Oil Shortage by Andrew L. Niven, Staff Director for the New England Conference of Public Utilities Commissioners, Inc., March 15, 1979.

APPENDIX II

PERCENTAGE OF ELECTRIC CONSUMPTION SAVED BY BUILDING FUNCTION AND END USE (%)[(a)]

Existing	Office	Retail	Hospital	School	Other
Space Heat	0	0	0	0	0
Air Conditioning	0	0	0	0	0
Light and Power	20	10	5	12	6
Auxiliary	0	0	0	0	0
New					
Space Heat	25	30	20	30	30
Air Conditioning	20	25	15	25	25
Light and Power	15	15	10	15	15
Auxiliary	10	10	10	20	20

a) Long Range Forecast of Electric Energy and Demand in New Hampshire, Energy Systems Research Group, Inc., Boston, MA, March 1, 1979. Maine was assumed to be similar to New Hampshire for electric use by building type and building mix due to proximity of climate and distance. The table for existing buildings was derived assuming a moderate approach to conservation. Since a retroactive lighting code would effect only lighting on existing buildings, 40% of light and power savings estimates were used. The table for new buildings was taken from the source directly and assumes the "lightest" application of a conservation policy.

APPENDIX III

BUILDING TYPE	SIC CODE	AVERAGE AREA[a] PER EMPLOYEE(SQ.FT.)	EMPLOYEES[b] 1967	1977	TOTAL AREA (X1000 sq. ft.) 1967	1977
Office	60	155	3841	5968	595.4	925.0
	61	214	1019	1089	218.1	233.0
	62	176	287	314	50.5	55.3
	63	149	2728	3979	406.5	592.9
	64	149	1357	1837	202.2	273.7
	65	390	1287	1452	501.9	566.3
	66	187	244	353	45.6	66.0
	67	156	86	126	13.4	196.6
	91	189	17946	17035	3391.8	3219.6
	92	183	13399	20600	2452.0	3769.8
	93	383	28191	39634	11079.1	15576.2
	81	211	756	1665	159.5	351.3
	83	216	3849	5204	831.4	1124.1
	89	312	1011	2717	315.4	847.7
	73	275	2054	3706	564.9	1019.2
Retail	53	271	7720	7853	2092.1	2128.2
	54	509	8507	12194	4330.1	6206.7
	55	502	8032	9984	4032.1	5012.0
	56	532	2676	3158	1423.6	1680.1
	57	878	1717	2065	1507.6	1813.1
	58	270	7320	17382	1976.4	4693.1
	59	444	6034	9116	2679.1	4047.5
Other	50,51	682	14610	18601	9964.0	12685.9
	52	987	3150	3402	3109.1	3357.8
	42	3162	4190	4425	13248.8	13991.9
	41	280	1031	974	288.7	272.7
	44	139	465	899	64.6	125.0
	45	809	107	383	86.6	309.8
	46	8050	166	112	1336.3	901.6
	47	780	122	259	95.2	202.0
	48	177	4141	5091	733.0	901.1
	70	837	4004	6072	3351.3	5082.3
	72	304	3257	3246	990.1	986.8
	75	275	1434	2109	2039.1	2999.0
	76	270	342	855	92.3	230.9
	78	777	565	515	439.0	400.2
	79	871	982	1874	855.3	1632.3
	84	2000	13	144	26.0	288.0
	86	860	3145	4252	2704.7	3656.7
	40	187	3826	2709	715.5	506.6

	TOTAL 1967	TOTAL 1977
Office	20,827.7	28,816.7
Retail	18,041.0	25,580.7
Other	40,139.6	48,530.6
	(X 1000 sq. ft.)	

a) Kaufman, H., et. al., "Energy Consumption in Commercial Industries by Census Division - 1974". Jack Faucett Associates, March 1977, PB-268851, and;

Ide, Edward, "Estimating Land and Floor Area Implicit in Employment Projections," for US/DOT, July, 1970, PB-200-069, as cited in;

Long Range Forecast of Electric Energy and Demand in New Hampshire, Energy Systems Research Group, Inc., Boston, MA, March 1, 1979.

b) "Maine's Statewide Total Wage and Salary Employment in Selected Industries by Standard Industrial Classifications," Maine Employment Security Commission, various years.

APPENDIX IV

TYPE	1967 BASE YEAR (X 1000 sq. ft.)	1977 BASE YEAR (X 1000 sq. ft.)	AVERAGE YEARLY GROWTH RATES(%)
Office[a]	20,827.7	28,816.7	3.30
Retail[a]	18,041.0	25,580.7	3.55
Hospital[b]	2,412.4	3,094.1	2.52
School[c]	19,507.0	21,000.0	0.74
Other[a]	40,139.6	48,530.6	1.92
TOTAL	100,927.7	127,022.1	2.33

YEAR

TYPE	1978	1979	1980	1981	1982	1983
Office	29,767.7	30,750.0	31,764.7	32,813.0	33,895.8	35,014.4
Retail	26,488.8	27,429.2	28,402.9	29,411.2	30,455.3	31,536.5
Hospital	3,172.1	3,252.0	3,334.0	3,418.0	3,504.1	3,592.4
School	21,155.4	21,311.9	21,469.7	21,628.5	21,788.6	21,949.8
Other	49,462.4	50,412.1	51,380.0	52,366.5	53,371.9	54,396.6
TOTAL	130,046.4	133,155.2	136,351.3	139,637.2	143,015.7	146,489.7
% INCREASE	2.38	2.39	2.40	2.41	2.42	2.43

YEAR

TYPE	1984	1985	1986	1987	1988	1989	1990
Office	36,169.9	37,363.4	38,596.4	39,870.1	41,185.8	42,545.0	43,948.9
Retail	32,656.0	33,815.3	35,015.7	36,258.8	37,546.0	38,878.9	40,259.1
Hospital	3,682.9	3,775.7	3,870.9	3,968.4	4,068.4	4,171.0	4,276.1
School	22,112.2	22,275.9	22,440.7	22,606.8	22,774.1	22,942.6	23,112.4
Other	55,441.1	56,505.5	57,590.4	58,696.2	59,823.1	60,971.7	62,142.4
TOTAL	150,062.1	153,735.8	157,514.1	161,400.3	165,397.0	169,509.2	173,738.9
% INCREASE	2.44	2.45	2.46	2.47	2.48	2.49	2.50

a) From Appendix III.

b) Total electric sales to hospitals was taken from Appendix I Table 2. From a representative example of 23 Maine hospitals given by the Maine Hospital Association, Augusta, ME, average electric consumption in hospitals in 1977-78 is 16 kilowatt-hours per square foot. Division of the former by the latter yields the 1977 base year. The growth rate in hospital beds in Maine, from Statistical Abstracts of the United States, U.S. Department of Commerce, Bureau of the Census, 1968, 1978, was used to back-cast the 1967 base year datum for example, and to forecast yearly growth through 1990.

c) The 1977 base year datum was provided by the Maine Department of Education, as was data for enrollment in 1967 and 1977. Enrollment growth rate was used to determine both growth in building area and the 1967 base year datum, for example.

APPENDIX V

ELECTRIC SALES (MWH)

	ORIGINAL FORECAST			CONSERVATION FORECAST				
YEAR	TOTAL[a]	EXISTING[b]	NEW[b]	EXISTING	NEW	CARRY-OVER[c]		TOTAL[d]
1978	1,300,408	1,269,458	30,950			YEARLY	ACCUMULATED	
1979	1,268,464	1,238,148	30,316	I	II		III	
1980	1,295,231	1,264,146	31,085					
1981	1,418,882	1,384,687	34,195	1,300,235	28,965	0	0	1,329,200
1982	1,523,942	1,487,063	36,879	1,398,561	31,239	5230	5230	1,415,570
1983	1,636,389	1,596,625	39,764	1,503,969	33,682	5640	10870	1,526,781
1984	1,771,670	1,728,441	43,229	1,630,709	36,617	6082	16952	1,650,374
1985	1,855,576	1,810,114	45,462	1,710,468	38,508	6612	23564	1,725,412
1986	1,924,664	1,877,317	47,347	1,776,788	40,105	6954	30518	1,786,375
1987	2,001,173	1,951,744	49,429	1,850,170	41,869	7242	37760	1,854,279
1988	2,074,555	2,023,106	51,449	1,920,878	43,580	7560	45320	1,921,058
1989	2,151,846	2,098,265	53,581	1,995,426	45,386	7869	53189	1,987,623
1990	2,312,950	2,255,126	57,824	2,148,037	48,980	8195	61384	2,135,633

a) From Table 3, Commercial Sector.

b) These figures were established by applying the percentages of new construction to total sales data.

c) These data are yearly savings carry-over from new construction which are subtracted from electric consumption attributed to the lighting code for existing buildings.

d) Column I plus Column II minus Column III.

APPENDIX VI

	ELECTRIC SALES (MWH)		PERCENTAGES		
YEAR	ORIGINAL	CONSERVATION	DEMAND REDUCTION[(a)]	NEW BUILDINGS[(b)]	ACCUMULATED EXISTING BUILDINGS[(c)]
1978	1,300,408	1,300,408	0		
1979	1,268,464	1,268,464	0		
1980	1,295,231	1,295,231	0		
1981	1,418,882	1,329,200	6.32	2.41	100.00
1982	1,523,942	1,424,570	6.52	2.42	97.58
1983	1,636,389	1,526,781	7.18	2.43	95.15
1984	1,771,670	1,650,374	7.35	2.44	92.71
1985	1,855,576	1,725,412	7.54	2.45	90.26
1986	1,924,664	1,786,375	7.74	2.46	87.80
1987	2,001,173	1,854,279	7.92	2.47	85.33
1988	2,074,553	1,921,058	7.99	2.48	82.85
1989	2,151,846	1,987,623	8.26	2.49	80.36
1990	2,312,950	2,135,633	8.30	2.50	77.86

a) Percent of conservation forecast to original OER forecast.

b) Percent of new construction to existing buildings in each year.

c) Percent of existing buildings in each year to existing buildings in 1981.

APPENDIX VII

TABLE 1

SOLAR WATER HEAT

	EXISTING CUSTOMERS			NEW CUSTOMERS		
YEAR	50% POTENTIAL CUSTOMERS [a]	PARTICIPANTS (%) [b]	REDUCTION (MW) [c]	90% POTENTIAL CUSTOMERS [d]	PARTICIPANTS (%) [b]	REDUCTION (MW) [c]
1978	50,000	0	0	0	0	0
1979		.1	.05	4,025	.1	0
1980		.5	.25	7,250	.5	.04
1981		1.5	.75	10,550	1.5	.16
1982		2	1.0	14,025	2	.3
1983		4	2.0	17,600	4	.7
1984		7	3.5	21,350	7	1.5
1985		10	5.0	25,400	10	2.5
1986		13	6.5	29,325	13	3.8
1987		16	8.0	32,575	16	5.2
1988		20	10.0	35,000	20	7.0
1989		23	11.5	37,325	23	8.6
1990		25	12.5	39,550	25	9.9
1991		27	13.5	41,425	27	11.2
1992		29	14.5	43,200	29	12.5
1993	50,000	30	15.0	44,875	30	13.5

a) 50,000 is about 50% of all existing water heating customers as described in the text as being possible hot water retrofits.

b) These percentages were selected to model the trend in solar hot water system installation which can be expected from the rising availability of solar systems.

c) These figures were calculated by applying the participation percentages to potential customers using 1 kilowatt reduction in demand per system.

d) These numbers were calculated by adding each year's forecast for new customers as given in the CMP forecast and applying the 90% factor for possible solar utilization.

TABLE 2

SOLAR GREENHOUSE AND SUN-TEMPERED HOME

	EXISTING CUSTOMERS			NEW CUSTOMERS		
YEAR	40% POTENTIAL CUSTOMERS (a)	PARTICIPATION (%) (b)	REDUCTION (MW) (c)	80% POTENTIAL CUSTOMERS (d)	PARTICIPATION (%) (b)	REDUCTION (MW) (c)
1978	9000	0	0	0	0	0
1979		.05	0	2325	.05	0
1980		.1	0	4150	.2	0
1981		.3	.01	6025	.5	.02
1982		.5	.02	8025	1	.04
1983		1	.04	10050	4	.2
1984		2	.09	12200	8	.5
1985		4	.18	14525	12	.9
1986		6	.27	16800	15	1.3
1987		8	.36	18650	18	1.7
1988		10	.45	20000	20	2
1989		12	.54	21300	21	2.2
1990		14	.63	22525	22	2.5
1991		15	.68	23575	23	2.7
1992		16	.72	24550	24	2.9
1993	9000	17	.77	25475	25	3.2

a) About 40% of existing space heat customers or 12,000, could retrofit with solar greenhouses. It is assumed that three-quarters would select a solar greenhouse rather than an active space heat system.

b) These percentages were selected to model the trend in solar greenhouse construction which can be expected from the awareness of the greenhouse as a heating and food-producing alternative.

c) These figures were calculated by applying the participation percentages to potential customers using 0.5 kilowatt reduction in demand per greenhouse.

d) These numbers were calculated by adding each year's forecast for new space heat customers as given in the CMP forecast, assuming that two-thirds would select a solar greenhouse or sun-tempered home rather than a solar designed active or passive system, and applying the 80% factor for possible solar utilization.

TABLE 3

SOLAR SPACE HEAT

	EXISTING CUSTOMERS			NEW CUSTOMERS		
YEAR	40% POTENTIAL CUSTOMERS[a]	PARTICIPATION (%)[b]	REDUCTION (MW)[c]	80% POTENTIAL CUSTOMERS[d]	PARTICIPATION (%)[b]	REDUCTION (MW)[c]
1978	3000	0	0	0	0	0
1979		.01	0	1150	.01	0
1980		.02	0	2075	.02	0
1981		.04	0	3000	.1	.01
1982		.1	.01	4000	.5	.06
1983		.5	.05	5025	1	.15
1984		1	.09	6100	3	.55
1985		2	.18	7250	5	1.1
1986		4	.36	8400	10	2.5
1987		5	.45	9325	15	4.2
1988		6	.54	10000	20	6.0
1989		7	.63	10650	25	8.0
1990		7.5	.68	11250	30	10.1
1991		8	.72	11800	31	11.0
1992		8.5	.76	12275	32	11.8
1993	3000	9	.81	12750	33	12.6

a) About 40% of existing space heat customers, or 12,000, could retrofit with active or hybrid passive solar space heat systems. It is assumed that one-quarter would select such a system rather than a solar greenhouse.

b) These percentages were selected to model the trend in retrofitted solar space heat system which can be expected from the development of solar technology which will become cost-competitive.

c) These figures were calculated by applying the participation percentages to potential customers using 3 kilowatts reduction in demand per system.

d) These numbers were calculated by adding each year's forecast for new space heat customers as given in the CMP forecast, assuming that one-third would select a space heat system rather than a greenhouse or sun-tempered home alone, and applying the 80% factor for possible solar utilization.

TABLE 4

EFFECT OF THE SOLAR SUB-SCENARIO

YEAR	ORIGINAL FORECAST PEAK (MW)	TOTAL REDUCTION (MW)[c]	TOTAL RESIDENTIAL SALES (GWH)[b]	PEAK SOLAR SAVINGS (%)
1978	1185	0	2314	0
1979	1192	.07	2337	0
1980	1240	.29	2421	0
1981	1312	.95	2536	0.1
1982	1375	1.43	2660	0.1
1983	1444	3.14	2793	0.3
1984	1533	6.23	2949	0.4
1985	1585	9.86	3074	0.6
1986	1628	14.73	3175	0.9
1987	1668	19.91	3262	1.2
1988	1704	25.99	3329	1.5
1989	1738	31.47	3395	1.8
1990	1823	36.31	3516	2.0
1991	1887[a]	39.80	--	2.2
1992	1953[a]	43.18	--	2.3
1993	2021[a]	45.88	--	2.3

a) These estimates were derived by extrapolation using the OER 1978-1988 growth rate for peak demand.

b) Since the solar scenario dealt directly with demand and not with overall consumption of electricity, these numbers were, for the sake of visualization, computed by applying the peak equation coefficient for the residential sector to the new calculated peak forecast.

c) Yearly totals of demand reduction from Tables 1,2, and 3.

APPENDIX VIII

EFFECTS ON CONSERVATION SCENARIO

FIGURES IN MEGAWATTS

YEAR	ORIGINAL FORECAST PEAK	RESIDENTIAL REDUCTION[a]	COMMERCIAL REDUCTION[b]	NEW FORECAST PEAK
1978	1185	0	0	1185
1979	1192	.07	0	1192
1980	1240	.29	0	1240
1981	1312	.95	0	1311
1982	1375	1.43	.85	1373
1983	1444	3.14	1.8	1439
1984	1533	6.23	2.8	1524
1985	1585	9.86	3.9	1571
1986	1628	14.73	5.0	1608
1987	1668	19.91	6.2	1642
1988	1704	25.99	7.4	1671
1989	1738	31.47	8.7	1698
1990	1823	36.31	10.1	1777
1991	1887[c]	39.80	11.6[d]	1836
1992	1953[c]	43.18	13.1[d]	1897
1993	2021[c]	45.88	14.7[d]	1960

a) Appendix VII, Table

b) These figures were calculated by applying the peak equation coefficient for combined commercial and industrial sales to the accumulated savings for the commercial conservation scenario from Appendix V, Column III.

c) These figures were derived by extrapolation using the OER 1978-1988 growth rate for peak demand.

d) These figures are extrapolations to provide a visual representation of the new forecast to 1993.

VIII. THE DEMAND FOR GENERATING CAPACITY

Introduction

The overriding question of whether (and when) the Searsport plant will be needed can be decomposed into two related questions. First, is there a need for generating capacity of the magnitude represented by the Searsport plant, and, if so, when will that capacity be needed? Secondly, is the Searsport plant the best approach to supplying that capacity? In this report we address only the first of these questions.

The question of whether and when this magnitude of generating capacity would be needed depends on the level of peak demand in future years. This level of peak demand, in turn, depends on economic conditions and on the policy initiatives undertaken to stimulate conservation. In the preceeding sections an econometric forecasting model has been developed and used to estimate a baseline forecast. This forecast was then used to develop a conservation scenario, which is intended to capture, in an admittedly rough way, the degree to which the need for capacity can be delayed by expected trends in energy conservation and solar technology.

In the next section a direct comparison of the CMP forecast with the two OER forecasts is presented. In the final section the implications of these forecasts on the timing of the need for generating capacity of the magnitude represented by the Searsport plant are discussed.

A Comparison of the Forecasts

The results of these forecasts are presented in Tables 21 and 22. Several characteristics of these forecasts are discernable. Both OER forecasts are lower than the CMP forecast. For 1978 the OER forecast predicts the total system demand exactly, but predicted a higher peak than actually occurred. The reader is cautioned not to put much stock in these latter two characteristics.

The exact prediction of 1978 energy demand is not an indication of the superiority of the OER model, because as can be seen it results from an under prediction in the residential sector which just happens to cancel out the overprediction in the commercial and industrial sector. Likewise one should not make too much of the overprediction of the peak because not long after the beginning of the new year the peak was already well beyond that predicted by the OER model.

TABLE 21

A COMPARISON OF THE CMP FORECAST WITH THE TWO OER SCENARIO FORECASTS (1978 and 1988)

	1978				1988		
	CMP	OER BASELINE	OER CONSERVATION	ACTUAL	CMP	OER BASELINE	OER CONSERVATION
Residential Sales (GWH)	2341	2291	2291	2320	3379	3429	3329
Commercial and Industrial Sales (GWH)	3381	3425	3425	3397	5445	4693	4539
Other Sales (GWH)	128	128	128	127	168	168	168
Total Sales (GWH)	5850	5844	5844	5844	8992	8290	8036
Peak (MW)	1169	1185	1185	1173.3	1796	1704	1671

TABLE 22

FORECASTED ANNUALIZED COMPOUND GROWTH RATES

1978-88

	CMP	OER BASELINE	OER CONSERVATION
Residential	3.7%	4.1%	3.8%
Commercial	5.3%	4.8%	2.9%
Industrial	4.5%	2.1%	2.1%
Other	2.8%	2.8%	2.8%
Total	4.4%	3.5%	3.2%
Peak	4.4%	3.7%	3.5%

The Implications for Generating Capacity

Since the peak demand ultimately determines the need for generating capacity and all scenarios forecast growth in peak demand, eventually some generating capacity of the magnitude represented by the Searsport plant will be needed.14/ The question is "when?"

One way to answer this question is to use the benchmark provided by the CMP forecast. The CMP planners have argued that the plant will be needed in 1987. Their forecast of peak demand in that year is 1741 megawatts. Without forming a judgement on whether or not 1741 megawatts is the level of demand which justifies the construction of the Searsport plant it is instructive to compute the dates at which the peak demand reaches 1741 megawatts.

The OER baseline forecast suggests that this 1741 figure will be reached sometime early in the year during 1990. This is approximately two years later than the date suggested by the CMP planners.

14/ The reader should note the distinction here between "the need for generating capacity of the magnitude represented by the Searsport plant" and " the need for the Searsport plant." The latter depends on the former plus some evidence that the Searsport plant represents the best approach to obtaining that generating capacity, a subject not treated in this report.

The OER conservation scenario suggests that the need for this capacity could be delayed until somewhat later in 1990 than the need under the baseline scenario. It is clear that the effect of this particular conservation scenario is not terribly large. It seems clear that if conservation is to play a role in delaying the need for generating capacity significantly, the program would have to be much more vigorous than the program analyzed in this scenario.

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Office of Energy Resources
Technical Report
Supplement

INTENSIVE ENERGY CONSERVATION SCENARIO

By:

Alfred Maxwell
Office of Energy Resources
Augusta, ME 04330

Introduction

The OER baseline forecast was generated assuming a consistant relationship between electricity consumption and the exogenous variables used in the econometric equations. The OER conservation scenario modified these relationships to model recent changes resulting from the advent of solar technology and initiation of a building code. The latter forecast showed a fairly small impact on electric demand. A more intensive energy conservation program could have a large impact on electric demand without affecting "normal" economic and health standards. Such changes cannot be modeled directly in an econometric study due to the independence of economic/demographic variables and engineering variances (resulting from conservation) in electricity use. However, the impact of an intensive energy conservation scenario can be derived separately and be used to modify the OER baseline forecast as was done for the original OER conservation scenario.

Criteria for a Data Base

It is important to note the factors involved in this intensive conservation scenario so that the impact of these factors can be estimated to derive a new forecast for electric demand. Much of the groundwork was laid in the original OER conservation scenario and, as such, should be used as a reference to explain any unclear areas in the text of this supplement. The concepts and methods for determining the impact of conservation will remain the same, but the level of intensity will be increased to reflect the results of a vigorous program. A summary of the factors which were considered to generate the intensive conservation scenario are listed below.

- Residential Sector
  - Existing buildings
    - Solar hot water heat (OER report - Page 78).[1/]

      There is a potential for solar hot water systems to be installed for 50,000 customers, each displacing one kilowatt of electric demand. (Table 4).

    - Solar space heat (OER report - Page 79).

      (Note: The conservation scenario in the original OER report erroneously reported 30,000 potential space heat retrofits on Page 79. The number used for calculating savings -- the real number -- in that scenario was 12,000.) Twelve thousand homes could be retrofitted with solar space heating systems, from greenhouse additions to active integrated space heat systems, displacing from 0.5 to 3 kilowatts of electric demand per installation. (Tables 5 and 6)

    - Thermal envelope improvements

      Considerable energy could be saved with improvements in this area through an intensive program aimed at the household consumer, involving general awareness, retrofit education courses, home energy audits, tax incentives, and low interest loans. Between 1.0 and 2.7 megawatt-hours of electricity per year (3.4 and 8.9 x 10^6 BTU respectively at .95 conversion efficiency) could be saved for each existing electrically-heated structure.[2/] (Table 7)

1/ All notes of this type refer to the OER Technical Report. Electric Demand in the Central Maine Marketing Area: An Econometric Forecast where additional data and text is presented to verify the criteria in the supplement.

2/ "Energy Conservation in Maine: Weatherization Improvements to the Existing Housing Stock," Urban Planning Policy Analysis and Administration, Department of City and Regional Planning, Harvard University, Cambridge, MA, June 1977.

- New construction
  - Solar hot water heat (OER report - Page 78)

    There is a potential for solar hot water heat to be utilized by 35,000 new customers by 1988, each displacing one kilowatt of electric demand. (Table 4)
  - Solar space heat (OER report - Page 79)

    By 1988, 30,000 new electrically heated homes could incorporate solar space heating, from greenhouse additions and sun-tempered dwellings to integrated passive or active solar heating systems, displacing from 0.5 to 3 kilowatts of electric demand per unit. (Table 5 and 6)
  - Thermal envelope performance

    Between 1.0 and 2.7 megawatt-hours per year could be saved on various building types by assuming high standards of thermal performance in each new electrically-heated building. (Table 7)

- Commercial Sector
  - Existing buildings

    Through a vigorous program of energy education and energy management, the commercial sector may show large reductions in electric consumption without adversely affecting 'normal' operating procedures. Schools, hospitals, and municipal and State government offices are currently receiving energy audits and technical assistance to improve energy performance. Retail stores and other buildings could be enticed by proper incentives, educated by an intensive program, and forced by economics and energy standards to manage and modify energy consumption levels. Electricity requirements could be reduced by significant percentages for space heat, air conditioning, lighting, and auxiliary power. (Table 2)

- New construction

  With energy-conscious design, careful site planning, and building standards, new construction in the commercial sector would show a larger reduction in electric demand than existing buildings.

Assumptions for a Scenario

- Solar water heat

In the original OER conservation scenario, the assumption was made that 20% of both existing and new 'potential' customers would incorporate solar heating systems by 1988. This estimate was used to determine expected trends in solar energy and may seem over-ambitious, particularly with respect to existing buildings. However, a concerted effort to introduce solar hot water heating systems by tax incentives, financial assistance (by private or public institutions), and intensive marketing could result in at least the same level of participation (20%) for existing customers and a much higher level of participation (50%) for new structures by 1988.

- Solar space heat

Low level technology such as solar greenhouse additions on existing buildings and new dwellings were assumed to have higher sun-tempered participation levels in 1988 for 'potential' customers than in the original OER conservation scenario; 12% opposed to 10% for existing buildings and 90% opposed to 20% for new construction. This was done to reflect a very vigorous conservation policy which greatly affects new construction.

High level technology assumed the same level of participation for active system retrofits as in the original OER conservation scenario, and a higher level of participation for active or passive integrated solar systems for new construction (80% opposed to 20% in 1988).

Another assumption which was made to reflect the intensity of a vigorous conservation scenario predicted that 2/3 of the 'potential' customers would choose high level solar systems whereas the original OER conservation scenario predicted that only 1/3 would do so.

. Thermal envelope performance

Following is a table which represents the possible savings attributed to thermal efficiency improvements. For existing buildings, the assumption made is that participation will increase by 10% per year reaching 90% in 1988. For new construction, 100% will assume to adhere to thermal standards beginning in 1980.

TABLE 1

THERMAL ENVELOPE EFFICIENCY SAVINGS

Structure	Percent of Electrically Heated Homes[a]	Energy Savings Per Unit (MWH/YR)
Single Family Detached	52	2.745
Single Family Attached	15	1.943
Multi-Family Low-Rise	7	1.049
Mobile Homes	26	2.665

Weighted Average Savings - 2.48518

It is assumed that the percent ratios in the above table will remain constant year by year.

(a) These data were taken from "Energy Conservation in Maine: Weatherization Improvements to the Existing Housing Stock," Urban Planning Policy Analysis and Administration, Department of City and Regional Planning, Harvard University, Cambridge, MA, June 1977.

. Commercial conservation

An intense conservation program would have more effect on existing buildings than effecting a reduction in lighting levels. Energy management techniques and technical assistance could achieve reductions in electric consumption for both existing and new construction. The amounts estimated by the Energy Systems Research Group 3/ for types of buildings and end use consumption are shown below. Increases in electricity savings over the original OER conservation scenario reflects the vigorous impact which an intensive program would have on the commercial sector. For all existing and new retail, office, and other buildings, percent reduction data in the table reflects improvements which require some modifications to energy systems. For existing and new schools and hospitals, percent reduction data in the table reflects both improvements which require some modifications to the energy systems and capital intensive modifications requiring considerable engineering support which should be realized by the government-sponsored audit and technical assistance program which now exists for these building types.

TABLE 2

Existing	Office	Retail	Hospital	School	Other
Space Heat	15	23	16	29	15
Air Conditioning	17	20	28	56	12
Light and Power	50	25	17	42	15
Auxiliary	28	36	30	53	23
New					
Space Heat	35	42	40	50	42
Air Conditioning	35	37	33	41	35
Light and Power	25	24	15	20	15
Auxiliary	16	16	15	30	20

3/ "Long Range Forecast of Electric Energy and Demand in New Hampshire," Energy Systems Research Group, Inc., Boston, MA, March 1, 1979. See also OER report - Page 85.

Effects of an Intensive Conservation Scenario

The following data tables show the reduction in electric consumption and peak demand which might be expected to result from vigorous efforts made to conserve energy. It should be stressed here that many assumptions have been made which may, or may not, reflect 'real-life' conditions. The approach taken assumes a vigorous policy and implementation initiative which should have effects similar to those presented in this supplement based on data compiled by various sources which estimate energy reduction along plausible lines of action. The scenario then predicts optimistic, yet realistic possible reductions in electricity consumption.

Note: There are additional conservation measures which could have been included in the commercial sectors in this scenario - solar energy utilization, the use of fuel cells, and so on, which show promise for saving energy. The reason they were not included as separate discussions is a result of the laxitude taken in acquiring the commercial percent reduction data. Specifically, although the levels of reduction estimated by the Energy Systems Research Group require modifications and capital investments, there were no specific technologies mentioned. To retain a realistic intensive scenario here, additonal energy saving conservation methods were omitted to prevent overlapping with the percent reduction estimates which were used. Overlap in the residential sector as a result of thermal efficiency improvements and solar energy utilization in combination should not be a problem since they are both fixed and separate energy reduction mechanisms.

The industrial sector was not addressed in this report because of differences in the data sources. The possibility for conservation in the industrial sector requires further investigation and analysis.

TABLE 3

ELECTRIC SALES (MWH)

	ORIGINAL FORECAST			CONSERVATION FORECAST					
YEAR	TOTAL[a]	EXISTING[b]	NEW[b]	% PARTICIPATION[e]	EXISTING	NEW	CARRY-OVER[c]		TOTAL[d]
				I	II		III		
							YEARLY	ACCUMULATED	
1978	1,300,408	1,269,458	30,950						
1979	1,268,464	1,238,148	30,316						
1980	1,295,231	1,264,146	31,085						
1981	1,418,882	1,384,687	34,195	20	1,297,197	26,411	0	0	1,323,608
1982	1,523,942	1,487,063	36,879	40	1,303,693	28,484	7,784	7,784	1,324,393
1983	1,636,389	1,596,625	39,764	60	1,308,659	30,712	8,395	16,179	1,323,192
1984	1,771,670	1,728,441	43,229	80	1,323,447	33,388	9,052	25,231	1,331,604
1985	1,855,576	1,810,114	45,462	100	1,293,961	35,113	9,841	35,072	1,294,002
1986	1,924,664	1,877,317	47,347	100	1,356,591	36,509	10,349	45,421	1,347,739
1987	2,001,173	1,951,744	49,429	100	1,425,603	38,177	10,778	56,199	1,407,581
1988	2,074,555	2,023,106	51,449	100	1,493,579	39,737	11,252	67,451	1,465,865
1989	2,151,846	2,098,265	53,581	100	1,565,572	41,384	11,712	79,163	1,527,793
1990	2,312,950	2,255,126	57,824	100	1,700,421	44,661	12,197	91,360	1,653,722

(a) From Table 3, Commercial Sector, OER report.

(b) These figures were established by applying the percentages of new construction to total sales data.

(c) These data are yearly savings carry-over from new construction which are subtracted from electric consumption of each new year's existing buildings.

(d) Column I plus Column II minus Column III.

(e) These are the rates of participation at which the commercial sector is assumed to matriculate toward conservation.

TABLE 4

SOLAR WATER HEAT

YEAR	EXISTING CUSTOMERS: 50% POTENTIAL CUSTOMERS [(a)]	EXISTING CUSTOMERS: PARTICIPANTS (%) [(b)]	EXISTING CUSTOMERS: REDUCTION (MW) [(c)]	NEW CUSTOMERS: 90% POTENTIAL CUSTOMERS [(d)]	NEW CUSTOMERS: PARTICIPANTS (%) [(b)]	NEW CUSTOMERS: REDUCTION (MW) [(c)]
1978	50,000	0	0	0	0	0
1979	↓	.1	.05	4,025	.1	0
1980	↓	.5	.25	7,250	.5	.04
1981	↓	1.5	.75	10,550	1.5	.16
1982	↓	2	1.0	14,025	3	.42
1983	↓	4	2.0	17,600	6	1.1
1984	↓	7	3.5	21,350	10	2.1
1985	↓	10	5.0	25,400	20	5.1
1986	↓	13	6.5	29,325	30	8.8
1987	↓	16	8.0	32,575	40	13.0
1988	↓	20	10.0	35,000	50	17.5
1989	↓	23	11.5	37,325	55	20.5
1990	↓	25	12.5	39,550	60	23.7
1991	↓	27	13.5	41,425	65	26.9
1992	↓	29	14.5	43,200	70	30.2
1993	50,000	30	15.0	44,875	75	33.7

a) 50,000 is about 50% of all existing water heating customers as described in the text as being possible hot water retrofits.

b) These percentages were selected to model the trend in solar hot water system installation which can be expected from the rising availability of solar systems.

c) These figures were calculated by applying the participation percentages to potential customers using 1 kilowatt reduction in demand per system.

d) These numbers were calculated by adding each year's forecast for new customers as given in the CMP forecast and applying the 90% factor for possible solar utilization.

TABLE 5

SOLAR GREENHOUSE AND SUN-TEMPERED HOME

YEAR	EXISTING CUSTOMERS: 40% POTENTIAL CUSTOMERS[(a)]	EXISTING CUSTOMERS: PARTICIPATION (%)[(b)]	EXISTING CUSTOMERS: REDUCTION (MW)[(c)]	NEW CUSTOMERS: 80% POTENTIAL CUSTOMERS[(d)]	NEW CUSTOMERS: PARTICIPATION (%)[(b)]	NEW CUSTOMERS: REDUCTION (MW)[(c)]
1978	9,000	0	0	0	0	0
1979	│	.05	0	1,150	.05	0
1980	│	.1	0	2,075	1	.01
1981	│	.5	.02	3,000	2	.03
1982	│	1	.04	4,000	10	.20
1983	│	2	.09	5,025	25	.63
1984	│	4	.18	6,100	40	1.2
1985	│	6	.27	7,250	60	2.2
1986	│	8	.36	8,400	80	3.4
1987	│	10	.45	9,325	90	4.2
1988	│	12	.54	10,000	90	4.5
1989	│	14	.63	10,650	90	4.8
1990	│	16	.72	11,250	90	5.1
1991	│	18	.81	11,800	90	5.3
1992	│	20	.90	12,275	90	5.5
1993	9,000	22	.99	12,750	90	5.7

a) About 40% of existing space heat customers or 12,000, could retrofit with solar greenhouses. It is assumed that three-quarters would select a solar greenhouse rather than an active space heat system.

b) These percentages were selected to model the trend in solar greenhouse construction which can be expected from the awareness of the greenhouse as a heating and food-producing alternative.

c) These figures were calculated by applying the participation percentages to potential customers using 0.5 kilowatt reduction in demand per greenhouse.

d) These numbers were calculated by adding each year's forecast for new space heat customers as given in the CMP forecast, assuming that one-third would select a solar greenhouse or sun-tempered home rather than a solar designed active or passive system, and applying the 80% factor for possible solar utilization.

TABLE 6

SOLAR SPACE HEAT

	EXISTING CUSTOMERS			NEW CUSTOMERS		
YEAR	40% POTENTIAL CUSTOMERS [a]	PARTICIPATION (%) [b]	REDUCTION (MW) [c]	80% POTENTIAL CUSTOMERS [d]	PARTICIPATION (%) [b]	REDUCTION (MW) [c]
1978	3,000	0	0	0	0	0
1979		.01	0	2,325	.01	0
1980		.02	0	4,150	.5	.06
1981		.04	0	6,025	2	.36
1982		.1	.01	8,025	10	2.4
1983		.5	.05	10,050	25	7.5
1984		1	.09	12,200	40	14.6
1985		2	.18	14,525	60	26.1
1986		4	.36	16,800	80	40.3
1987		5	.45	18,650	80	44.8
1988		6	.54	20,000	80	48.0
1989		7	.63	21,300	80	51.1
1990		7.5	.68	22,525	80	54.1
1991		8	.72	23,575	80	56.6
1992		8.5	.76	24,550	80	58.9
1993	3,000	9	.81	25,475	80	61.1

a) About 40% of existing space heat customers, or 12,000, could retrofit with active or hybrid passive solar space heat systems. It is assumed that one-quarter would select such a system rather than a solar greenhouse.

b) These percentages were selected to model the trend in retrofitted in solar space heat system which can be expected from the development of solar technology which will become cost-competitive.

c) These figures were calculated by applying the participation percentages to potential customers using 3 kilowatts reduction in demand per system.

d) These numbers were calculated by adding each year's forecast for new space heat customers as given in the CMP forecast, assuming that two-thirdswould select a space heat system rather than a greenhouse or sun-tempered home alone, and applying the 80% factor for possible solar utilization.

TABLE 7

THERMAL EFFICENCY IMPROVEMENTS

YEAR	EXISTING CUSTOMERS [(a)]	PER CENT PARTICIPANTS [(b)]	REDUCTION (MWH/YR) [(c)]	NEW CUSTOMERS [(a)]	PARTICIPANTS [(b)]	REDUCTION (MWH/YR) [(c)]	TOTAL MWH REDUCTION
1978	31,867	0%	0	0	0%	0	0
1979	36,151	0%	0	0	0%	0	0
1980	39,552	10%	9,829	0	0%	0	9,829
1981		20%	19,659	3,473	100%	8,630	28,289
1982		30%	29,488	7,149	100%	17,765	47,253
1983		40%	39,317	10,915	100%	20,301	59,618
1984		50%	49,416	14,903	100%	37,037	86,183
1985		60%	58,976	19,190	100%	47,691	106,667
1986		70%	68,805	23,382	100%	58,108	126,913
1987		80%	78,634	26,798	100%	66,598	145,232
1988		90%	88,464	29,311	100%	72,843	161,307
1989		90%		31,710	100%	78,805	167,269
1990		90%		33,997	100%	84,489	172,953
1991		90%		35,918	100%	89,263	177,727
1992		90%		37,724	100%	93,751	182,215
1993	39,552	90%	88,464	39,418	100%	97,961	186,425

(a) These figures were taken from the CMP forecast for electric heat customers. Existing customers were held constant in 1980 (the first year that conservation efforts should have an effect) and new customers were added yearly.

(b) These percentages were selected to model the trend in matriculation rates of customers adopting thermal efficiency improvements. It was assumed that all new customers would follow these thermal standards beginning in 1980.

(c) These figures were calculated by applying estimated energy saving data (From Table 1) to each year's customer forecast using the weighted average energy reduction per customer (2.48518).

TABLE 8

PEAK REDUCTION AS A RESULT OF

AN INTENSIVE ENERGY CONSERVATION SCENARIO (MW)

YEAR	COMMERCIAL[b]	SOLAR WATER[c]	SOLAR(d) LOW/LEVEL	SOLAR(e) HIGH LEVEL	THERMAL ENVELOPE[f]	TOTAL
1978	0	0	0	0	0	0
1979	0	.05	0	0	0	0
1980	0	.29	.01	.06	2.56	3
1981	15.0	.91	.05	.36	7.37	24
1982	32.7	1.42	.24	2.41	12.32	49
1983	51.4	3.1	.72	7.55	15.54	78
1984	72.2	5.6	3.00	14.69	22.47	118
1985	92.1	10.1	2.47	26.28	27.81	159
1986	94.6	15.3	3.76	40.66	33.08	187
1987	97.3	21.0	4.65	45.25	37.86	206
1988	99.8	27.5	5.04	48.54	42.05	223
1989	102.3	32.0	5.23	51.73	43.60	235
1990	108.1	36.2	5.82	54.78	45.08	250
1991	111.6[a]	40.4	6.11	57.32	46.33	262
1992	115.2[a]	44.7	6.40	59.66	47.50	273
1993	119.0[a]	48.7	6.69	61.91	48.60	285

(a) These figures are extrapolations to provide a visual representation of the new forecast to 1993.

(b) These figures were calculated by applying the peak equation coefficient for combined commercial and industrial sales to the total savings for the intensive commercial conservation scenario. From Table 3, this is the total from the original forecast minus the total for the new forecast. (It should be noted that the comparable procedure in the original OER Conservation scenario was faulty as the coefficients were applied to only the carry-over data. If done properly, there would have been a larger reduction in peak demand due to commercial conservation.)

(c) From Table 4.

(d) From Table 5.

(e) From Table 6.

(f) From Table 7.

TABLE 9

ELECTRIC SALES TO THE SECTORS (GWH)

YEAR	INDUSTRIAL[a]	COMMERCIAL[b]	RESIDENTIAL[c]	OTHER[d]	TOTAL
1978	2,124	1,300	2,292	128	5,844
1979	2,101	1,268	2,337	128	5,834
1980	2,220	1,295	2,411	133	6,059
1981	2,345	1,324	2,507	137	6,313
1982	2,415	1,324	2,602	141	6,482
1983	2,497	1,323	2,702	146	6,668
1984	2,630	1,331	2,798	150	6,909
1985	2,637	1,294	2,856	155	6,942
1986	2,633	1,348	2,876	159	7,016
1987	2,626	1,408	2,921	164	7,119
1988	2,619	1,466	2,957	168	7,210
1989	2,609	1,528	3,008	172	7,317
1990	2,740	1,654	3,111	176	7,645

(a) OER report - Page 30.

(b) From Table 3.

(c) These figures were derived by applying the residential peak equation coefficient to the peak reduction data for the residential sector (from Table 8) and subtracting the result from the OER forecast for total residential sales (OER report - Page 54).

(d) From "CMP Long Range Forecast Sales, Energy and Peak Loads 1978-1993," 1978, Page 56.

TABLE 10

INTENSIVE CONSERVATION SCENARIO FORECAST PEAK

YEAR	ORIGINAL OER FORECAST	CONSERVATION FORECAST
1978	1,185	1,185
1979	1,192	1,192
1980	1,240	1,237
1981	1,312	1,288
1982	1,375	1,326
1983	1,444	1,366
1984	1,533	1,415
1985	1,585	1,426
1986	1,628	1,441
1987	1,668	1,462
1988	1,704	1,481
1989	1,738	1,503
1990	1,823	1,573
1991	1,887 (a)	1,625
1992	1,953 (a)	1,680
1993	2,021 (a)	1,736

1978-88 Annualized Growth Rate - 2.3

(a) Extrapolated for visual representation and comparison.

TABLE 11

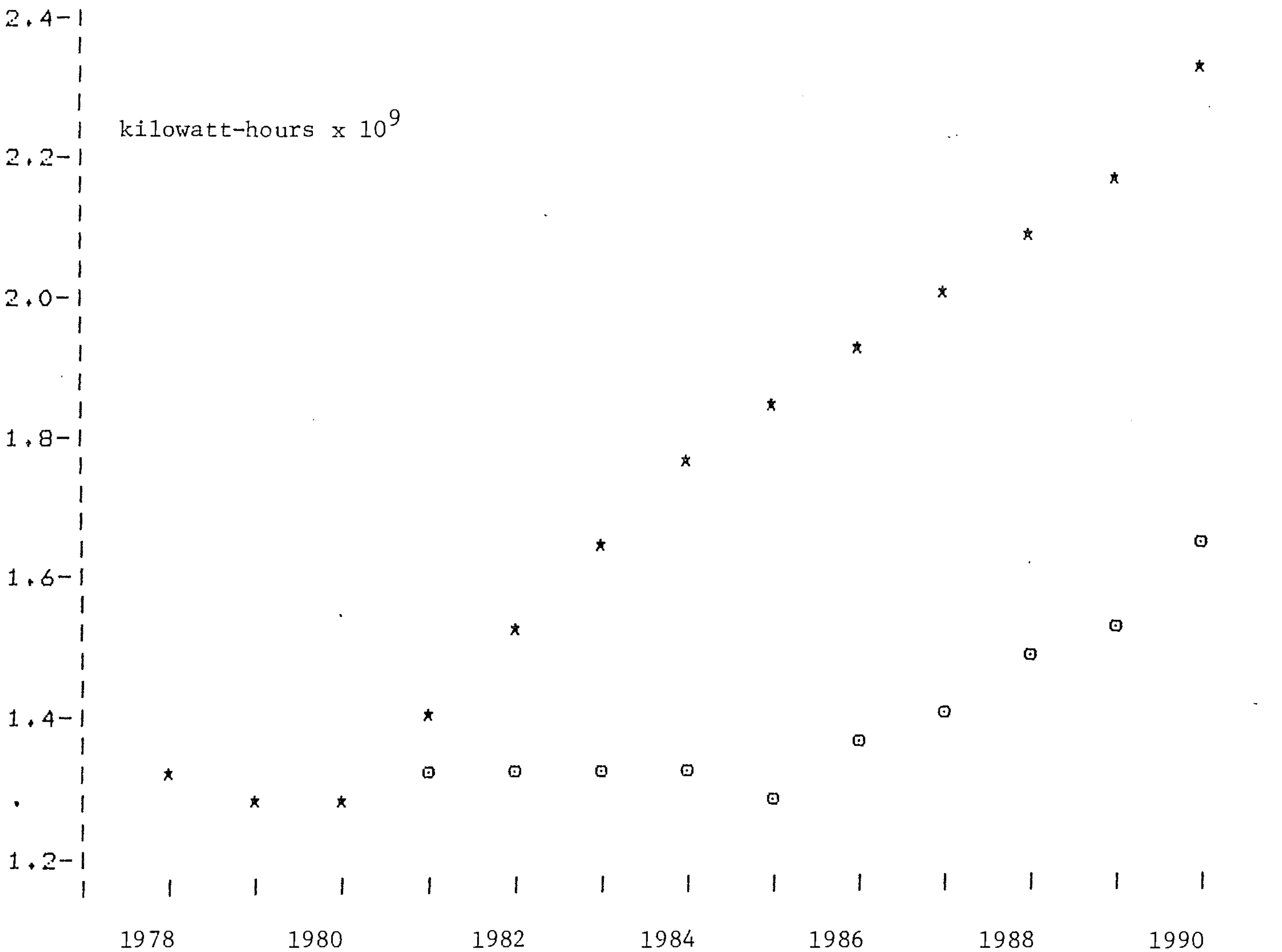
FORECASTED ANNUALIZED COMPOUND GROWTH RATES

	CMP	OER BASELINE	OER CONSERVATION	INTENSIVE OER CONSERVATION
Residential	3.7%	4.1%	3.8%	2.6%
Commercial	5.3%	4.8%	2.9%	1.2%
Industrial	4.5%	2.1%	2.1%	2.1%
Other	2.8%	2.8%	2.8%	2.8%
Total	4.4%	3.5%	3.2%	2.1%
Peak	4.4%	3.7%	3.5%	2.3%

Summary and Forecast

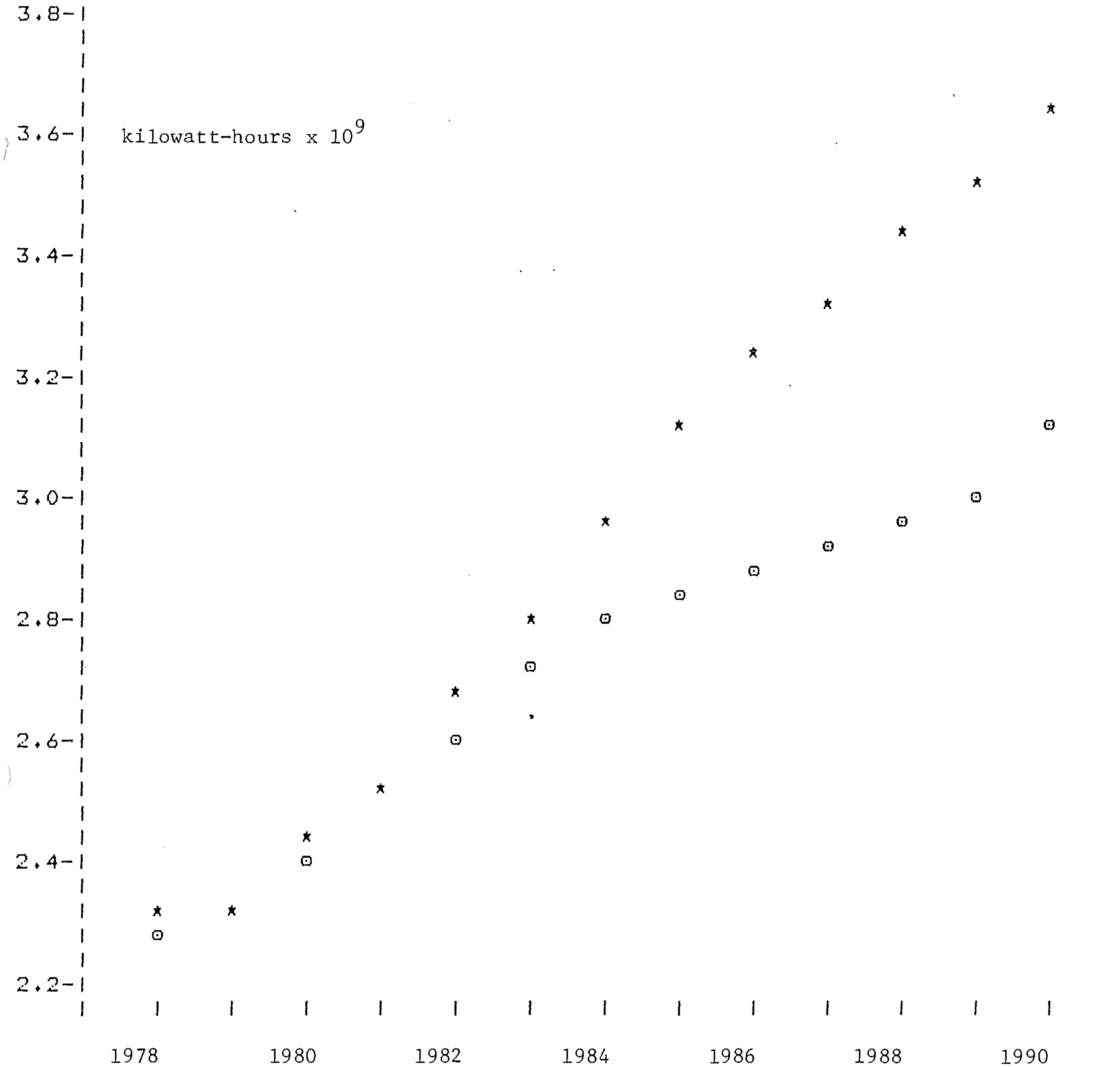
This analysis indicates that it is physically possible for solar energy utilization and energy conservation to have a significant effect on the need for electric generating capacity by reducing the net demand and peak load. Whether or not this conservation potential can be realized depends upon many factors including relative costs.

The conservation scenario outlined here indicates an overall electric demand growth rate of 2.1% and a peak growth rate of 2.3%.



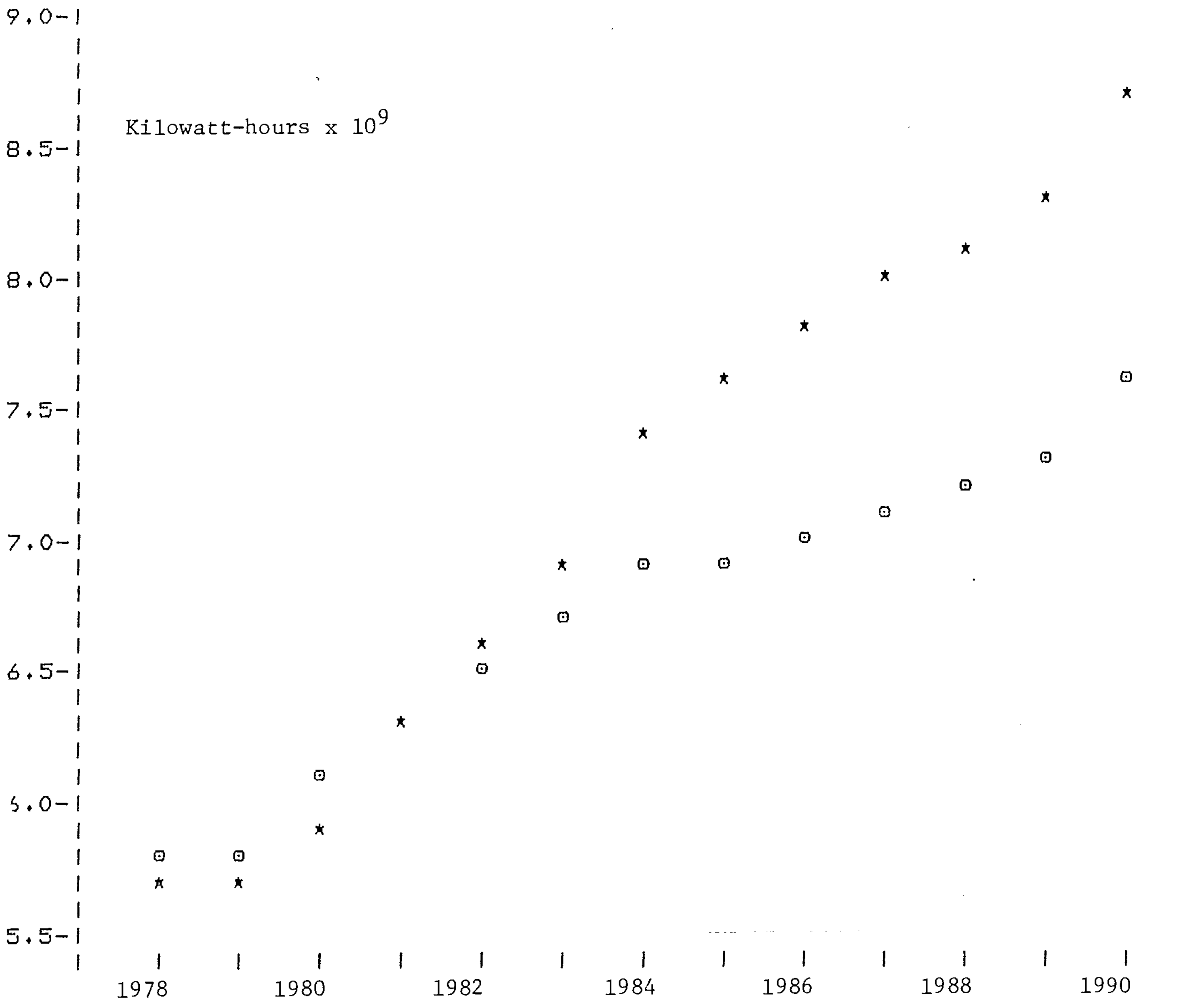
TOTAL COMMERCIAL SALES

* Original OER forecast
⊙ Intensive conservation forecast



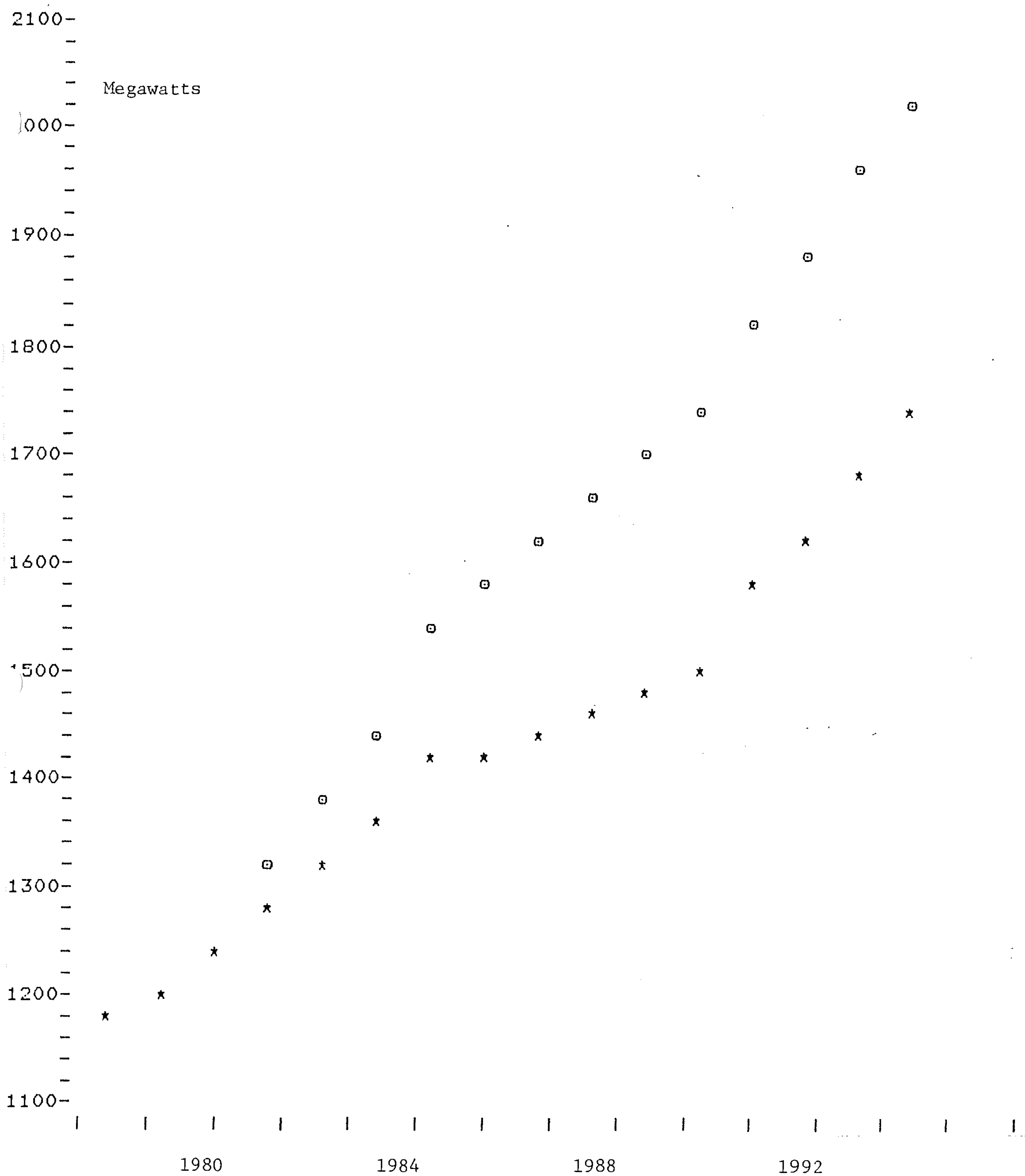
RESIDENTIAL ELECTRIC SALES

* Original OER forecast
⊙ Intensive conservation forecast



TOTAL ELECTRIC SALES

* Original OER forecast
⊙ Intensive conservation forecast



PEAK FORECAST

⊙ Original OER forecast
* Intensive conservation forecast