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AN ASSESSMENT OF ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION PRIORITIES FOR NEW YORK STATE

Interim Report

Volume II

Reference Case Supply Demand Projections
Fuel Demand Tables and Summaries

November 1977

POLICY ANALYSIS DIVISION
NATIONAL CENTER FOR ANALYSIS
OF ENERGY SYSTEMS
BROOKHAVEN NATIONAL LABORATORY

INSTITUTE FOR ENERGY RESEARCH
STATE UNIVERSITY OF NEW YORK
AT STONY BROOK

prepared for the
NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

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Volume II

**Reference Case Supply Demand Projections
Fuel Demand Tables and Summaries**

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November, 1977

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Abstract

In compliance with its mandate to accelerate the development and use of energy technologies in furtherance of the state's economic growth and the best interests of its population the New York State Energy Research and Development Authority (NYSERDA) initiated, in March 1977, an assessment of energy research and development priorities. This project was undertaken as a collaboration between the Authority, Brookhaven National Laboratory, the State University of New York at Stony Brook and the firm of Donovan, Harvester and Rattien.

The report, presents a view of the energy supply-demand future of the state, and the ways in which this future can be affected by external contingencies and concerted policies. That view takes into consideration energy supplies that may be available to the state as well as energy demands as they are affected by demographic and economic changes within the state. Also included are the effects of national energy policies and technological developments as they modify both supplies and demands in New York State. Finally this report proceeds to identify those general technological areas in which the Authority's program can be of greatest potential benefit to the state's social and economic well being. This effort is preliminary to the work of subsequent phases of the project which will aim at a cost-benefit analysis determination of RD&D priorities.

The preliminary analysis conducted in the study thus far indicates the following RD&D areas as being of highest priority: energy conservation in buildings (promotion and execution of RD&D) and industry; district heating; fuel cell demonstration; solar heating and cooling (analysis, demonstration and information dissemination); energy-environment interaction (analysis); energy information services; and, in general, the attraction of federal RD&D programs to the state.

PREFACE

In March of 1977 the New York State Energy Research and Development Authority (NYSERDA) initiated a systematic assessment of energy research and development priorities in New York State. The project was designed as an 18 month effort but it was considered to be useful to produce a report at this time to provide interim results from the project to date. This is one of three volumes of that interim report.

The first volume presents an overview of the current energy situation of the State in the national context and suggests some technological areas which, according to our preliminary analysis, appear to be of high priority for NYSERDA activity. The third volume summarizes the development of a R&D planning methodology that will be applied in the second phase of the program. In this volume we present the technical analysis of the New York State energy situation that was used in the first phase of the study. In Part A we present the Reference Case scenario of future energy supply and demand in the state. Alternative assumptions to those in the Reference Case are examined in Part B as a basis for identifying the most important technological changes that can be promoted by actions on the part of NYSERDA.

TABLE OF CONTENTS

	<u>PAGE</u>
Preface.	iv
Part A	
Summary.	1
I. Introduction.	5
II. Characterization of Energy Demands; Construction of the RES. . .	11
III. The National Energy Plan and the New York State Reference Case. .	16
IV. The Residential Sector.	21
V. The Commercial Sector	27
VI. The Industrial Sector	33
VII. The Transportation Sector	40
VIII. The Government Sector	45
IX. The Agricultural Sector	49
X. Base Case Fuel Supplies	52
XI. Electric Energy Supply and Fuel Demands: The Electric Utility Sector.	55
XII. Supply-Demand Integration	60
XIII. Environmental Pollution	63
Summary of Part B.	72
Part B	
XIV. Introduction.	75
XV. The Impact of Conservation Options.	77
XVI. Innovative Technologies	83
XVII. Electric Utility Sector	90
XVIII. Summary	96
References	98

LIST OF TABLES

	<u>Page</u>
1 Efficiencies: Commercial/Residential Sector	17
2 NYS Market Penetration New Technologies - Residential/Commercial Sector - % of Total Subsector Energy Demand	17
3 NYS Changes in Electric Energy Market Share: Residential/ Commercial Share- % of Total Subsector Energy Demand.	18
4 NYS Automobile Fuel Economy (miles per gallon).	19
5 Composition of Energy Input to U.S. Electric Generation	19
6 Summary of Residential Energy Use	23
7 NYS Household and Population Projections.	25
8 Summary of Household Distribution by Housing Type and Fuel, 1974.	25
9 Annual Growth Rates and Basis Changes for Reference Years	26
10 Summary of Commercial Energy Demand	29
11 Annual Growth Rates and Basis Changes for Reference Years	31
12 Summary of Energy Use in the Manufacturing Sector	35
13 Industrial Subsectors Ordered by Energy Use in 1974	36
14 Annual Growth Rates and Basis Changes for Reference Years	38
15 Major Industrial Energy Users: Total Fuel Demand.	39
16 Manufacturing Energy Demand by Fuel Type.	39
17 Summary of Transportation Energy Demands.	42
18 Annual Growth Rates and Basis Changes for Reference Years	43
19 Transportation Fuel Demand.	44
20 Summary of Energy Use in the Government Sector.	47
21 Annual Growth Rates and Basis Changes by Reference Years.	48
22 Summary of Energy Use in the Agricultural Sector.	50
23 U.S. Domestic Oil Production Estimates.	53
24 Base Case Domestic Oil Supplies - To New York State	53
25 NET Receipts from U.S. Pipelines (Consumption and Losses) Not Including In-State Production or Imports and Exports.	54
26 Domestic Gas Productions: NEP Estimates	54
27 Natural Gas Available to New York State	54
28 Estimated Generation.	56
29 NERA Estimates of NYPP.	56
30 1974 Generation Mix	58

LIST OF TABLES - continued

<u>Table</u>		<u>Page</u>
31	Generation Mix	59
32	NYPP Plant Factors %	59
33	Electric Sector Demand	59
34	1974 Energy Demand Summary	61
35	1985 Energy Demand Balance	61
36	2000 Energy Demand Balance	62
37	Pollution Coefficients (Ton/10 ¹² Btu); Fossil Fuels in Electric Power Plants	65
38	Pollution Coefficients (Ton/10 ¹² But): Energy Demanding Sectors. . .	66
39	Pollutants from the Combustion of Fossil Fuels Base Case -1974 . . .	67
40	Pollutants from the Combustion of Fossil Fuels (Tons) 1985	68
41	Pollutants from the Combustion of Fossil Fuels (Tons) 2000	69
42	Pollutants from Use of Fossil Fuels - Average Annual Growth Rate . .	70
43	Pollution by Sector - Percent 1974	70
44	Pollution by Sector - Percent 1985	71
45	Pollution by Sector - Percent 2000	71
46	End Use Efficiencies: Residential and Commercial Sectors	77
47	Residential and Commercial Fuel Demands: 1974.	77
48	Residential and Commercial Fuel Demands: No Improvements in End Use Efficiency	78
49	Residential and Commercial Fuel Demands: Estimated 1985 Efficiencies Achieved in 2000.	78
50	Unit Demands: Transportation Sector.	79
51	Transportation Sector Fuel Oil Demands: Unit Demand Improvements Not Realized.	80
52	Transportation Sector: Forecast 1985 Unit Demand Improvements Not Achieved Until 2000.	80
53	1974 Manufacturing Reference Case Demand	80
54	Manufacturing - 1974 Efficiencies in 1985 and 2000: No Switch to Coal	81
55	Manufacturing - 1974 Deferred Efficiencies in 1985, 1985 Deferred Efficiency in 2000: No Switch to Coal.	81
56	Additional Oil and Natural Gas Demands: No Efficiency Improvements after 1974.	82
57	Additional Oil and Natural Gas Demands: Efficiency Improvements Deferred Until 2000.	82

LIST OF TABLES - continued

<u>Table</u>		<u>Page</u>
58	Alternative Solar Technology Realization: Residential/Commercial Sectors.	83
59	Residential/Commercial Sectors - Implementation of Solar Technology: Changed Fuel Demands	84
60	NYS District Hot Water Heating Potential	86
61	Utility Sector Increased Coal Demand Due to Hot Water District Heating.. . . .	86
62	Generation Mix and Fuel Demands.	91
63	Generation Mix and Fuel Demands.	91
64	Generation Mix and Fuel Demands.	92
65	Generation Mix and Fuel Demands.	92
66	Generation Mix and Fuel Demands.	93
67	Utility Expansion Alternatives - Fuel Demands Compared with Base Case.	93
68	Utility Alternatives: Fuel Demand Changes as Percent of Total Reference Case Demands	94
69	Electric Utility Sector Environmental Pollutants - 1985.	95
70	Electric Utility Sector Environmental Pollutants - 2000.	95
71	Electric Utility Sector Annual Incremental - Sludge Pond Capacity.	95
72	Effects of Technological Eventualities: Changes in Fuel Demands Percent of Base Case	96
	Appendix A - Fuel Demand Tables.	101
	Appendix B - Summary Tables.	145

LIST OF FIGURES

Figures

1	Reference Energy System, Year 1985 NEP.	6
2	Reference Energy System, Year 2000 NEP.	7
3	Reference Energy System, Year 1985	8
4	Reference Energy System, Year 2000	9
5	NYS Reference Energy System, Year 1974	13
6	Utility Generation Requirements.	57

Part A

SUMMARY*

A Reference Case energy supply-demand projection has been made for New York State assuming a continuation of current trends in energy prices, national and state energy policies and conservative estimates of the availability of new technologies. This reference case of Part A is intended to serve as a basis for policy analysis rather than representing a prediction of the future. The average annual growth rates calculated for the major consuming sectors were as follows.

ENERGY DEMAND BY SECTOR		
ANNUAL GROWTH RATE, PERCENT PER YEAR		
SECTOR	<u>1974-1985</u>	<u>1985-2000</u>
Residential	-1.0	- .2
Commercial	.3	- .8
Industrial	2.1	1.7
Transportation	1.7	1.0
TOTAL	.8	.6

This compares with an annual growth rate in total energy consumption of 3.8% per year in the 1960-1970 period.

Growth in the demand for electrical energy causes a 4.1% per year average annual growth in the energy input to the electric public utilities in 1974-85 and 1.9% per year between 1985 and 2000. Historical growth rates in the electrical sector have been about 6% per year (1960-1970). The demands for fuels change as follows:

ANNUAL GROWTH RATE		
PERCENT PER YEAR		
	<u>1974-1985</u>	<u>1985-2000</u>
Coal	6.2	4.6
Oil	.8	-1.1
Gas	-1.1	-1.3
Nuclear	11.1	6.4

*The sensitivity of the reference case to certain alternative assumptions, presented in Part B is summarized separately on page 81.

An analysis of fuels potentially available to New York State in the future indicates that the fraction of oil imported from foreign sources will be about the same in 1985 as it is currently-63%. Thereafter some decrease -- to about 58% in 2000-is anticipated. The feasibility of such import levels is open to considerable question but has not been investigated in this report. For natural gas a policy of not increasing the number of natural gas heated homes in the State, and substituting coal for natural gas in industry would seem to assure adequate supplies by 2000. Anticipated demand in 1985, however, would appear to be hard to satisfy with currently projected domestic production.

Looking behind the aggregated numbers for the energy consuming sectors we see the following.

Residential Sector: Between 1974 and 1985 a major shift occurs in space and water heating from oil and natural gas to electricity with oil maintaining its primacy. In the period 1985 to 2000 this shift continues. In addition the effects of the penetration of heat pumps and solar technology becomes apparent.

- Commercial Sector: Shifts in this sector are similar to those observed in the residential sector discussed above.

- Industrial Sector: Projections in this sector reflect efficiency improvements in process heating and a steady shift away from oil and gas to coal.

- Transportation Sector: The transportation sector consumes more energy than any other direct consuming sector in each year of the study. In 1974 energy consumption by this sector was 998×10^{12} Btu. This consumption, despite a large increase in end-use efficiency, increases to 1215×10^{12} Btu and 1412×10^{12} Btu in 1985 and 2000 respectively. The transportation mode which experiences the greatest rate of growth in both periods is air. This is reflected by a large increase in the requirements for jet-fuel by 2000.

- Agricultural Sector: The energy demands of the agricultural sector are modest though they grow at a substantial rate driven by a high projected growth in the value of this sector's output. Growth in output takes place despite a projected decrease in the number of farms. The energy consumption of this sector, relative to the state's total, is less than .5% in 1974 decreasing to .3% by 2000.

● Government Sector: The state government consumes even less than the agricultural sector, using about .16% of the state's total in 1985 dropping to less than .11% in 2000.

● Utility Sector: In 1974 this sector consumed 53% of the state's coal consumption using 7.5 million of 14-million tons. In 1985 this proportion is estimated to rise to 70% of the state's requirements with a forecast demand of 20 million tons. By 2000 the utility sector will require 78% of the state's total demand of 58-million tons. Coal requirements of the state's utilities are critically dependent on the share of coal in baseload capacity expansion plans and the conversion of oil-fired generation to coal. Oil fueled production of 45 thousand gigawatt-hours (GWH) in 1974 will rise to an estimated 66 thousand GWH, in 1985 requiring 120×10^6 barrels of oil.

● An examination of the utility sector's ability to meet the BNL forecast load in 1985 leads to the conclusion that the required capacity factor for oil-fired generation will have to be greater than 70% while for coal and nuclear generation it will be 75%. These capacity factors, in the context of utility experience, appear to be high with the implication that capacity expansion plans to 1985 on a aggregate state level may not be conservative.

● By 2000 sufficient base-load coal and nuclear capacity can be made available so as to eliminate the need for base load generation fueled by residual oil. In addition, the BNL estimated load may be supplied without operating power plants at unrealistically high capacity factors.

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I

INTRODUCTION

A first step in assessing priority areas for energy research and development (R&D) in New York State is to create a view of the future energy supply-demand situation in the State. This report presents such a view, concentrating on the years 1985 and 2000. These energy supply-demand projections for the state are intended to satisfy two functions. First, by comparing future anticipated energy demand with anticipated fuel supply one can identify major problem areas in which excessive pressure on certain fuels for certain purposes may lead to significantly higher prices or actual short-falls or both. The second purpose of this supply-demand projection is to provide a framework in which to evaluate the impact of specific State R&D programs, or Federal programs as they can be influenced by State action.

These purposes impose a number of requirements on the projections. The realistic identification of potential supply problems requires that a realistic demand projection be created, which does not incorporate undue expectations regarding new prices or conservation actions. Secondly, the requirement that the introduction of new technology be evaluated requires that the projections be relatively free of such new technologies. These requirements, therefore, imply a surprise-free reference case which corresponds to a state of affairs that can be arrived at from existing conditions without major discontinuities and without major shifts in Federal or State policies.

To accomplish these purposes we have aligned our projections of energy supplies and demands with the National Energy Plan (NEP). The energy demand-supply consequences of the NEP in the national context are presented for 1985 and 2000, in the Brookhaven Reference Energy System (RES) format in Figures 1 and 2 respectively. (The construction and use of the RES is described in the next section). These contrast with RES representations of the national demand-supply picture for those years, absent the NEP, which are displayed in Figures 3 and 4. The effects of the NEP are discussed in detail in Section III as are its consequences for New York State (NYS).

Figure 1. Reference Energy System, Year 1985, NEP.

Figure 3. Reference Energy System, Year 1985.

Reference energy system, year 1985.

Figure 4. Reference Energy System, Year 2000.

Further, our purpose requires that the supply-demand pictures be characterized in sufficient detail so that the introduction of technologies, that could result from specific R&D programs (on, for example, heat pumps or more efficient air conditioners) can be analyzed. Thus, the base case has been developed with considerable detail on demand, end use technologies and resulting environmental pollution.

Our alignment of the NYS demand-supply projections with the NEP is founded on the belief that any view of the state's energy future which runs counter to national goals is not credible. On the other hand certain implications of the NEP are not compatible with New York's economic and demographic future. In such cases our perceptions of a likely future were allowed to take precedence. In short our approach has been pragmatic rather than rigidly dogmatic.

The numerical form taken here by our view of the future, with its aura of precision, stands in sharp contrast to our uncertain knowledge of that future. Political forces, based on conflicting regional and economic interests, may have significant impacts in reshaping the NEP. Nor is our energy future immune from action taken by foreign governments--actions over which we may have little or no control. Thus we cannot ascribe a very high probability to one base case. In order to explore the sensitivity of our eventual R&D priorities to our assumptions, and to explore contingencies, a set of alternative scenarios will be constructed in the continuation of this work. The most important of these will be developed in the same detail as the base case.

II

CHARACTERIZATION OF ENERGY DEMANDS: CONSTRUCTION OF THE RES

The Brookhaven Reference Energy System (RES) is a convenient way of representing the energy system of a state. In Figures 1-4, we have shown the national RES for two different years. Figure 5 is the New York 1974 RES. This system and the detailed technological, economic, and environmental assumptions which comprise the supporting data base have been developed to program the kind of technology assessment required in this study. In the paragraphs which follow we describe the construction and use of the RES and its application to the organization of demand data for this study. In Sections IV-IX the development of the 1974 data base and its projection to 1985 and 2000 is described on a sector by sector basis.

Construction of the RES

The format for the reference system is a network diagram which indicates energy flows and associated conversion efficiencies, along with the reference technologies used to accomplish the energy conversion. The system indicates the reference conversion processes used in the following activities, where each applies to a specific energy resource or form.

1. Extraction
2. Refining and/or conversion
3. Transport of primary energy source
4. Centralized conversion (e.g., electricity generation)
5. Transport or transmission and storage of secondary energy form
6. Decentralized conversion
7. Utilization in an end use device

A single path through the network reflects the application of a specific energy resource to a given demand category. Alternate paths and branches reflect the amount of substitutability that is feasible among different resources. Demand figures are exogeneously estimated for each reference year.

Associated with each energy flow or link in the RES are two coefficients: efficiency and environmental. The RES's developed for visual display purposes in this report depict only the efficiency coefficients (shown in parentheses). The environmental coefficients, which at this point include only air pollutant emissions, are discussed in Section XIII of this report.

The RES representation allows one to calculate the amount of a particular energy resource (e.g., oil) used to satisfy a particular demand (e.g., space heating) either through a particular intermediate fuel form, such as electricity, or directly. It also allows one to calculate the gross environmental impacts (emissions) associated with a particular supply pattern or set of patterns.

Data Included in the Data Base

Total demands for oil and oil products, natural gas, coal and electricity are aggregated from specific demand in the residential, commercial, industrial transportation, governmental and agricultural sectors of New York State. The electrical sector supplies electric energy to the six sectors listed above and requires fuel inputs already mentioned in addition to uranium and hydropower. The energy requirements of a small utility steam sector are considered as well.

Future energy demand is projected by considering the underlying determinants of demand--the energy services required and then the efficiency with which various fuels are used to provide those services. More explicitly, the data listed below are included under the following heading.

1. Subsector for example, in the transportation sector, passenger or freight or in the residential sector, single family or high-rise dwellings.
2. Basis B, a projection variable which conveniently characterizes change in the subsector; for example, in the commercial sector the principal determinant of energy use is the amount of floorspace.
3. Fuel Demand D_i is the quantity of a fuel, i, actually consumed in a specific demand category, such as residential space heating or commercial air conditioning.
4. Total Fuel Demand D_s is the total fuel required to satisfy the requirements of a specific demand category. Electricity is considered as a fuel in this sense and $D_s = \sum_i D_i$.

5. Relative System Efficiency e_i , is the relative effectiveness with which fuel, i , is used in a demand category. This parameter depends on the utilization technology employed. For space heating, e_i is defined as 1 for existing electrically heated homes. The values of e_i for other structures are given in the fuel mix tables.
6. Degree of Saturation S , is the fraction of the potential demand for a particular energy use actually being fulfilled at a given time. For example, if 95% of all households have refrigerators and the potential demand for refrigerators is taken to be one per house, $S = 0.95$.
7. Unit Energy Demand E_u , is the amount of energy per unit that would be required for a specific end use, assuming a relative system efficiency, e_i , of 100% for each fuel employed. Thus, for a given end use, the actual fuel demand per unit is E_u/e_i , where e_i is the actual relative system efficiency.
8. Technology Fraction f_i is the number of energy consuming units satisfied by fuel i . $\sum f_i = S \cdot B$

By specifying the technology fraction, f_i , and relative system efficiency, e_i , the fuel demand D_i , can be derived by the equation:

$$D_i = E_u \times f_i \div e_i$$

The data described above appear in the Fuel Demand Tables displayed in Appendix A for each subsector of the six energy consuming sectors.

Sample Calculations

The following is a sample calculation for space heating of commercial office space fuel demands.

$$E_u = \text{Unit Demand} = 142.00 \times 10^3 \text{ Btu/Sq. Ft.}$$

<u>Fuel</u>	<u>Technology Fraction = f_i (10^6)</u>	<u>Efficiency = e_i</u>
Oil	346.71 sq. ft.	.52
Gas	68.43 sq. ft.	.53
Steam	41.06 sq. ft.	.65

$$\text{Fuel Demand} = D_i = E_u \times f_i \div e_i$$

$$\text{For oil: } D_i = (346.71 \times 10^6 \text{ sq. ft.}) \times (142.00 \times 10^3 \text{ Btu/sq. ft.}) \div .52 = 94678.5 \times 10^9 \text{ Btu}$$

$$\text{For gas: } D_i = (68.43 \times 10^6 \text{ sq. ft.}) \times (142.00 \times 10^3 \text{ Btu/sq. ft.}) \div .53 = 18334.1 \times 10^9 \text{ Btu}$$

$$\text{For steam } D_i = (41.06 \times 10^6 \text{ sq. ft.}) \times (142.00 \times 10^3 \text{ Btu/sq. ft.}) \div .65 = 8970.0 \times 10^9 \text{ Btu}$$

$$\text{Total Fuel Demand} = \sum D_i = 121,982.6 \times 10^9 \text{ Btu}$$

III

THE NATIONAL ENERGY PLAN AND THE NEW YORK STATE REFERENCE CASE

In the paragraphs which follow, the reduction of the NEP to RES format is described. Following that its implications for the NYS Reference Case are examined. It is not our intention to provide a detailed insight into the computation of every energy value, but rather to provide an overall perspective on the methodology underlying these forecasts. The level of services in the projection years, in terms of basic energy demand represented on the right-hand-side of the RES, is computed using a series of economic models. Long-run trends of consumption and investment are obtained from the DRI macroeconomic growth model and supplied to the DRI inter-industry energy model. The economic output obtained from the inter-industry model is then applied to energy-related coefficients from the BNL input-output model, resulting in the Btu final demands shown on the right-hand-side of the RES.

For 1985, the mix of fuels satisfying these final demands are set equal to the fuel mix specified in the NEP outlined by the Executive Office of the President-Energy Policy and Planning. Fuels to the residential, commercial, industrial, transportation, and electric utility sectors in 1990 and 2000 are projected according to fuel prices, tax incentives, penalties, and regulatory policy as outlined in the NEP. New technology implementation levels are determined by U.S. Energy Research and Development Administration (US ERDA).

Efficiency improvements are determined from specific proposals in the NEP. Proposals in the buildings sector, for example, include a homeowner tax-credit of 25 percent of the first \$800 and 15 percent of the next \$1400 spent on approved conservation measures. These proposals are translated into end-use device efficiency improvements such as a reduction in average heat loss per housing unit from an estimate of the number of new and retrofit housing units having a given level of conservation due to fuel prices, tax incentives and other policy proposals as illustrated above.

The implications of the NEP are reflected in the NYS reference case on the demand side in several ways: changed efficiencies of conventional technologies, substitution of other fuels for oil and gas, and market penetration of innovative technologies. On the supply side it has consequences for our study by increasing the quantity of coal which otherwise would be available nationally.

Residential and Commercial Sectors

In Table 1 we show changes in efficiencies in energy consumption in the residential and commercial sectors which flow from the NEP to the NYS reference case. The efficiencies, absent the NEP, are from Reference 3.

Table 1

Efficiencies: Commercial/Residential Sector

	<u>1985</u>		<u>2000</u>	
	<u>NEP</u>	<u>No NEP</u>	<u>NEP</u>	<u>No NEP</u>
Space heating				
Oil	.52	.45	.69	.46
Gas	.58	.49	.75	.55
Water Heating				
Oil	.63	.63	.63	.63
Gas	.61	.55	.63	.55
Air Conditioning				
Vapor Compression	3.3	3.0	3.6	3.6

The market penetration of innovative technologies under the NEP is displayed in Table 2. In the absence of the NEP it is estimated that the market penetration of these technologies would have been negligible in New York State.

Table 2

NYS Market Penetration New Technologies

Residential/Commercial Sector

% of Total Subsector Energy Demand

	<u>1985</u>	<u>2000</u>
Space Heating		
Heat Pump	10	20
Solar	-	2
Water Heating		
Solar	2	6

In addition to promoting efficiency improvements and the market penetration of innovative technologies, NEP limits the growth of electric resistance heating for space heating while encouraging it for water heating. These changes in market shares of electricity are shown in Table 3.

Table 3
NYS Changes in Electric Energy
Market Share: Residential/Commercial Share
% of Total Subsector Energy Demand

	1985		2000	
	<u>NEP</u>	<u>No NEP</u>	<u>NEP</u>	<u>No NEP</u>
Space Heating	8	15	8	30
Water Heating	40	37	63	46

Manufacturing Sector

In the manufacturing sector the NEP has its greatest impact by encouraging a shift away from gas and oil toward coal. This is in addition to increased efficiencies of fossil fuels for process heat. These effects are reflected in the New York reference case by estimating increasing coal use in each SIC for process heat at a constant annual growth rate chosen to effect a doubling of coal use for this purpose in 2000 from what it would have been absent the NEP. While forecasting increasing coal use we estimate decreased use of oil and gas so as to leave the total energy input to process heat the same for each SIC as it would have been without the NEP, adjusted, however, for efficiency improvements. The total decrease in oil and gas for each SIC is assumed to be shared between the two in proportion to their use for process heating in that SIC before NEP. More detailed studies in the manufacturing sector are appropriate.

Transportation Sector

The implications of the NEP for the transportation sector include efficiency improvements for automobiles. These improvements are stated in terms of miles per gallon on a fleet basis. In Table 4 automobile fuel economy with NEP and in its absence are compared. National average automobile fuel economy is reflected in our New York reference case estimates.

Table 4
NYS Automobile Fuel Economy
(miles per gallon)

	<u>1985</u>	<u>2000</u>
With NEP	19.05	26
No NEP	18.35	25

The penetration of the electric automobile on the national scene, derived from our analysis of the NEP, is assumed to be reflected in the NY transportation sector. This penetration amounts to 1% of the automobile subsector in 2000, having no effect in 1985.

Electric Utilities, Cogeneration

For the nation as a whole the NEP is estimated to effect a shift from oil and gas to coal. The composition of energy supplies to electric generation both with and without the NEP is shown in Table 5.

Table 5
Composition of Energy Input to
U.S. Electric Generation
Percent

	<u>1985</u>		<u>2000</u>	
	<u>NEP</u>	<u>No NEP</u>	<u>NEP</u>	<u>No NEP</u>
Oil	8	10	4	7
Gas	2	9	-	3
Coal	55	39	45	28
Nuclear	25	32	40	57
Hydro	10	19	7	5
Other	-	-	5	1

The estimated consequences of the NEP for utility capacity expansion, plant conversion and operations serve as a guide for reference case forecasts of fuel mix for the NYS utility sector. In that case the shift from oil to coal by 2000 is substantial. Differences between the NYS reference case generation

mix and the national mix are the consequence of taking into account the state's existing generation mix as well as the potential for conversion of existing oil-fired plants to coal. In addition the New York Power Pool's expansion plan was included as a constraint. This matter is explained in greater detail in Section XI below. The NEP analysis estimates small amounts of cogeneration in 1985 and 2000. These are reflected in the New York reference case by decreases in the amount of electric energy demanded by the manufacturing sector as a whole from the electric utility sector. This approach, it is recognized, is arbitrary, since cogeneration may find a more significant role in the state's urban areas by providing district heating.

Innovative Supply Technologies

We have already discussed the estimated role of innovative technologies in supplying residential end uses. We have also discussed the penetration of the electric car into the transportation sector. Supply contributions by other innovative technologies such as bio-mass, solid waste, geothermal and solar electric are assumed to have no effect in the New York reference case. The contribution of shale oil shown in Figures 1 and 2 to the national oil supply is reflected, on the other hand, in domestic supplies estimated to be available to New York consumers.

IV

THE RESIDENTIAL SECTOR

A. Highlights

Highlighting energy consumption in this sector for each reference year were the following.

1974

- Total energy consumption: 1050×10^{12} Btu
- Consumes 31% of total state energy demand
- By energy form, demands in terms of state totals are: oil, 20%; gas, 57%; electricity, 31%
- By energy form, demands in terms of residential totals are: oil, 52%; gas, 35%; electricity 11%
- By end use energy demands as a fraction of sectorial total energy are:

Space Heating	oil, 82%; gas, 65%; electricity, 5%
Water Heating	oil, 17%; gas, 25%; electricity, 8%
Air conditioning	electricity, 9%
Lights - Appliances	electricity, 73%

1985

- Total energy consumption: 941×10^{12} Btu
- Consumes 25% of total state energy demand
- By energy form, demands in terms of state totals are: oil, 13%; gas, 54%; electricity, 41%
- By energy form, demands in terms of residential totals are: oil, 43%; gas, 30%; electricity 25%
- By end use energy demand as a fraction of sectorial total energy are:

Space Heating	oil, 82%; gas, 66%; electricity, 20%
Water Heating	oil, 17%; gas, 22%; electricity, 22%
Air Conditioning	electricity, 5%
Lights-Appliances	electricity, 48%
- Changes in energy use for space heat and water heat arise from a shift from oil and gas to electricity
- Consumption of natural gas and oil decreases 23% and 28% respectively from 1974 quantities. Electricity use increases 107%

- Electricity for space heat increases 780%, for water heating 44%
- Lighting and appliance demand increases 36% (over 1974)
- Air conditioning demand increases 40%
- The impact of new technologies is small.

2000

- Total energy consumption: 904×10^{12} Btu
- Consumes 22% of total state energy demand
- By energy form, demands in terms of state totals are: oil, 13%; gas, 51%; electricity, 45%
- By energy form, demands in terms of residential totals are: oil, 33%; gas, 25%; electricity, 39%
- Demand for electricity increases 50% (from 1985)
- By end use energy demands as a fraction of sectorial total energy are:

Space Heating	oil, 84%; gas, 63%; electricity, 21%
Water Heating	oil, 14%; gas, 17%; electricity, 28%
Air Conditioning	electricity, 6%
Lights-Appliances	electricity, 44%
- Total space heating demand decreases 16% while electricity for space heating increases 53%
- Changes in energy use for space and water heating arise from a shift from oil and gas to electricity and new technologies
- Demand for natural gas and oil decreases 22% and 27% respectively from 1985
- Solar provides:
 - 2% of total energy
 - 1.7% of space heating
 - 5.1% water heating
- Heat pumps consume 5% of total residential energy.

A summary of data for each reference year is shown in Table 6.

B. Projection of Residential Unit Demands, Saturation, and Efficiencies

Unit energy demands for other than space heating and uses in residential dwellings were obtained from the Brookhaven National Laboratory Report 50552, "Future Residential and Commercial Energy Demand in the Northeast"³ and from the Oak Ridge report, "Residential Consumption of Electricity, 1950-1970".⁴ For space heating, we utilized the average unit demands in the A.D. Little report, "Residential and Commercial Energy Use Patterns". (These were adjusted for heating degree days and average dwelling unit size in New York State.)

TABLE 6
SUMMARY OF RESIDENTIAL ENERGY USE
(Btu x 10¹²)

	<u>NATURAL GAS</u>	<u>OIL</u>	<u>ELECTRICITY</u>	<u>OTHER</u>	<u>SOLAR</u>	<u>TOTAL</u>
<u>1974</u>						
Air Cond.			10.3		.0	10.8
Cooking	36.1	4.64	4.11			44.8
Light-Appli.			84.4			84.4
Space Heat	243.5	451.3	5.53	13.0	.0	713.3
Water Heat	<u>91.9</u>	<u>94.6</u>	<u>9.73</u>		<u>.0</u>	<u>196.2</u>
TOTAL	371.5	550.5	114.5	13.0	.0	1049.5
<u>1985</u>						
Air Cond.			15.1		.0	15.1
Cooking	36.2	4.55	6.49			47.2
Light-Appli.			115.2			115.2
Space Heat	188.0	326.3	48.6	12.5	.0	575.4
Water Heat	<u>61.9</u>	<u>69.3</u>	<u>53.7</u>		<u>2.86</u>	<u>187.8</u>
TOTAL	286.1	400.1	239.1	12.5	2.86	940.7
<u>2000</u>						
Air Cond.			21.3		0.76	22.1
Cooking	45.8	5.81	5.18			56.8
Light-Appli.			156.9			156.8
Space Heat	140.2	246.7	74.5	12.5	8.06	482.0
Water Heat	<u>36.6</u>	<u>41.1</u>	<u>99.5</u>		<u>9.59</u>	<u>186.8</u>
TOTAL	222.6	293.6	357.4	12.5	18.4	904.6

The saturation rate for space heating, water heating, and cooking were taken as unity for the two future reference years. For air conditioning and light appliances, we adopted the values projected in the A.D. Little and Oak Ridge reports mentioned above for the years 1985 and 2000. We include the results of introducing heat pumps and solar assorted space and water heating devices as shown in Table 2.

Efficiency values for all energy devices are taken from the BNL report "Sourcebook for Energy Assessment".⁵ For the future reference years, we include increases in efficiencies shown in Table 1.

C. Residential Sector Projection Basis and Data Sources

To project residential energy and fuel demands, we require the following input.

- Estimates of the numbers of households for 1974, 1985, and 2000.
(See NYS Household and Population Projections, Table 7).
- Breakdown according to housing types in the years 1974, 1985, and 2000.
(See Household Distribution, Table 8)
- Unit energy demands for major end use service in residential units (Space heating, water heating, lighting, etc.) (See Appendix A, Fuel Demand Tables)
- Saturation values for major end uses (See Appendix A)
- Breakdown according to fuel usage to meet energy end-use demand (See Appendix A)

D. Residential Fuel Mix Projections

To obtain projections of fuel utilization in the residential sector we use the following procedure:

1. The 1974 fuel utilization breakdown assumes that the data given in the 1970 Bureau of Census Report, "Detailed Housing Characteristics, 1970" is applicable to the 1974 housing stock. These results are shown in Table 9.

2. In the allocation of fuels to space and water heating end uses, we estimate electricity usage from Table 3 which shows nation-wide values for the percentages of total energy demand for these two uses which will be met by electricity under the National Energy Plan. Oil and gas are allocated to the remaining energy demand in these end use areas in the same proportion as in 1974 with the additional constraint that total natural gas consumption cannot go above current levels.

Table 7
N.Y.S. Household and Population Projections
 (Numbers are in Thousands)

	<u>1974*</u>	<u>1985</u>	<u>2000</u>
Households	6,126	6,878	7,754
Population	18,246	18,630	19,456

Source: New York State Economic Development Board. (EDB)

*By interpolation from N.Y.S. E.D.B. 1970 and 1975 estimates.

TABLE 8
SUMMARY OF HOUSEHOLD DISTRIBUTION BY HOUSING TYPE AND FUEL, 1974
 (10³ Households)

<u>Housing Type</u>	<u>Space Heating</u>				<u>Water Heating</u>			<u>Cooking</u>			<u>Lights-Appliances</u>	<u>Air Conditioning</u>
	<u>Oil</u>	<u>Gas</u>	<u>Electric</u>	<u>Other</u>	<u>Oil</u>	<u>Gas</u>	<u>Electric</u>	<u>Oil</u>	<u>Gas</u>	<u>Electric</u>	<u>Electric</u>	<u>Electric</u>
Single Family	1360	880	40	30	1130	1000	180	200	1630	480	1390	760
Low Density	860	550	20	20	710	630	110	130	1020	300	880	480
Low Rise	460	300	10	10	390	340	60	70	550	160	470	260
High Rise	890	580	20	20	740	650	120	130	1070	320	910	420

E. Housing Projections

Housing was categorized into four basic types:

- Single family - one unit detached structure
- Low Density - one unit attached structure and 2 to 4 unit structures
- Low Rise - structures with 5 to 19 housing units
- High Rise - structures with 20 or more units

The projected housing mix shown in Table 9 was obtained using the following procedure.

1. The 1974 breakdown for New York State was assumed to be the same as that given in the 1970 Census of Housing¹
2. The 1985 and 2000 housing breakdown was distributed according to data in the "Project Independence Task Force Report."⁽²⁾
The resulting breakdown of housing types together with the annual growth rate (AGR) for each basic type are shown in Table 9.

TABLE 9
Annual Growth Rates and Basis
Changes for Reference Years
(10⁶ Households)

<u>Subsector</u>	<u>1974 Basis</u>	<u>1974-85 AGR*</u>	<u>1985 Basis</u>	<u>1985-2000 AGR*</u>	<u>2000 Basis</u>
High Rise	1.53	.0041	1.60	0	1.60
Low Density	1.47	.0006	1.48	.0039	1.57
Low Rise	.79	.0217	1.0	.0094	1.15
Single Family	2.33	.0165	2.79	.0139	3.43
Total**	6.13	.0106	6.88	.0081	7.75

*Annual Growth Rate

**Total may not add due to rounding

3. For the remaining end use demands, allocation among fuels is based on the 1974 breakdown.

Fuel demands in the residential sector for 1985 and 2000 are shown in Appendix A.

THE COMMERCIAL SECTOR

A. Highlights

Highlighting energy consumption in this sector in all reference years were the following.

1974

- Total energy consumption: 642×10^{12} Btu
- Consumes 19% of total state energy demand
- By energy form demands in terms of state totals are: oil, 13%; gas, 17%; electricity, 35%
- By energy form, demands in terms of commercial totals are: oil, 57%; gas, 18%; electricity, 20%
- By end use energy, demands as a fraction of sectorial total energy are as follows:

Space Heat	oil 100%, gas 62%, electricity 0%
Water Heat	oil 0%, gas 36%, electricity 11%
Lighting	electricity 46%
App-Aux Equip.	electricity 31%

1985

- Total energy consumption: 665×10^{12} Btu
 - Consumes 18% of total state energy demand
 - By energy form, demands in terms of state totals are: oil, 12%; gas, 19%; electricity, 32%
 - By energy form, demands in terms of commercial totals are: oil, 51%; gas, 16%; electricity, 28%
 - By end use, demands as a fraction of sectorial total energy are as follows:
Space Heat	oil 100%, gas 55%, electricity 14%
Water Heat	oil 0%, gas 44%, electricity 9%
Lighting	electricity 38%
App-Aux Equip.	electricity 29%

- Demand for electricity increases 41% while natural gas and oil decrease 7% each (from 1974)
- Space heating demand decreases 3%
- Heat pumps provide 2% of space heating
- Solar provides 1% of water heating
- Changes in energy use for space heating and water heating arise from a shift to electricity and new technologies from natural gas and oil

2000

- Total energy consumption: 594×10^{12} Btu
- Consumes 14% of total state energy demand
- By energy form, demands are in terms of state totals: oil, 11%; gas, 18%; electricity, 29%
- By energy form, demands are in terms of commercial totals: oil, 42%; gas, 13%; electricity, 38%
- By end use, energy demands as a fraction of sectorial total energy are as follows:

Space Heating: oil 100%, gas 56%, electricity 18%

Water Heating: oil 0%, gas 43%, electricity 12%

Lighting: electricity 35%

App-Aux Equip.: electricity 26%

- Electricity use increases 20% (from 1985) because of a change in energy use for space heating and water heating arising from a shift to electricity and new technologies from oil and gas
- Oil decreases 28%, gas 27% (from 1985)
- Space heating demand decreases 19%
- Solar provides 1% of total commercial demand

A summary of data for each reference year is shown in Table 10.

B. Commercial Sector Projection Basis and Data Sources

Included in the commercial sector are structures serving such diverse activities as wholesale and retail trade, services (finance, insurance, etc.) schools, and hospitals.

To project the energy demand in each of these categories, we require the following input:

- a breakdown according to activities indicated above by square footage of floorspace in the reference years.

TABLE 10

SUMMARY OF COMMERCIAL ENERGY DEMAND(Btu x 10¹²)

	<u>NATURAL GAS</u>	<u>OIL</u>	<u>ELECTRICITY</u>	<u>STEAM</u>	<u>SOLAR</u>	<u>TOTAL DIRECT USE</u>
<u>1974</u>						
Air Cond.	1.00		17.4			18.4
App-Aux Equip.			40.5			40.5
Lighting			59.9			59.9
Space Heat	70.5	363.4		34.3		468.2
Water Heat	<u>41.2</u>	<u> </u>	<u>13.6</u>	<u> </u>	<u> </u>	<u>54.8</u>
TOTAL	112.7	363.4	131.4	34.3	0	641.8
<u>1985</u>						
Air Cond.	0.90		19.5			20.4
App-Aux Equip.			54.0			54.0
Lighting			71.7			71.7
Space Heat	56.6	337.5	26.3	33.4		453.8
Water Heat	<u>46.8</u>	<u>.0</u>	<u>17.2</u>	<u> </u>	<u>0.68</u>	<u>64.7</u>
TOTAL	104.3	337.5	188.7	33.4	0.68	664.6
<u>2000</u>						
Air Cond.	0.80		21.5		0.63	22.9
App-Aux Equip.			58.5			58.5
Lighting			79.2			79.2
Space Heat	43.0	249.3	39.8	33.4	4.3	369.8
Water Heat	<u>32.8</u>	<u> </u>	<u>28.5</u>	<u> </u>	<u>2.33</u>	<u>63.6</u>
TOTAL	765.	249.3	227.5	33.4	7.26	594.0

- unit energy demands for major energy end uses (space and water heating, air conditioning, lighting, etc.) (Btu/sq. ft.).
- saturation values for major end uses.
- breakdown of fuels utilized for each end use.

C. Commercial Sector Projections

Determination of floorspace in this sector for New York State was difficult as little data have been published at the level of disaggregation required. National data obtained from Project Independence: Residential and Commercial Energy Use Patterns,² and regionalized to New York State as explained in BNL-50552,³ were used as a starting point for further analysis.

The following assumptions were made to allow a more detailed breakdown:

- a. Office floorspace is proportional to employment levels in finance, insurance, real estate, and government.
- b. Likewise, retail floorspace is based on employment in the wholesale and retail trade.
- c. Hospital floorspace is proportional to the number of hospital beds.
- d. Miscellaneous floorspace is a function of total population.

Coefficients in each of these commercial subsectors were obtained from the A.D. Little² report and the U.S. Statistical Abstracts, 1972.⁶

School floorspace for 1974 was obtained as follows:

- a. College floorspace was obtained from the New York State Dept. of Education, Post Secondary Education.⁷
- b. Enrollment data for 1974 for all pre-college pupils was obtained from Reference 8. Floorspace was estimated by multiplying enrollment for 1974 by a 100 sq. ft. per pupil, as recommended by Reference 8.
- c. College floorspace and estimated pre-college floorspace were added together to obtain 1974 school floorspace.

The 1974 floorspace breakdown by subsector is shown in Table 11.

TABLE 11
Annual Growth Rates and Basis
Changes for Reference Years
(10⁶ sq. ft.)

<u>Subsector</u>	<u>1974 Basis</u>	<u>1974-85 AGR*</u>	<u>1985 Basis</u>	<u>1985-2000 AGR*</u>	<u>2000 Basis</u>
School	574.00	0	574.00	0	574.00
Hospital	208.70	0	208.70	0	208.70
Office	456.20	.0087	501.82	.0064	552.00
Retail	509.99	.0131	588.53	.0101	683.87
Services	<u>780.00</u>	<u>.0131</u>	<u>900.12</u>	<u>.0101</u>	<u>1045.94</u>
Total	2528.89	.0084	2773.17	.0067	3064.51

*Annual Growth Rate

The projected growth rates in each of the commercial sub-sectors were obtained using the following procedure.

1. Office: The Regional Plan Association⁹ (R.P.A.) projections for growth of office space in the downstate area are modified to cover the entire state. These values are then scaled down to take account of the differences between the population projections used in R.P.A. estimates which were judged to be too high and the population projections used by the New York State Economic Development Board.

2. Schools: As a starting basis, the New York State Education Department projections for student enrollments are used. These show a 20% decrease by 1985 and from then on to the year 2000 only a slight increase.¹¹ These enrollment decreases were then translated into decreases in floorspace. These resultant figures were then adjusted upward to take account of a lowered rate of school closings to reduce overcrowding, shifts in population and the fact that even closed schools will require some energy to be maintained.

3. Hospitals: A reduction in the total number of hospital beds of 18% by 1980 is used as the basis of projecting hospital floor space.¹² The resultant drop in total state hospital square footage which is calculated on the basis of the current proportionality between hospital beds and floor area is adjusted upward to take into account (i) a trend toward increasing floorspace/bed, (ii) shifting state population which will lead to demands for hospitals in newly developed areas, and (iii) a time lag in the closing of entire hospital units.

4. Trade: Trade employment projections based on current employment/population ratios were used to estimate the projected total retail and wholesale floor area. The employment/population factors are taken from, "1972 OBERS Projections: Economic Activity in the U.S."¹⁰ The projected state population figures are obtained from the New York State Economic Development Board.

Table 11 shows a summary of the commercial sector projections through the year 2000.

D. Projections of Commercial Unit Demand, Saturation, and Efficiencies

Because of the wide variety in the construction age and function of commercial buildings, it is much more difficult to characterize their technical performance than other buildings. BNL Report 50552 (Ref. 3) which is based on buildings characteristic of the Northeast part of the country was used to obtain current values for unit energy demand, levels of saturation and end-use device efficiencies. Efficiency changes and a rate of introduction of heat pumps and solar heating and cooling consistent with the National Energy Plan (Tables 1 and 2) were used in projecting these values to 1985 and 2000.

E. Commercial Fuel Mix Projections

The procedure used here is similar to that used in the residential sector.

The final results for the commercial sector energy demand and fuel mix utilization are given in Appendix A.

VI
THE INDUSTRIAL SECTOR

A. Highlights

Highlighting the energy consumption for this sector for each reference year were the following.

1974

- Total energy consumption: 703×10^{12} Btu
- Consumes 19% of the total state energy demand
- The five largest energy consumers in the manufacturing sector were (in decreasing order):
 - Chemical and allied products, SIC 28
 - Primary metal industries, SIC 33
 - Stone, clay and glass products, SIC 32
 - Paper and allied products, SIC 26
 - Food and kindred products, SIC 20
- By energy source, the manufacturing sectors demand as a percentage of state totals were: oil, 11%*; gas, 19%; coal, 47%**; electricity, 31%
- Petrochemical feedstocks to chemical and allied products, (SIC 28) constituted 53% of total oil demand of the manufacturing sector
- Coke to primary metal industries (SIC33) constituted 63% of the total manufacturing coal demand

1985

- Total energy consumption: 899×10^{12} Btu
- Consumes 24% of the total state energy demand
- By energy source, the manufacturing sectors demand as a percentage of state totals were: oil, 12%*; gas, 27%; coal, 30%**; electricity, 25%
- Petrochemical feedstocks to SIC 28 constituted 60% of sectorial oil demand
- Coke to SIC 33 constituted 52% of sectorial coal demand
- Coal demand (excluding coke) increases 73% because of a shift to coal from natural gas and oil
- Oil (excluding petrochemical feedstock) increases by 11% over 1974, gas by 15%,

*includes petrochemical feedstocks

**includes coke

- The increases in fuel demand from 1974 of the sector's major users of energy were:

SIC28	(Chemical and allied products)	44%
SIC33	(Primary metal industries)	5%
SIC32	(Stone, clay and glass products)	72%
SIC26	(Paper and allied products)	29%
SIC20	(Food and kindred products)	8%

2000

- Total energy consumption: 1178×10^{12} Btu
- Consumes 29% of the total state energy demand
- By energy source, the manufacturing sectors demand as a percentage of state totals were: oil, 20%; gas, 31%; coal, 22%; electricity, 24%
- Petrochemical feedstocks to SIC28 constituted 70% of this sectors oil demand
- Coke to SIC33 constituted 36% of this sectors total coal demand
- Coal demand increases by 44% arising from a continued shift to coal from natural gas and oil (92% excluding coke)
- Oil (excluding petrochemical feedstocks) increases 4% from 1985, petrochemical feedstock by 62%
- Gas decreases 5% (from 1985)
- The changes in fuel demand from 1985 of the sector's major users of energy were:

SIC28	(Chemical and allied products)	+58%
SIC33	(Primary metal industries)	-3%
SIC32	(Stone, clay and glass products)	+10%
SIC26	(Paper and allied products)	+30%
SIC20	(Food and kindred products)	+15%

Energy use data for all reference years are summarized in Table 12.

B. Industrial Sector Projection Basis and Data Sources

The energy intensiveness of each industrial subsector is represented by the ratio $\frac{\text{Btu}}{\text{dollar-value added}}$. Value added for 1974 was obtained from Reference 13.

Fuel consumption for 1974 by 2 digit SIC code was obtained from the 1974 Census of Manufacturers Special Fuel Series.¹⁴ Natural gas consumption was computed from 1974 N.Y. gas utility information.¹⁵ Additional coal data were obtained from the U.S. Bureau of Mines.¹⁶ Total fuel consumption by SIC is shown in Table 13. Industrial fuel mix by end use was difficult to characterize because the

TABLE 12
SUMMARY OF ENERGY USE IN
THE MANUFACTURING SECTOR

	(Btu x 10 ⁹)					
	<u>NATURAL</u> <u>GAS</u>	<u>OIL</u>	<u>COAL</u>	<u>ELECTRICITY</u>	<u>FEEDSTOCK</u>	<u>TOTAL</u>
<u>1975</u>						
SIC 20	16007.7	14689.3	307.0	7201.5		38205.5
SIC 22	2628.7	2438.8	.0	2241.6		7309.1
SIC 23	250.2	683.7	.0	4443.2		5377.0
SIC 24	499.9	670.5	29.2	938.4		2137.9
SIC 25	500.5	897.8	13.3	776.6		2188.3
SIC 26	3380.0	31771.2	5782.8	10750.9		51684.9
SIC 27	747.8	1024.5		5186.8		6959.1
SIC 28	14890.3	21732.0	21858.0	13397.0	154997.3(1)	226874.6
SIC 30	2130.4	1717.1	6955.8	3785.6		14588.9
SIC 31	250.6	478.8	89.7	.0		819.2
SIC 32	19767.8	20374.2	10964.8	5828.0		56934.9
SIC 33	28269.8	17558.5	4592.6	27901.7	110207.0(2)	188529.6
SIC 34	7007.5	3535.6	177.6	5221.7		15942.4
SIC 35	7380.1	7080.1	943.4	7011.1		22414.6
SIC 36	8006.4	4288.4	114.0	9557.9		21966.7
SIC 37	8759.1	3480.0	1506.4	4720.7		18466.2
SIC 38	3002.7	3263.2	9758.3	2408.9		18433.1
SIC 39	749.1	859.2	335.2	2407.3		4350.7
TOTAL	124228.6	136542.8	63428.1	113778.8	265204.3	703182.7
<u>1985</u>						
SIC 20	17307.3	14774.6	415.4	8052.0		40549.3
SIC 22	3164.1	2731.6	.0	2781.1		8676.8
SIC 23	301.8	767.4	.0	5524.5		6593.7
SIC 24	592.5	741.4	43.6	1158.0		2535.5
SIC 25	581.2	972.1	19.4	933.8		2506.5
SIC 26	3261.2	39009.7	9824.6	15089.7		67185.2
SIC 27	967.3	1233.2		6915.9		9116.4
SIC 28	16017.7	24038.7	39124.4	19810.8	229194.5(1)	328186.1
SIC 30	1348.6	706.3	12384.5	5568.2		20007.5
SIC 31	333.7	611.6	158.7	.0		1104.0
SIC 32	25461.0	24494.4	19459.6	8545.1		77960.1
SIC 33	29451.6	17022.2	4931.3	28445.8	118346.3(2)	198197.2
SIC 34	10030.5	4689.4	318.5	7737.7		22776.1
SIC 35	8793.3	7842.6	1433.7	8802.3		26871.9
SIC 36	11409.3	5674.6	203.1	14073.4		31360.4
SIC 37	11345.1	4802.2	2507.9	6492.8		24348.0
SIC 38	1905.7	2118.2	17318.6	3531.9		24874.5
SIC 39	984.3	1061.7	594.8	3529.5		6170.3
TOTAL	143256.1	152492.0	108738.1	146992.5	347540.8	899019.5
<u>2000</u>						
SIC 20	19850.7	16607.5	701.4	10126.6		47286.2
SIC 22	3679.3	3114.7	.0	3523.6		10317.5
SIC 23	354.1	882.8	.0	7061.7		8298.5
SIC 24	717.7	885.1	78.7	1558.5		3239.9
SIC 25	711.6	1171.8	35.0	1256.8		3175.2
SIC 26	866.9	46731.4	18715.2	21410.9		87724.3
SIC 27	1289.6	1612.2		10045.6		12947.4
SIC 28	8461.2	21059.4	85234.8	32147.6	371918.6(1)	518821.7
SIC 30	.0	.0	19680.1	8487.4		28167.6
SIC 31	408.2	785.5	324.9	.0		1518.5
SIC 32	28427.3	27039.5	39822.2	13025.3		108314.2
SIC 33	27562.9	15621.5	4799.6	26338.4	116206.5(2)	190528.8
SIC 34	10242.0	4656.1	479.7	8681.3		24059.0
SIC 35	8562.0	7473.6	2133.9	9758.7		27928.2
SIC 36	10820.0	5255.4	283.0	14610.5		30969.0
SIC 37	13351.7	4149.5	4585.0	8841.8		30928.1
SIC 38	.0	.0	29097.3	5383.7		34480.9
SIC 39	1157.1	1255.9	1217.3	5380.0		9010.3
TOTAL	136462.1	158301.8	207188.1	187638.2	488125.1	1177715.3

Note: Data are retained to one decimal place for convenience of computations.
In general, current data are, at least accurate to a few percent. Projected data are, of course much less certain.

(1) Petrochemical Feedstock

(2) Coke

Table 13

INDUSTRIAL SUBSECTORS ORDERED BY ENERGY USE IN 1974

<u>Order</u>	<u>SIC</u>	<u>Description</u>	<u>Energy Demand (10¹² Btu)</u>
1	28	Chemical and allied products	226.9
2	33	Primary metal industries	188.5
3	32	Stone, clay, and glass products	56.9
4	26	Paper and allied products	51.7
5	20	Food and kindred products	38.21
6	35	Machinery, except electrical	22.41
7	36	Electrical equipment supplies	22.0
8	37	Transportation equipment	18.53
9	38	Instruments and related products	18.43
10	34	Fabricated metal products	15.9
11	30	Rubber and plastic products	14.6
12	22	Textile mill products	7.31
13	27	Printing and publishing	6.96
14	23	Apparel and other fabric products	5.38
15	39	Misc. manufacturing industries	4.35
16	25	Furniture and fixtures	2.19
17	24	Lumber and wood products	2.14
18	31	Leather and leather products	<u>0.82</u>
			703.2

fuels used were dependent on the industrial processes employed. This analysis of fuel mix was based on a combination of all functional end uses -- process heat, space conditioning, lighting, etc. - and fuel mix for an aggregate end use by subsector (by 2 digit SIC code) was obtained. Since end uses were aggregated saturation was assumed to be 1. Efficiencies were taken from Brookhaven's Report "Sourcebook for Energy Assessment", BNL-50483.⁵

C. Industrial Fuel Mix Projections

Projections of fuel demands by SIC are based on estimates of values added in 1985 and 2000, on changes in the efficiency of industrial processes and fuel substitutions. In the paragraphs which follow, the first of these factors, the projection of value added is described.

A constant national ratio of Gross Product Originating (GPO) to earnings was obtained from Reference 10 by 2 digit SIC for 1974, 1985, and 2000. The 1974 New York State GPO was obtained for each SIC by multiplying the New York State 1974 earnings for each SIC (from Ref. 10) by the national GPO/earnings ratio. The 1985 GPO was obtained by multiplying the 1985 GPO/earnings ratio by the 1985 projected earnings for each SIC. The 2000 GPO for each SIC was estimated similarly.

Growth rates for each SIC were then calculated by determining the difference in GPO from 1974 to 1985 and from 1985 to 2000. These rates were then used to determine 1985 and 2000 value added by SIC.

Table 14 summarizes 1985 and 2000 value added.

Fuel demand by SIC are then estimated by application of the energy intensiveness coefficients described above to the projected value added taking into account efficiency changes and fuel substitutions described in Section II. Projected fuel demands for the major industrial consumers of energy are shown in Table 15. Projected fuel demand by energy source is shown in Table 16. A description of fuel mix by SIC for each reference year is shown in Appendix A.

Table 14
Annual Growth Rates and Basis
Changes for Reference Years
(Value Added = 10⁶\$)

<u>Subsector</u>	<u>1974</u> <u>Basis *</u>	<u>1974-85</u> <u>AGR**</u>	<u>1985</u> <u>Basis *</u>	<u>1985-2000</u> <u>AGR**</u>	<u>2000</u> <u>Basis *</u>
SIC 20	2600.2	.0102	2907.3	.0154	3656.3
22	716.1	.0198	888.5	.0159	1125.7
23	2902.4	.0200	3608.8	.0165	4612.9
24	243.7	.0193	300.7	.0200	404.7
25	488.2	.0169	538.9	.0200	725.3
26	1089.8	.0313	1529.6	.0236	2170.4
27	4695.4	.0265	6260.7	.0252	9093.9
28	2367.6	.0362	3501.0	.0328	5681.9
30	688.4	.0357	1012.6	.0285	1543.4
31	337.0	.0351	492.5	.0285	750.8
32	924.2	.0354	1355.1	.0285	2065.5
33	1818.3	.0065	1952.6	.0013	1991.0
34	1884.1	.0364	2791.9	.0077	3132.3
35	3816.9	.0209	4792.1	.0069	5312.8
36	3435.4	.0358	5058.4	.0025	5251.4
37	1597.1	.0294	2196.6	.0208	2991.4
38	4392.0	.0354	6439.5	.0285	9815.6
39	1211.4	.0354	1776.4	.0285	2707.3

*The basis for this sector is value added

**Annual Growth Rate

TABLE 15
MAJOR INDUSTRIAL ENERGY USERS: TOTAL FUEL DEMAND
 Btu x 10¹² (%)

<u>SIC</u>	<u>Description</u>	<u>1974</u>	<u>%</u>	<u>1985</u>	<u>%</u>	<u>2000</u>	
28	Chemical and allied products	227	(32.2)	328	(36.5)	519	(44.0)
33	Primary metal industries	189	(26.9)	198	(22.0)	191	(16.2)
32	Stone, clay, and glass products	57	(8.1)	78	(8.7)	108	(9.2)
26	Paper and allied products	52	(7.3)	67	(7.5)	88	(7.4)
20	Food and kindred products	38	(5.3)	41	(4.6)	47	(4.0)

TABLE 16
Manufacturing Energy Demand by Fuel Type
 % and (Btu x 10¹²)

<u>Fuel Type</u>	<u>%</u>	<u>1974</u> <u>Btu x 10¹²</u>	<u>%</u>	<u>1985</u> <u>Btu x 10¹²</u>	<u>%</u>	<u>2000</u> <u>Btu x 10¹²</u>
Coal*	24.7	174	25.3	227	27.5	323
Natural Gas	19.5	124	15.9	143	11.6	136
Oil	17.6	137	16.9	153	13.4	158
Electricity	16.2	114	16.4	147	16.0	188
Petrochemical Feedstock	21.9	155	25.5	229	31.6	372

*Includes coke

VII
THE TRANSPORTATION SECTOR

A. Highlights

Highlighting energy consumption in this sector for each reference year were the following.

1974

- Total energy consumption: 998×10^{12} Btu
- Consumes 29% of the total state energy demand
- By energy form, demands are in terms of state totals: oil, 36%; elec. 3%.
- By mode, energy demands as a fraction of sectorial total energy are as follows:

Automobile	64%
Air Pass	13%
Truck	10%
Air Freight	5%
Water Freight	5%
Rail	3%

1985

- Total energy consumption: 1215×10^{12} Btu
- Consumes 33% of state's total energy demand
- By energy form, demands are in terms of state totals: oil, 39%; elec. 2%
- By mode, energy demands as a fraction of sectorial total energy are as follows:

Automobile	60%
Air Pass	16%
Truck	10%
Air Freight	6%
Water Freight	5%
Rail	3%

- Fuel demand by automobiles increases by 13%, accompanied by a decrease in the unit demand of 32%.
- Fuel demand of the air subsectors increases 52% from 1974 as a consequence of increases in demand despite decreased unit demand.

2000

- Total energy consumption: 1413×10^{12} Btu
- Consumes 34% of states total energy demand
- By energy form, demands are in terms of state totals: oil, 54%; electricity 2%
- By mode energy demands as a fraction of sectorial total energy are as follows:

Automobile	46%
Air Pass	25%
Air Freight	11%
Truck	9%
Water Freight	6%
Rail	3%

- Fuel demand by automobiles decreases 14% from 1985, despite a growth in passenger-miles, due to a decrease in the unit demand of 36%.
- Truck and bus unit demands decrease by about 20%
- Air subsectors demands increase by 88% from 1985
- Electric car penetration of 1% reduces automobile oil requirements by 6.47×10^{12} Btu while increasing fuel demands in the utility sector.

A summary of reference year fuel demands by end use is presented in Table 17.

B. Transportation Sector Projection Basis and Data Sources

Data of ton-miles for freight carriers, passenger-miles for passenger carriers as well as fuel demands for 1974 were obtained from a previous study by Systems Designs, Inc.¹⁷ Modifications where appropriate were made based on more recent information. For instance, air passenger and air freight fuel consumption data for 1974 were modified, based on information from the Air Transport Association.¹⁸

For the automobile subsector, the Department of Taxation and Finance furnished data for 1974 gasoline tax revenues. This was used as an indicator of state gas consumption. Vehicle miles and growth rates were obtained from Highway Statistics, 1974¹⁹ and Systems Design, Inc.¹⁷ respectively.

The 1974 fuel demand is presented in Appendix A.

Table 17
SUMMARY OF TRANSPORTATION ENERGY DEMANDS
 (Btu x 10⁹)

<u>1974</u>	<u>Oil</u>	<u>Electricity</u>	<u>Total</u>
Freight	213.5	0.	213,685.1
Passenger	773,260.1	10,808.6	784,068.7
Total	986,429.5	11,024.3	997,753.9
<u>1985</u>			
Freight	268,970.1	665.8	269,635.9
Passenger	934,284.4	11,287.6	945,572.0
Total	1,203,254.6	11,953.3	1,215,207.9
<u>2000</u>			
Freight	384,943.1	811.7	385,754.8
Passenger	1,014,045.9	12,746.5	1,026,792.4
Total	1,398,989.0	13,558.1	1,412,547.1

Note: For the sake of consistency and computational convenience, one decimal place has been retained in all entries. This does not indicate the accuracy of the data.

Table 18

Annual Growth Rates and Basis

Changes for Reference Years

(10⁶ Passenger miles for passenger transport:

10⁶ Ton miles for freight)

<u>Subsector</u>	<u>1974 Basis</u>	<u>1974-85 AGR*</u>	<u>1985 Basis</u>	<u>1985-2000 AGR*</u>	<u>2000 Basis</u>
Air Pass	8,376	.04	12,895	.04	23,223
Air Freight	1,209	.05	2,068	.05	4,301
Auto	101,041	.0352	125,750	.0186	165,778
Bus	622	.0140	725	.0182	953
Rail-Pass	10,702	.0190	13,164	.0081	14,865
Rail-Freight	4,309	.0190	5,300	.0133	6,463
Truck	28,045	.0120	31,972	.0171	41,227
Water-Freight	1,125	.0256	1,485	.0182	1,946

*Annual Growth Rate

C. Fuel Projections

Ton-mile, passenger-mile, and fuel demand data for 1985 and 2000 were obtained from Reference 17. Data for the air subsectors were modified according to Reference 18 and 20. Values used in this study are presented in Table 18. Efficiency and unit demands were modified to conform with National Energy Plan goals.

Table 19 summarizes transportation energy demand by reference year. The 1985 and 2000 fuel demands are shown in Appendix A.

TABLE 19
Transportation Fuel Demand
(Btu x 10¹²)

	<u>Autos</u>	<u>Truck</u>	<u>Air Pass</u>	<u>Air Freight</u>	<u>Water</u>	<u>Rail</u>	<u>Bus</u>	<u>Total</u>
1974	636.7	102.6	126.8	52.7	48.7	22.1	8.31	997.8
1985	723.0	118.2	193.0	75.4	64.2	31.7	9.68	1215.2
2000	646.5	130.5	347.6	156.7	84.2	36.8	10.3	1412.5

VIII
THE GOVERNMENT SECTOR

A. Highlights

Highlighting energy consumption in this sector for all reference years were the following.

1974

- Total energy consumption: 6.8×10^{12} Btu
- Consumes less than .2% of total state energy demand
- By energy form, demands in terms of government totals are: oil, 69%; gas, 12%; electricity, 14%
- By end use, energy demands as a fraction of sectorial total energy are as follows:

Space Heating	oil, 79%; gas, 90%; electricity 0%
Auto	oil 21%
Lighting	electricity 49%
App-Aux Equip.	electricity 26%
Air conditioning	electricity 23%

1985

- Total energy consumption: 6.0×10^{12} Btu
- Consumes less than .2% of total state energy demand
- By energy form, demands in terms of government totals are: oil, 61%; gas, 11%; electricity, 22%
- By end use, energy demands as a fraction of sectorial total energy as follows:

Space Heating	oil, 79%; gas, 93%; electricity, 28%
Auto	oil, 21%
Lighting	electricity, 36%
App-Aux Equip.	electricity, 19%
Air conditioning	electricity, 15%
- Electrical demand increases 15% over 1974 arising from a shift to electricity from natural gas and oil
- Oil demand decreases 16%, and gas by 22% (from 1974)
- Automobile demand decreases 21%, Space heat demand decreases 16%

2000

- Total energy consumption: 4.8×10^{12} Btu
- Consumes .1% of total state energy demand
- By energy form, demands in terms of government totals are: oil, 53%; gas, 8%; electricity, 31%
- By end use, energy demands as a fraction of sectorial total energy are as follows:

Space Heating	oil, 78%; gas, 65%; electricity, 34%
Auto	oil, 22%
Lighting	electricity, 33%
App-Aux Equip.	electricity, 18%
Air conditioning	electricity, 13%
- Electrical demand increases 18% from 1985 arising from a shift to electricity and new technologies from gas and oil
- Oil use declines 31% (from 1985)
- Automobile demand decreases 30%, space heating demand by 24%
- Solar provides 1% of government demand
- Heat pumps require 9% of space heating demand

A summary of government fuel demands for each reference year is presented in Table 20.

B. Government Sector Projection Basis and Data Sources

Government offices and auto fleet are the primary energy consuming units in the government sector. As in the commercial sector, floorspace was selected as a projection variable for government offices. Total passenger miles was selected as the projection variable for government auto fleets, as for the autos in the transportation sector. Office space data were obtained from the NYS Bureau of Space Planning²¹ and the number of automobiles and the average yearly mileage from the NYS Office of General Services.²²

Unit demands and efficiencies for office energy use are assumed to be the same as for commercial sector office energy use. Unit demands and efficiencies of state automobiles are assumed to be the same as those for privately owned automobiles in the transportation sector. Fuel demands for 1974 are presented in Appendix A.

TABLE 20
SUMMARY OF ENERGY USE IN THE GOVERNMENT SECTOR
(Btu x 10⁹)

	<u>NATURAL GAS</u>	<u>OIL</u>	<u>ELECTRICITY</u>	<u>STEAM</u>	<u>SOLAR</u>	<u>TOTAL</u>
<u>1974</u>						
Air Cond	13.0		209.4		.0	222.4
App-Aux Equip			242.1			242.1
Autos		988.5				988.5
Lighting			453.9			453.9
Space Heat	715.4	3694.7	.0	349.5	.0	4759.6
Water Heat	<u>64.6</u>	<u>.0</u>	<u>21.3</u>	<u> </u>	<u>.0</u>	<u>86.0</u>
TOTAL	793.0	4683.2	926.6	349.5	.0	6752.4
 <u>1985</u>						
Air Cond	7.		194.1		.0	201.4
App-Aux Equip			247.0			247.0
Autos		778.2				778.2
Lighting			463.1			463.1
Space Heat	622.1	2888.1	362.8	349.5	.0	4222.5
Water Heat	<u>40.0</u>	<u> </u>	<u>26.6</u>	<u> </u>	<u>1.3</u>	<u>67.9</u>
TOTAL	669.4	3666.3	1293.5	349.5	1.3	5980.1
 <u>2000</u>						
Air Cond	4.7		185.2		7.0	196.8
App-Aux Equip			258.0			258.0
Autos		546.9				546.9
Lighting			483.7			483.7
Space Heat	357.8	1975.7	498.4	349.5	53.8	3235.3
Water Heat	<u>34.9</u>	<u> </u>	<u>44.7</u>	<u> </u>	<u>4.3</u>	<u>83.9</u>
TOTAL	397.4	2522.6	1470.1	349.5	65.0	4804.7

C. Fuel Mix Projections

It was assumed that office space and passenger miles, would increase at the same rate as the state's population. Population projections for 1985 and 2000 were those of the N.Y. EDP. Growth rates and projected floorspace and passenger miles for 1985 and 2000 are shown in Table 21.

Changes in fuel utilization in 1985 and 2000 are attributed to efficiency changes in accordance with the National Energy Plan. The 1985 and 2000 fuel demands are presented in Appendix A.

Table 21
Annual Growth Rates and Basis
Changes by Reference Year

<u>Subsector</u>	<u>1974 Basis</u>	<u>1974-85 AGR*</u>	<u>1985 Basis</u>	<u>1985-2000 AGR*</u>	<u>2000 Basis</u>
Offices (10 ⁶ sq. ft)	17.8	.0019	18.2	.0029	19.0
Pass Trans. (10 ⁶ veh. mile)	115.5	.0018	117.9	.0028	122.9

*Annual Growth Rate

IX

THE AGRICULTURAL SECTOR

A. Highlights

Highlights for the agricultural sector for each reference year are as follows:

1974

- Total energy consumption: 10.8×10^{12} Btu
- Consumes less than 1% of state's energy consumption
- By energy forms, demands in terms of agricultural totals are: oil, 86%; electricity, 14%

1985

- Total energy consumption: 11.8×10^{12} Btu
- Consumes less than 1% of state's energy consumption
- By energy form, demands in terms of agriculture total are: oil, 90%; electricity, 10%;
- Electricity demand decreases 20%, oil demand increases 13% (from 1974)

2000

- Total energy consumption: 13.2×10^{12} Btu
- Consumes less than 1% of state's energy consumption
- By energy form, demands in terms of agricultural total are: oil, 91%; electricity, 9%
- Oil demand increases 13%, electricity demand remains the same

A summary of agricultural fuel demand by reference year is presented in Table 22.

B. Agricultural Demand

The underlying determinants of energy use in the agricultural sector are number of farms, acres harvested by kind of crop and heads of livestock. For 1974, data of these subsectors as determined from Reference 23 and 24 are shown below.

AGRICULTURAL SUBSECTORS - 1974

<u>Subsector</u>	<u>Basis</u>
Crops	4176 thousand acres harvested
Livestock	1720 thousand head of cattle
Farms	48 thousand farms

TABLE 22
SUMMARY OF ENERGY USE IN THE AGRICULTURAL SECTOR
(Btu x 10⁹)

<u>1974</u>	<u>OIL</u>	<u>ELECTRICITY</u>	<u>TOTAL DIRECT USE</u>
All Crops	6952.7		6952.7
All Stock	1607.9		1607.9
Electricity		1464.4	1464.4
Propane	<u>800.4</u>		<u>800.4</u>
TOTAL	9361.0	1464.4	10825.5
 <u>1985</u>			
All Crops	8045.4		8045.4
All Stock	1853.4		1853.4
Electricity		1170.7	1170.7
Propane	<u>639.9</u>		<u>639.9</u>
TOTAL	10538.6	1170.7	11709.3
 <u>2000</u>			
All Crops	9234.1		9234.1
All Stock	2135.5		2135.5
Electricity		1170.7	1170.7
Propane	<u>639.9</u>		<u>639.9</u>
TOTAL	12009.5	1170.7	13180.2

Note: For the sake of consistency and computational convenience, one decimal place has been retained in all entries. This does not indicate the accuracy of the data.

To estimate energy consumption in the crops subsector, it would be desirable to determine energy consumption by specific end uses. Since such data are currently unavailable an aggregate end use is defined. This encompasses all end uses for a subsector. For crops, this includes tilling, planting, cultivating, harvesting, drying, etc. Fuel consumption patterns will reflect the crop acreage harvested and the choice of technologies employed. For this study, technologies have been specified by the type of fuel using average efficiencies of typical devices which use that fuel. The energy consumption for crops is determined by this technology mix, the technology basis - in this case total acres harvested - and the average efficiency of fuel use for that technology. Similarly, an aggregate end use is defined for the livestock subsector including, for example, heating barns and cleaning milk machines. The fuel consumption patterns will reflect the composition of total livestock, and a technology specified by type of fuel with an efficiency typical of the various devices using that fuel.

The 1974 fuel demands are presented in Appendix A.

Projections of energy demands for this sector were derived from 1972 OBERS projections for New York State using projected total earnings in agriculture for 1974 and 1985. These earnings data yield a 15.5 percent increase from 1974 to 1985 and a 15.0 percent increase from 1985-2000. Unit demands as well as fuel fractions and efficiencies are assumed to remain constant through the year 2000.

While increasing income is projected, the number of farms is expected to decrease by 20% in the period 1974 to 1985 (Ref. 23). It was assumed that no further decrease would occur between 1985 and 2000.

Projected energy demands for the agricultural sector in 1985 and 2000 are presented in Appendix A.

X

BASE CASE FUEL SUPPLIES

Fuel availability to New York is as uncertain as energy demands. Among the factors contributing to this uncertainty are questions as to the actual quantities of domestic reserves of fuel resources, the willingness of entrepreneurs to expand extraction and the physical constraints to such expansion. Finally, there is the uncertainty as to the fraction of national production which will be available to New York State.

In the paragraphs which follow we discuss these availabilities and estimate reference case supplies of oil and natural gas in 1985 and 2000. We avoid the hazard of estimating supplies of nuclear fuel by making the not unreasonable assumption that, at least until 2000, such supplies to New York will be adequate for the planned nuclear capacity. Similarly we assume that the expansion of coal production implicit in the NEP will be sufficient to supply the entire national demand in 1985 and 2000. The sources of coal supplies to New York State in 1985 and 2000 may be expected to be different from what they are at present. The coal basins from which NY supplies are drawn are likely to depend in a complex way on whether or not "best available control technology" is a requirement for all new installations and on the siting of new power plants. Finally, the outcome of studies underway of the effects of long range transport of pollutants from combustion of coal in other regions is likely to have an impact not only on sulphur content of coals allowed in the state but also on control technology and siting. It is recognized that control technology may play a significant role in determining utility expansion plans through its effect on power plant reliability.

For the purpose of this study we disregard all of the above complications and assume that coal of whatever quality required in the state will be available in the quantities demanded. Implicit in this assumption is the existence, when required, of adequate transportation facilities to the state and within it as well.

In place of our assumptions stated above, we might assume alternatively that New York will continue to receive in 1985 and 2000 the same fraction of the nation's output as it had received in 1974, some 3%. In that event supplies

available to New York State would be, as a consequence of NEP, 785×10^{12} Btu and 1200×10^{12} Btu in 1985 and 2000 respectively.

Base Case Oil Supply

In estimating the quantity of U.S. oil production available to New York State in 1985 and 2000 we make the assumption that New York will continue to receive the same proportion, 6% as in past years.*

Estimates of domestic oil production made by several sources are in remarkable agreement. They are displayed in Table 23 below.

<u>Table 23</u>		
<u>U.S. Domestic Oil Production Estimates</u>		
	<u>Btu x 10¹⁵</u>	
	<u>1985</u>	<u>2000</u>
PIES/BAU ²⁵	21.8	-
CIA ²⁶	21.8	-
NEP ²⁷	21.6	21.6 (includes 3.0 from shale)

On the basis of these estimates we forecast the quantities shown in Table 24 as available to New York in 1985 and 2000.

<u>Table 24</u>		
<u>Base Case Domestic Oil Supplies**</u>		
	<u>To New York State</u>	
	<u>Btu x 10¹⁵</u>	
	<u>1985</u>	<u>2000</u>
	1.1	1.1

Base Case Natural Gas Supply

The base case natural gas supply scenario is founded on the assumption that whatever the marketed quantity of natural gas, New York State's allocation is similar to the proportion delivered in the years 1968 to 1973. Quantities delivered to New York State and national production are displayed in Table 25.

For the period shown, New York's share has been approximately 3%.

*New York's share is approximately 30% of the 20% of national production reaching the Northeast.

**Refining losses account for 8% of production.

TABLE 25

NET RECEIPTS FROM U.S. PIPELINES (CONSUMPTION AND LOSSES) NOT INCLUDING
IN-STATE PRODUCTION OR IMPORTS AND EXPORTS (Bcf)

	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Conn. ^a	55.3	59.4	62.4	62.9	66.9	63.9
Mass.	136.9	138.4	147.5	155.5	164.5	154.0
R.I.	21.4	23.1	26.1	25.7	23.5	20.8
Vt. ^b	(1.5)	(2.1)	(2.5)	(2.8)	(3.7)	(3.9)
N.H. + Me.	5.7	7.6	8.4	9.6	10.3	10.4
N.Y. ^c	643.3	686.4	701.1	731.2	674.3	689.8
Penn.	668.7	730.6	763.2	764.9	766.6	771.9
N.J.	281.2	316.8	334.0	341.5	332.9	304.3
Md. + D.C.	155.8	166.1	187.7	194.3	212.1	205.0
Del.	24.3	25.6	26.9	26.9	24.0	23.5
Total	1992.5	2134.0	2257.1	2312.6	2248.1	2243.4
Net U.S. pro- duction (Tcf)	19.8	21.2	22.4	22.8	22.8	22.9
Region as % of Nation	10.1	10.1	10.1	10.1	9.9	9.8

^a LNG imports from Algeria and Canada removed.

^b All gas to Vermont is from Canada.

^c Imports from Canada removed.

Source: Ref. 28.

The NEP derived estimates of domestic production for 1985 and 2000 including small contributions from coal gasification are shown in Table 26.

Table 26

<u>Domestic Gas Production: NEP Estimates</u>
<u>Btu x 10¹⁵</u>
<u>1985</u> <u>2000</u>
17.2 15.7

The base case projection of gas available to New York is shown in Table 27.

Table 27

<u>Natural Gas Available to New York State</u>
<u>Btu x 10¹²</u>
<u>1985</u> <u>2000</u>
515 470

Here we note that National Economic Research Associates (NERA) projects a 1985 supply to New York State of 450 bcf.²⁹

XI
ELECTRIC ENERGY SUPPLY AND FUEL
DEMANDS: THE ELECTRIC UTILITY SECTOR

The electric utility sector supplies electric energy demanded by the six consuming sectors of our study and requires fuel inputs to meet these demands. In order to determine the magnitude of utility fuel requirements we make the following assumptions for our base case:

1. Transmission and distribution losses account for 8% of the energy at generator bus-bars. This was the average loss for privately owned public utilities in the United States in 1974. (Ref. 30.)
2. The state's conventional hydro-resource will not be developed beyond its 1992 capacity in the years before 2000. The energy which the New York Power Pool (NYPP) estimates will be produced by conventional hydro in 1992 represents the maximum amount available before 2000.
3. Policy will place a limit on the amount of energy to be produced from petroleum as a boiler fuel. This limit will be 64 GWH requiring 103 million barrels of oil and will be reached in 1982.
4. Electric power plants in the state at the present time with previous coal burning capacity account for 5700 MW of the total existing oil fired capacity. Of the total 4200 MW will have been converted to coal by 1985 with no further conversion thereafter.
5. The NYPP's forecast of coal and nuclear capacity based on their 50% coal/50% nuclear plan will be realized in 1985 and 2000 and that these plants will be operated at a plant factor not to exceed .75.
6. Combustion turbines will for technical reasons provide a minimum of 1% of the electric energy demanded and will assume all load which cannot be otherwise served.
7. Whenever available alternative capacity will be used to reduce consumption of residual oil.

Energy Generation Forecast

The load on the electric utility sector is derived by summing the demands for electric energy of the six sectors discussed in previous sections.

Electric generation requirements as estimated by the NYPP (Ref.31) and BNL are displayed in Table 28. These estimates are based on adding transmission and distribution losses to the demands of consumers.

Table 28

<u>Estimated Generation</u> (GWh x 10 ³)						
1982	<u>NYPP</u>				<u>BNL</u>	
	1985*	1987	1992	2000*	1985	2000
136.1	154	167.7	200	265	185.0	252**

*BNL interpolation or extrapolation of NYPP Forecast.

**Net effect of reduction in electric demand due to cogeneration and total generation systems and increased demand due to electric automobiles is less than 1% of estimated total demand and is neglected.

Source of NYPP Forecast: Ref. 31.

National Economic Research Associates (NERA) have estimated generation requirements to meet the NYPP's load in 1985 and 1995. (Ref.31). In Table 29 the NERA forecast to 1985 is displayed along with a BNL extrapolation of that forecast to 2000.

Table 29

<u>NERA Estimates of NYPP</u> <u>Generation Requirements (GWh x 10³)</u>						
<u>1985</u>			<u>1995</u>			
Low	Mid	High	Low	Mid	High	
163	174	185	221	251	283	
<u>2000 (BNL Extrapolation)</u>						
<u>Low</u>			<u>Mid</u>	<u>High</u>		
256			301	350		

Source: Ref. 31.

Examination of the data of Tables 28 and 29 reveals that the BNL estimation of base case generation requirements based on the BNL load projections of the previous sections is similar to NERA's high projection in 1985 and NERA's low projection in 2000. On the other hand NYPP planned generation is less than NERA's low estimate in 1985. See Figure 6.

So that we may determine fuel requirements by type it is necessary to forecast the generation mix. To provide a point of departure we display the actual 1974 generation mix in Table 30. In Table 31 we compare the NYPP

Figure 6. Utility Generation Requirements.

forecast generation mix with the BNL forecast. To provide a measure of plausibility to our generation forecasts, we display in Table 32 the plant factors for each type of generation implied by that forecast in the context of the NYPP's capacity projections. These plant factors in 1985 appear to be higher than what might reasonably be expected and would indicate a lack of conservatism in system capacity expansion planning. From the data of Table 31 we are able to estimate the fuel requirements of the electrical sector. The results of this estimation are detailed in Table 33

Finally, departing from our practice of including only domestic supplies we consider net imported electric energy. Importation of 800 MW of Hydro-Quebec capacity is offset in part by exports of 150 MW, to Vermont. (Ref. 51). However, the export has already been accounted for in generation requirements. Arrangements for importing Hydro-Quebec power are as yet unclear. It has been presented as a seasonal exchange with New York receiving 800 MW during the New York peak load (air-conditioning) season and returning capacity during the Quebec peak (winter) season. This arrangement might relieve New York fossil burning facilities in the summer and load New York nuclear units in the winter. The effect, if it is assumed that power flows in opposite directions in six month cycles, would be to save the equivalent of $.45 \times 10^6$ tons of coal.

Table 30
1974 Generation Mix

<u>Fuel</u>	<u>GWh x 10³</u>	<u>%</u>
Residual	45.0	43.0
Distillate	2.5	2.3
Coal	16.7	15.9
Gas	3.0	2.9
Nuclear	9.6	9.1
Conv. Hydro	<u>20.3</u>	<u>26.9</u>
	105.1	100

Source: Ref. 26.

Table 31

GENERATION MIX

Fuel	NYPP*						BNL			
	1982		1987		1992		1985		2000	
	GWHx10 ³	%	GWHx10 ³	%	GWHx10 ³	%	GWHx10 ³	%	GWHx10 ³	%
Resid.	64	47	56.2	33.5	62.2	31.1	64	34.6	-	-
Distillate	.8	1.2	1.2	.7	2.2	1.1	2.2	1.2	3.0	1
Coal ^(a)	-	-	-	-	-	-	24.5	13.2	24.5	9.7
Coal	21.3	15.7	34.2	20.4	38.6	19.3	32.6	17.5	100	39.7
Gas	-	-	-	-	-	-	-	-	-	-
Nuclear	26	19.1	51.4	30.6	71.8	35.9	37.0	20.0	100	39.7
Conv. Hydro	24	17.6	24.7	14.7	25.2	12.6	24.7	13.4	25.2	10
Total	136.1		167.7		200		185		252	

a) Coal plants converted from oil-fired

*Source Ref. 26 applies to NYPP projections.

Table 32

NYPP PLANT FACTORS %

	1985	2000
Residual*	71	-
Coal**	75	64
Nuclear	75	60
Conv. Hydro	70	68

*Includes residual converted to coal.

**New coal capacity.

TABLE 33

ELECTRIC SECTOR DEMAND

Btu x 10¹², Standard Measure

	Oil		Gas		Coal		Nuclear
	Btu x 10 ¹²	bbl x 10 ⁶	Btu x 10 ¹²	bcf	Btu x 10 ¹²	Tons x 10 ⁶	Btu x 10 ¹²
1974	506	80.3	37.7	37.7	196.5	7.5	108.0
1985	705	112	-	-	542	20	383
2000	54	8.5	-	-	1183	45	1035

XII

SUPPLY-DEMAND INTEGRATION

In this section the fuel demand derived in the preceding sections is compared with the supplies of Section X. This comparison is summarized in Tables 34, 35, and 36.

Since we have not addressed the availability of foreign supplies of oil the interpretation we make of our results for oil is merely that the dependence on foreign supplies decreases from some 64% in 1985 to 58% in 2000.

For coal we note our assumption that adequate supplies will be available in 1985 and 2000. In Section X we addressed elements of uncertainty in coal supply which temper our assumptions of adequacy of supply. For natural gas a balance between supply and demand is attained in 2000 but in 1985 demand exceeds supply by roughly 4%.

Nuclear demands and supplies are not compared since we assume that through the period of the study they remain in balance.

Finally, we repeat the results of our comparison of generating capacity and electric demand in 1985 discussed more fully in the previous section. Capacity in that year is adequate only if plants operate at a plant factor of .70 - .75. This, in the light of past experience, is not conservative.

Table 34
1974 Energy Demand Summary

	Oil		Gas		Coal	
	<u>Btux10¹²</u>	<u>bblx10⁶</u>	<u>Btux10¹²</u>	<u>bcf</u>	<u>Btux10¹²</u>	<u>tonsx10⁶</u>
Direct Use	2206.3	350.2	609	609	173.6	6.6
Elect. Sect.	540.0 ^a	86.0	37.7	37.7	196.5	7.5
Total	2746.3	436.2	646.7	646.7	370.1	14.1

^aIncludes fuel input for utility generation 34.7×10^{12} Btu of steam.

Table 35
1985 Energy Demand Balance
Supplies/Demands - Btu x 10¹², Standard Measure

	Oil		Gas		Coal	
	<u>Btux10¹²</u>	<u>bblx10⁶</u>	<u>Btux10¹²</u>	<u>bcf</u>	<u>Btux10¹²</u>	<u>tonsx10⁶</u>
Direct Use	2336.8	370.9	534	535	227	8.7
Elect. Sect.	738.5	117.2	-	-	542	20.7
Total	3075.3	488.1	534	534	769	29.4
Supplies	1100.0	174.6	515	515	769	29.4
Surplus (Shortage)	(1975.3)	(313.5)	(19)	(19)	-	-

^aIncludes fuel input for utility generation of 34.7×10^{12} Btu of steam.

^bNYS Oil import requirements are 14.7% of national imports assuming 8% refining losses.

Table 36
2000 Energy Demand Balance
Supplies/Demands - Btu x 10¹², Standard Measure

	Oil		Gas		Coal	
	<u>Btux10¹²</u>	<u>bblx10⁶</u>	<u>Btux10¹²</u>	<u>bcf</u>	<u>Btux10¹²</u>	<u>tonsx10⁶</u>
Direct Use	2486.6	394.6	436.6	436.6	328.1	12.5
Elect. Sect.	111	17.6	-	-	1183.0	45.2
Total	2597.6	412.2	436.6	436.6	1511.1	57.7
Supplies	1100.0	174.6	470	470	1511.1	57.7
Surplus (Shortage)	(1497.6)	(237.7)	34	34		

^aIncludes fuel input for utility generation of 34.7 x 10¹² Btu of steam.

^bNYS oil import requirements are 10.0% of national imports assuming 8% refining losses.

XIII

ENVIRONMENTAL POLLUTION

In previous sections we estimated the use of energy in New York State by each of six energy consuming sectors and the public utility sector. In this section we review the gaseous and solid pollutants which result from the use of fossil fuels. We have not included any pollutants from the nuclear fuel cycle nor have we considered waste heat from any process as a pollutant.

In Table 37 below we display the pollution coefficients for the combustion of fossil fuels in electric power plants. These coefficients are in terms of tons of pollutant per Btu. Since we base our estimates of pollution from the use of coal in this sector on the assumption that 3/4 of the total will be Western coal and 1/4 Appalachian coal we have estimated coefficients for such a mixture. (In Section X we have discussed uncertainties as to sources and control technology for coal,)

In Table 38 we display similar coefficients for pollution which is the consequence of energy use in other (than the utility) sectors.

In Tables 39-41 total pollution of various kinds from the combustion of fossil fuels is shown.

Finally in Table 42 the average annual growth rates in pollution are shown. In order to get a clearer view of what the major contributors to the different types of pollution are, we have found it convenient to break down the sources of pollution into four distinct groupings: the transportation sector; the industrial sector, utilities; and the combined commercial-residential-government (CRG) sectors.

Tables 43-45 show the percentage of each pollution type that is contributed by these four energy using groupings.

The transportation sector is the major source of two pollution types: carbon monoxide and nitrous oxides. Total emissions for these two types increase until 1985 and then, either level off or decrease until 2000. The

transportation sector also accounts for a large share of the hydrocarbon pollution, which is projected to decrease at a slower rate from 1985 through 2000 than over the period from 1974 to 1985. This is mostly a consequence of changes in automobile energy demand which is estimated to increase 19% from 1974 to 1985 and then decrease by 14% from 1985 to 2000. The utilities are also a significant contributor of nitrous oxide emission. As both coal and oil plants have the same emission coefficient for nitrous oxide, the impact of the planned changes in the generation mix on total nitrous oxide emission is muted.

Also in the transportation sector, we note that air transport increases from 18% of total transport demand in 1974 to a projected 22% in 2000 pushing up the emission of particulates.

In the industrial sector the ratio of coal use to gas and oil use gradually increases. This has several effects on total emissions. Firstly, it contributes to the steady and comparatively high growth rate of particulate emission; secondly, it slows down the growth rate of aldehydes (which are almost totally generated in this sector by the use of oil).

The switch from oil to coal and nuclear power plants in the utility sector is the major reason for the very low sulphur dioxide emission growth rate for the 1974 to 1985 period and the actual decline in total SO_2 emission during the period 1985 to 2000. This is the only significant impact that the changing generation mix has on pollution. Because of the use of scrubbers, particulate emission does not increase substantially as oil-fired electric generation is partially replaced by coal. In addition, for the utility sector we note that pollution control technology imposes substantial requirements for sludge disposal. In 1985, as a consequence of coal combustion at the level of the reference case forecast an annual increment of 4.2×10^3 acre-feet of sludge pond capacity is required. This figure rises to 9.2×10^3 in 2000.

Finally, there is a general improvement in efficiency and an increasing use of electricity in the CRG sector. The main consequence of this is the virtually zero growth in total CO_2 emission throughout the entire 1974-2000 period. There are also subsidiary ameliorative effects on other pollution types, especially particulates and sulphur dioxide.

Table 37

POLLUTION COEFFICIENTS (TON/10¹² Btu):
FOSSIL FUELS IN ELECTRIC POWER PLANTS

<u>Pollutant</u>	<u>Oil</u>	<u>Coal</u>		
		<u>Northwest Controlled</u>	<u>Northern Appalachian Controlled</u>	<u>3:1 Mix</u>
Particulates	27.2	15.41	24.91	17.79
Nitro-oxide	350.0	350.0	350.0	350.0
Sulphur Dioxide	320.0	91.91	247.05	130.70
Hydrocarbons	6.8	6.15	6.15	6.15
Carbon Monoxide	.138	20.50	20.5	20.5
Aldehydes	3.4	.103	.103	.103

Table 38

POLLUTION COEFFICIENTS (TON/10¹² Btu): Energy Demanding Sectors

Sector/ Subsector	End-use(s)	Fuel/ Tech.	Partic- ulates	Nitrous Oxides	Sulphur Dioxide	Hydro- carbons	Carbon Monoxide	Alde- hydes	Carbon Monoxide
Commercial	Space & water heat	Oil	54.	217.	114.	11.	72.	7.	85,000.
		Gas	9.	50.	1.	4.	10.	5.	61,000.
Industrial	Process Heating	Coal	1,030.	246.	533.	30.	36.	1,360	112,000.
		Gas	9.	85.	0.	1.	8.	970.	61,000.
		Oil	66.	207.	353.	10.	14.	10,220.	85,000.
Residential	Space & Water Heat	Oil	4.	4.	11.	1.	2.	1.	8,500.
		Gas	1.	2.	0.	0.	1.	0.	6,100.
	Cooking	Oil	66.	207.	353.	10.	14.	10,220.	85,000.
		Gas	9.	85.	0.	1.	8.	970.	61,000.
Auto		Int. Com	62.	355.	15.	390.	4,480	0.	74,500.
Air Pass		Agg.							
Air Freight		Tech	165.	103.	41.	350.	532.	105.	74,500.
Bus		Diesel	50.	1,410.	103.	860.	860.	11.	85,000.
Rail									
Truck									
Water									
Bus		Int.	62.	810.	15.	530.	5,390.	0.	75,000.
Truck		Con.							

Table 39

POLLUTANTS FROM THE COMBUSTION OF FOSSIL FUELS

BASE CASE - 1974

(Thousand tons)

<u>Sector</u>	<u>Parti- culates</u>	<u>Nitro- oxides</u>	<u>Sulphur Dioxide</u>	<u>Hydro- carbons</u>	<u>Carbon Monoxide</u>	<u>Aldehydes</u>	<u>Carbon Dioxide</u>
Commercial	20.5	83.6	41.5	4.4	27.1	3.0	36,642
Government	0.26	1.06	0.53	0.05	0.35	0.04	446
Manufacturing	75.5	54.4	82.0	3.29	5.2	1,602.2	26,288
Residential	25.5	32.6	64.2	7.43	14.6	87.9	69,452
Transport	76.5	382.5	25.8	408.6	3,322.9	19.7	71,726
Subtotal	198	554	214	424	3,370	1,712	204,555
Utilities	19	245	210	5	4	2	-
Total	217	800	425	428	3,274	1,715	204,555

Table 40
POLLUTANTS FROM THE COMBUSTION OF FOSSIL FUELS (IONS)
1985

<u>Sector</u>	<u>Parti- culates</u>	<u>Nitro- oxides</u>	<u>Sulphur Dioxide</u>	<u>Hydro- carbons</u>	<u>Carbon Monoxide</u>	<u>Aldehydes</u>	<u>Carbon Dioxide</u>
Commercial	19.1	77.5	38.6	4.09	25.2	2.83	34,371.9
Government	0.20	0.83	0.42	0.04	0.27	0.03	353.5
Manufacturing	123.4	70.5	111.8	4.93	7.20	1,845.3	33.879
Residential	18.7	24.8	46.9	5.43	10.7	85.6	51,469
Transport	98.4	453.0	33.2	498.1	3,838	29.3	87,495
Subtotal	260	627	231	513.6	3,882	1,963	207,563
Utilities	28	424	292	8.9	11	2	207
Total	288	1,051	523	521	3,893	1,965	207,563

Table 41

POLLUTANTS FROM THE COMBUSTION OF FOSSIL FUELS (TONS)

2000

<u>Sector</u>	<u>Parti- culates</u>	<u>Nitro- oxides</u>	<u>Sulphur Dioxide</u>	<u>Hydro- carbons</u>	<u>Carbon Monoxide</u>	<u>Aldehydes</u>	<u>Carbon Dioxide</u>
Commercial	14.1	57.7	28.5	3.01	18.6	2.09	25,340,051
Government	0.14	0.57	0.29	0.03	0.19	0.02	238,662
Manufacturing	255.1	95.3	166.3	7.9	10.8	2,032.0	44,984,908
Residential	13.9	20.1	35.0	3.9	7.8	106.7	38,530,387
Transport	133.8	454.9	43.5	568.8	3,667.5	54.2	101,277,165
Subtotal	387.0	628	273	583	3,705.9	2,195.0	210,371,176
Utilities	22.7	419	167	7	23	0.3	0
Total	409	1,047	448	590	3,728	2,195.	210,371,176

Table 42
 POLLUTANTS FROM USE OF FOSSIL FUELS
 AVERAGE ANNUAL GROWTH RATES
 PERCENT

<u>Pollutant</u>	<u>1974-1985</u>	<u>1985-2000</u>
Particulates	2.6	2.4
Nitro-Oxides	2.5	- .03
Sulphur-Dioxide	1.9	-1.1
Hydrocarbons	1.8	.9
Carbon Monoxide	1.3	- .3
Aldehydes	1.2	.7
Carbon Dioxide	.1	.1

Table 43
 Pollution by Sector - Percent
 1974

<u>Pollutant</u>	<u>CRG *</u>	<u>Manufacturing</u>	<u>Transport</u>	<u>Utilities</u>
Particulates	21	35	35	9
Nitro-Oxide	15	7	48	30
Sulphur Dioxide	25	19	6	50
Hydrocarbons	2	2	95	1
Carbon Monoxide	2	0	98	0
Aldehydes	6	93	1	0
Carbon Dioxide	52	13	35	0

*Commercial-residential-government

Table 44

Pollution by Sector - Percent
1985

Pollutant	CRG *	Manufacturing	Transport	Utilities
Particulates	13	43	34	10
Nitro-Oxide	10	7	43	40
Sulphur Dioxide	16	21	6	57
Hydrocarbons	1	1	96	2
Carbon Monoxide	1	0	99	0
Aldehydes	5	94	1	0
Carbon Dioxide	42	16	42	0

*Commercial-residential-government

Table 45

Pollution by Sector - Percent
2000

Pollutant	CRG *	Manufacturing	Transport	Utilities
Particulates	7	55	33	5
Nitro-oxide	7	9	44	40
Sulphur Dioxide	14	38	10	38
Hydrocarbons	2	1	96	1
Carbon Monoxide	1	0	98	1
Aldehydes	5	93	2	0
Carbon Dioxide	31	21	48	0

*Commercial-residential-government

SUMMARY OF PART B

In Part B, contain aspects of the energy system which can be affected through research and development activities as well as by public policy decisions become the focus of attention. The matters addressed here do not constitute an exhaustive set of alternatives. Their selection for inclusion is based, in the case of innovative technology, on the fact that technical barriers which may exist to practical implementation are likely to be overcome within the next 25 years. For changes which depend on the achievement of conservation goals the extent of delays in such achievement used in this study of alternative eventualities was arbitrarily determined with a view, however, to bracketting the range of possible variations. Finally, with regard to public policy on utility generation expansion the cases selected, to our mind, are representative of possible outcomes to the current controversy.

The consequences for fuel demands of alternative achievements in end use efficiency are stated below in terms of increases over reference case sectorial demands for oil and gas.

No efficiency improvements after 1974

- Residential/commercial sector-oil, 3% in 1985, 11% in 2000 - gas, 8% in 1985, 23% in 2000.
- Transportation - oil, 16% in 1985, 40% in 2000.
- Manufacturing - oil, 5% in 1985, 85% in 2000 - gas, 4% in 1985, 75% in 2000.

Efficiency improvements deferred until 2000

- Residential/commercial sector - oil, 3% in 1985, 11% in 2000 - gas, 8% in 1985, 23% in 2000.
- Transportation - oil, 16% in 1985, 23% in 2000.
- Manufacturing - oil 1% in 1985, 3% in 2000, - gas, 4% in 1985, 16% in 2000.

The consequences for fuel demands of the failure to implement solar technologies as assumed in the reference case are stated below in percent of total base case fuel demand.

- No solar energy supply in 1985; expectations for 1985 not realized until 2000. Gas demanded up 1% in 1985, electricity demanded up 1% in 2000.
- Accelerated implementation of solar technology; expectations for 2000 are realized in 1985, solar supplies in 2000 are triple reference case supplies. In 1985 gas demanded down 2%, 3% in 2000. Oil demanded down 1% in 2000, electricity down 4%.

The potential for fuel savings in district heating using waste heat from central station power plants appears substantial.

- Waste heat from new coal plants alone could save 3% of reference case oil demand by 1985 and 15% by 2000.

In the electric utility sector a potential for energy savings exists in innovations in generation and transmission technologies.

- Fuel cells which substitute for fossil-steam turbines in providing spinning reserve capacity may provide savings of 2% of the reference case oil demand in 2000.
- Fuel cells by 2000 may save some 1.6% of reference case oil demand when used to replace gas turbines in supplying peak load demand.
- In combined cycle operation using coal, fuel cells may save some 10 percent of reference case coal demand in 2000.
- By allowing for greater decentralization of generation and thus a decrease in transmission losses, fuel cells may provide a savings in energy equivalent to 2 percent of the base case oil demand in 2000.
- Energy from solid waste may substitute for some 2 percent of the reference case oil demand in 2000 or 4 percent of the reference case coal demand.

- Innovative transmission and distribution technology has the potential for saving energy otherwise lost as heat to the extent of .9 percent of reference case oil demands in 2000.
- Improved power plant practices which would increase efficiencies in the generation of electric energy have the potential for saving the equivalent of .4 percent of reference case oil demand in 2000.

Electric automobiles provide a means of switching from oil to other fuels in the transportation sector.

- Electric automobiles have the potential of saving .2 percent of reference case oil demand in 2000 at the expense of increasing demand for coal by 1 percent.

Alternative capacity expansion plans for the public utility sector have consequences for fuel demands which are stated below in terms of reference case fuel demands:

- Prohibition of nuclear expansion, beyond plants already licensed, while permitting unlimited expansion of coal fired generating capacity would increase the demand for coal by 13 percent and for oil by 1 percent over reference case fuel demands in 1985. In 2000 these amounts would be 4 percent and 5 percent respectively.
- Prohibition of coal fired generation capacity expansion after the completion of plants presently under construction and including PASNY's planned Arthur Kill Station would result in an increase of 9 percent in the demand for oil and a decrease of 30 percent for coal from 1985 reference case estimates. In 2000 these figures are +6 percent and -58 percent respectively.
- Prohibition of either coal or nuclear capacity expansion beyond facilities currently licensed or under construction would result in added requirements for oil to the extent of 12 percent over the reference case in 1985 and 10 percent in 2000.

Part B

XIV INTRODUCTION

In Chapter IV of Volume I we reviewed the basic features of New York State's energy situation and identified the major energy issues that the State is expected to confront in the future as it seeks to effect a transition from oil and natural gas to alternative fuels. In this part we focus more specifically on those aspects of the states energy system that are likely to be affected through research and development activities. This will provide us with a quantitative idea of how RD&D and the technological change that can result from it, will be able to ameliorate the State's future energy problems.

The energy supply-demand balances estimated in Chapter IV of Volume I depended, among other things, on the realization of expectations concerning certain developments on the national energy scene. On the demand side these included substantial improvements in the energy efficiencies of end use devices in the residential and commercial sectors and of manufacturing processes as well as the introduction of new devices. The average efficiency of the automobile fleet was also assumed to improve markedly by the century's end. On the supply side assumptions were incorporated which included for example that the availability of coal to New York would to be sufficient to provide unlimited latitude for fuel switching in the manufacturing and electric utility sectors. In addition innovative technologies such as solar in the residential and commercial sectors, electric automobiles in the transportation sector, and cogeneration in the industrial sector are assumed to satisfy modest fractions of energy demand. In the sections which follow we address the consequences on the one hand of expectations not being met and on the other of achieving greater success than anticipated in the reference case in realizing improved efficiencies in energy use and in implementing innovative technologies.

THE EFFECT OF ALTERNATIVE SUPPLY ASSUMPTIONS

In the reference case substantial availability of oil from shale in 2000 was assumed. On the other hand we did not include the enhanced availability of pipeline supplies of natural gas from high Btu coal gasification. Similarly we did not include the possible exploitation of oil supplies from the Continental Shelf.

In the event that oil from shale should not be available in 2000, the estimated supply of oil from domestic sources will be diminished by 16% of total oil requirements increasing the dependence of the state on imports in that amount.

The amount of potential production available from the Atlantic Outer Continental Shelf (OCS) is highly uncertain. The availability of $.2 \times 10^6$ bbl per day in 2000, an estimate in the intermediate range, would imply added supplies to New York State of $.06 \times 10^6$ bbl per day, amounting to 5% of average demand, on the basis of the entire Atlantic OCS production reaching the Northeast region. In the context of our reference case this amounts to increasing the State's supply from domestic sources by only 2%.

Finally turning to high Btu synthetic natural gas (SNG) we note that the Lurgi high pressure gasification process has produced pipe-line quality gas in commercial application. The base case deficiency in natural gas in 1985 was estimated at 19 bcf (3% of demand). If the historical New York allocation of 3% of total supplies continues to 1985 an increase in national supplies of 635 bcf would be required to satisfy New York's demand which otherwise might remain unfulfilled. This could be accomplished by the construction of several commercial scale SNG plants.

XV

THE IMPACT OF CONSERVATION OPTIONS

Residential and Commercial Sectors

In the paragraphs which follow we examine the consequences for the state's energy supply-demand future of the failure to achieve the end use efficiencies in the residential and commercial sector forecast on the basis of our analysis of the NEP. In Table 46 below we display 1974 end use efficiencies and NEP derived forecasts of 1985 and 2000 efficiencies.

Table 46
End Use Efficiencies: Residential
and Commercial Sectors

	<u>1974</u>	<u>1985 (NEP)</u>	<u>2000 (NEP)</u>
Space Heating			
Oil	.40	.52	.69
Gas	.48	.58	.75
Water Heating			
Oil	.63	.63	.63
Gas	.57	.61	.63
Air Conditioning			
Electric	2.5	3.3	3.6

Fuel demand in 1974 is shown in Table 47 while the forecast demand in 1985 and 2000 in the absence of any improvement in efficiency after 1974 is shown in Table 48. It is likely, however, that even if the targeted efficiency improvements are not met by 1985, they will be by 2000. Thus, in Table 49 the estimated fuel demands based on not achieving anticipated 1985 enhanced end use efficiencies until 2000 are displayed.

Table 47
Residential and Commercial Fuel Demands: 1974

<u>Fuel</u>	<u>Btu x 10¹²</u>	<u>Standard Measure</u>
Oil	913.9	156.9 x 10 ⁶ bbls
Gas	484.1	484 bcf
Electricity	245.9	72.1 x 10 ⁹ kwh

Table 48

Residential and Commercial Fuel Demands: No
Improvements in End Use Efficiency

1935					2000			
Adjusted Demand			Reference Case		Adjusted Demand		Reference Case	
Fuel	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure
Oil	835.5	143.3x10 ⁶ bbl	737.6	126.6x10 ⁶ bbl	803.3	137.9x10 ⁶ bbl	542.9	93.2x10 ⁶ bbl
Gas	433.5	434 bcf	390.4	390 bcf	396.7	397 bcf	299.1	299 bcf
Elec	439.0	128.7x10 ⁹	427.8	125.4x10 ⁹ KWH	605.3	177.4x10 ⁹ KWH	584.9	171.4x10 ⁹ KWH

Table 49

Residential and Commercial Fuel Demands:
Estimated 1935 Efficiencies Achieved in 2000

1935					2000			
Adjusted Demand			Reference Case		Adjusted Demand		Reference Case	
Fuel	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure
Oil	835.5	143.3x10 ⁶ bbl	737.6	126.6x10 ⁶ bbl	705.1	121.1	542.9	93.2x10 ⁶ bbl
Gas	433.5	434 bcf	390.4	390 bcf	355.4	355 bcf	299.1	299 bcf
Elec	439.0	128.7x10 ⁹ KWH	427.8	125.4x10 ⁹ KWH	588.8	172.6x10 ⁹ KWH	584.9	171.4x10 ⁹ KWH

Transportation Sector

Now we turn to the consequences of failing to achieve improved efficiencies in the transportation sector. In Table 50 the unit demands in transportation are shown for 1974 as well as those forecast for 1985 and 2000 on the basis of the BNL analysis of the NEP.

Table 50
Unit Demands: Transportation Sector
Btu x 10³/Passenger mile
(or ton-mile as appropriate)

	<u>1974</u>	<u>1985</u>	<u>2000</u>
Auto (Pass)	1.49	1.15	.78
Bus (Pass)	2.67	2.67	2.16
Air (Pass)	4.54	4.49	4.49
Truck (Freight)	.95	.95	.82
Air (Freight)	13.06	10.93	10.93

The fuel demands in the transportation sector for 1985 and 2000 estimated on the assumption that improved unit demands are never realized are shown in Table 51. In Table 52 we show estimated fuel demands in this sector on the basis of not achieving improvements forecast in the Reference Case for 1985 until 2000. Here too we would expect that 1985 improvements will be realized.

Table 51
Transportation Sector Fuel Oil Demands:
Unit Demand Improvements not Realized

<u>Units</u>	<u>1985</u>		<u>2000</u>	
	<u>Reference Case</u>	<u>Adjusted Demand</u>	<u>Reference Case</u>	<u>Adjusted Demand</u>
10 ⁶ bbl	231.5	307.9	269.1	433.9
Btu x 10 ¹²	1215	1617	1413	2277.9

Table 52
Transportation Sector: Forecast 1985 Unit Demand Improvements
Not Achieved Until 2000

<u>Units</u>	<u>1985</u>		<u>2000</u>	
	<u>Reference Case</u>	<u>Adjusted Demand</u>	<u>Reference Case</u>	<u>Adjusted Demand</u>
10 ⁶ bbls	231.5	307.9	269.1	364.2
Btu x 10 ¹²	1215	1617	1413	1912

Manufacturing Sector

For this sector, as in those above, we estimate adjusted fuel requirements under two sets of assumptions. In one case we assume that no efficiency improvements are realized after 1974. In the other we assume that improvements anticipated for 1985 are not realized until 2000. In addition for both cases we make the assumption that the substitution of coal for oil and gas in process heat which we made in the Reference Case does not take place. The results of these estimates along with the Reference Case are presented in Tables 53, 54, and 55.

Table 53
1974 Manufacturing Reference Case Demand

<u>Fuel</u>	<u>Btu x 10¹²</u>	<u>Standard Measure</u>
Gas	124.3	124 bcf
Oil	136.5	21.7 bbl x 10 ⁶
Coal	63.4	2.50 x tons x 10 ⁶
Elec	113.8	33.4 Gwh x 10 ³
Coke	110.2	4.44 tons x 10 ⁶

Table 54
Manufacturing
1974 Efficiencies in 1985 and 2000: No Switch to Coal

Fuel	1985				2000			
	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure
Gas	162.3	162 bcf	143.3	143 bcf	212.0	212 bcf	136.5	137 bcf
Oil*	183.5	29.2 bblx10 ⁶	152.5	24.3 bblx10 ⁶	253.2	40.3 bblx10 ⁶	158.3	25.2 bblx10 ⁶
Coal	90.7	3.57 tonsx10 ⁶	108.7	4.28 tonsx10 ⁶	136.9	5.39 tonsx10 ⁶	207.2	8.16 tonsx10 ⁶
Elec	148.5	43.5 GWHx10 ³	147.0	43.1 GWHx10 ³	191.9	56.2 GWHx10 ³	187.6	55.0 GWHx10 ⁶
Coke	118.4	4.77 tonsx10 ⁶	718.4	4.77 tonsx10 ⁶	120.7	4.87 tonsx10 ⁶	16.2	4.69 tonsx10 ⁶

*Excluding petro-chem feedstocks.

Table 55
Manufacturing
1974 Deferred Efficiencies in 1985, 1985 Deferred Efficiency in 2000: No Switch To Coal

Fuel	1985				2000			
	Base Case				Base Case			
Fuel	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure
	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure	Btu x 10 ¹²	Std. Measure
Gas	162.3	162 bcf	143.3	143 bcf	205.7	206 bcf	136.5	137 bcf
Oil*	183.5	29.2 bblx10 ⁶	152.5	24.3 bblx10 ⁶	228.6	36.4 bblx10 ⁶	158.3	25.2 bblx10 ⁶
Coal	90.7	3.57 tonsx10 ⁶	108.7	4.28 tonsx10 ⁶	124.1	4.89 tonsx10 ⁶	207.2	8.16 tonsx10 ⁶
Elec	148.5	43.5 GWHx10 ³	147.0	43.1 GWHx10 ⁶	187.6	55.0 GWHx10 ³	187.6	55.0 GWHx10 ⁶
Coke	118.4	4.77 tonsx10 ⁶	118.4	4.77 tonsx10 ⁶	120.7	4.87 tonsx10 ⁶	116.2	4.69 tonsx10 ⁶

*Excluding petro-chem feedstocks.

The consequences of the failure to meet efficiency improvement goals are summarized in the data of Tables 56 and 57. Here we show for each of the years 1985 and 2000 the additional oil and gas requirements of such failure.

Table 56

Additional Oil and Natural Gas Demands: No Efficiency Improvements after 1974
(Oil, bbl x 10⁶, gas, bcf

and percent of Reference Case Demand)

<u>Sector</u>	<u>1985</u>				<u>2000</u>			
	<u>Gas</u>	<u>%</u>	<u>Oil</u>	<u>%</u>	<u>Gas</u>	<u>%</u>	<u>Oil</u>	<u>%</u>
Resid/Comm	44	8	16.7	3	102	23	44.7	11
Transport.	-		76.4	16	-		164.8	40
Mfg.	<u>20</u>	4	<u>19</u>	4	<u>80</u>	18	<u>75.5</u>	18
Total	64		112.1		200		285.0	

Table 57

Additional Oil and Natural Gas Demands: Efficiency Improvements
Deferred Until 2000 (Oil, bbl x 10⁶, gas, bcf and percent of Reference Case Demand)

<u>Sector</u>	<u>1985</u>				<u>2000</u>			
	<u>Gas</u>	<u>%</u>	<u>Oil</u>	<u>%</u>	<u>Gas</u>	<u>%</u>	<u>Oil</u>	<u>%</u>
Resid/Comm	44	8	16.7	3	56	13	27.9	7
Transport	-		76.4	16	-		95.1	23
Mfg.	<u>19</u>	4	<u>4.9</u>	1	<u>70</u>	16	<u>11.2</u>	3
Total			98.0				134.2	

XVI
INNOVATIVE TECHNOLOGIES

Solar Technology

For the NYS Base Case we estimated that solar energy would supply 3.5×10^{12} Btu to the residential, commercial and government sectors by 1985 and 18.3×10^{12} Btu in 2000. In 1985 solar energy was assumed to supply water heating only, to the extent of 1.4% of the total demanded. Of the remaining demand for this end use oil, natural gas and electricity all supply substantial fractions. By 2000, solar technologies were assumed to supply other demands in these sectors including air conditioning and space heating. In that year it is estimated that solar will supply 25.7×10^{12} Btu or some 1.7% of the total demand of the commercial and residential sector.

In Table 58 we display our estimates of the changed requirements for other fuels for the following alternative assumptions on solar technology supplying residential and commercial energy demands:

- a. No solar energy supply in 1985. Expectations for 1985 are realized in 2000.
- b. Accelerated implementation of solar technology. Expectations for 2000 are realized in 1985. Actual solar supplies in 2000 are 3 times expectations.

TABLE 58.

Alternative Solar Technology Realization: Residential/Commercial Sectors Fuel Demands - Btu x 10^{12}								
Case	1985				2000			
	Gas	Oil	Elec	Solar	Gas	Oil	Elec	Solar
Reference	390.4	737.6	427.8	3.5	299.1	542.9	584.9	25.7
Delayed Realization ^a	396.2	737.6	427.8	0	304.9	553.6	594.2	4.4
Accelerated ^b Realization	382.1	724.3	423.5	22.0	284.9	519.3	564.1	76.8

^a1985 - No Solar Realization; 2000 - NEP 1985 Solar Forecast Realized

^b1985 - NEP 2000 Solar Forecast Realized; 2000 - NEP 2000 Solar Forecast tripled

In Table 59 we display for 1985 and 2000 changes in fuel demand as a percent of base case demands in the residential/commercial sectors first by failure to realize anticipated solar developments and alternatively by accelerated implementation of solar technology.

TABLE 59
Residential/Commercial Sectors
Implementation of Solar Technology: Changed Fuel

	Demands Percent							
	1985				2000			
	<u>Gas</u>	<u>Oil</u>	<u>Elec</u>	<u>Solar</u>	<u>Gas</u>	<u>Oil</u>	<u>Elec</u>	<u>Solar</u>
Delayed								
Implementation	+1	0	0	-100	1	0	1	-83
Accelerated								
Implementation	-2	0	-1	+629	-3	-1	-4	300

District Heating

In the Reference Case the existing modest role (35×10^{12} Btu) of central station steam in supplying residential, commercial and government space conditioning demands was forecasted to continue through 2000. This forecast reflects the assumed continued existence at its current scale of operation of the Consolidated Edison Company of New York's (Con Ed) steam service to portions of Manhattan Island. In the paragraphs which follow we discuss briefly the potential for hot water (as opposed to steam) district heating for New York's urban areas utilizing waste heat from central station electric generating plants.

For conventional fossil fuel fired steam-electric plants the average efficiency of conversion of fuel energy to electricity is 33%. Fifty-two percent of the fuel energy is discarded through the condenser as waste heat and 15% is lost up the stack or within the plant. In existing LWR nuclear power plants the waste heat is about 62% of the input energy, plant losses amount to 5%, and electricity is produced at the same efficiency. The annual production of waste heat from existing steam electric plants in New York is about 640×10^{12} Btu, an amount comparable to the total State space

and water heat consumption. (i.e., net consumption, not including conversion losses).

For New York State we shall assume that only new coal electric plants are available as heat sources for district heating. We reject nuclear plants as heat sources on the grounds that any change from conventional design may complicate the already complex licensing process to an intolerable degree. We restrict consideration of heat sources to new plants so as to avoid the power plant conversion process which in all likelihood would impose severe problems on an electric system which we have estimated will be short of capacity in 1985.

The effects on the utility system of cogenerating hot water for district heating along with electricity for the concurrent local utility load includes decreased efficiency in the latter function. This must be considered in estimating energy demand-supply balances.

To establish a maximum potential for district heating within the constraints already discussed we will assume that all coal plants are sited so as to make transmission to urban centers feasible (i.e., 50 miles). In addition we will assume a conjunction of other factors, technological, economic and institutional, which limits the amount of waste heat for this purpose to 50% of the total. In Table 60 below we display the waste energy available within the constraints which we have established above, the quantity of fuel oil which otherwise would have been required for this end use and the number of households served by district heating. The estimate of the additional coal required by utilities as a consequence of the increased heat-heat rate in the production of electric energy is shown in Table 61. These data ignore the existing steam district heating in New York City mentioned above. (Inclusion of heat from nuclear plants would double the amount available for district heating).

Fuel Cells

Fuel cells fueled by hydrogen or hydrogen-rich fuels have the potential for energy saving in four district roles on public utility systems:

TABLE 60
NYS DISTRICT HOT WATER HEATING POTENTIAL

	New Coal Gen. Gwh x 10 ³	Waste Heat Btu x 10 ¹²	Waste Heat Available for Space Htg Btu x 10 ¹²	Households Served by H.W. District Heating - 10 ⁶	Oil Saved		
					Btu x 10 ¹²	bbl x 10 ⁶	% Base Case
1985	15.4	83	42	.8	80.8	13	3.4
2000	98.0	536	268	5.1	388.4	63	15.3

TABLE 61
UTILITY SECTOR INCREASED COAL DEMAND DUE
TO HOT WATER DISTRICT HEATING

	<u>Increased Demand</u> Tons x 10 ⁶	<u>% Reference Case Demand</u>
1985	3.9	13
2000	12.1	21

1. Displace steam turbine capacity as spinning reserve

According to Fernandes,³² the New York Power Pool operating procedures require spinning reserves equal to 2/3 of total operating reserves. Half of the spinning reserve capacity is in turbines synchronized to the system. Of this fraction 1/2 is in steam turbine operating at less than full load. Steam turbine operation at less than optimum load entails an energy penalty. It is estimated that substitution of fuel cells, using hydrogen produced by base load nuclear or coal units, for fossil fueled cycling turbines would save the equivalent of 9×10^6 bbls of oil in 1990 assuming 1800 MW in fuel cell capacity. Assuming that this annual saving remains constant to 2000, it will then amount to 2% of the Reference Case oil demand.

2. Direct Energy Production: Peak Load Operation

Fuel cells may be substituted for gas turbine capacity offering a possibility for switching from distillates to nuclear or coal. In this mode, the possible savings in oil is up to the total amount estimated for use by combustion turbines however at the cost of additional coal or nuclear fuel. In 2000 this amounts to 6.7×10^6 bbl of oil or 1.6% of total demand.

3. Direct Energy Production: Base Load Operation

Systems including high temperature fuel cells operating in the neighborhood of 1200°F in a combined cycle with a coal gasifier and steam turbine or combustion turbine bottoming cycle have the potential for over-all thermal efficiencies in the vicinity of 45%. Such efficiencies represent an improvement of 36% over conventional fossil steam cycles. Installation of 10,000 MW of capacity in this mode of operation would save 148×10^{12} Btu or the equivalent of 5.6×10^6 tons of coal amounting to 10% of the Reference Case demand.

4. Transmission Loss Reduction

Fuel cells are ideally adapted to decentralized operation. They may be installed as an assembly of modules with individual units ranging in size from 1 MW (currently available) to 4.6 MW (presently being fabricated) to 26 MW (next generation). When installed at a load center they would save a considerable fraction of the 8-10% of energy generated at central stations estimated as lost in transmission and distribution. If 10,000 MW of fuel cells are assumed for 2000 on the NYPP system such saving might amount to the equivalent of 7×10^6 bbl of oil; somewhat less than 2% of the Reference Case oil demand.

Atmospheric Fluidized - Bed Steam Generator

Because of their low level of pollutant emission fluidized bed coal fired steam generators may provide a desirable alternative to conventional coal firing in central station power plants. For the same reason they also may remove siting constraints which require remote siting of conventionally fired coal steam plants from population load centers. Siting close to

urban centers would facilitate district hot water heating based on waste heat in addition to reducing electric transmission losses.

Energy From Solid Waste

Combustion of solid waste as a boiler fuel augmenting coal has the potential according to Becker³³ of producing the energy equivalent of 1000-2000 MW. It is to be noted that optimal firing of coal and urban wastes occurs when their ratio is 4:1 or greater.³⁴ Attaining a power equivalent of 2000 MW from urban waste would require a total of 10,000 MW of capacity. By 2000 however, under base case assumption, new (installed after 1984) coal capacity will be 14,210 MW. To expect that 70% of this capacity will be equipped for solid waste combustion does not seem reasonable. Hence we will adopt for our estimates Becker's lower figure of 1000 MW. It is not likely that solid waste combustion of itself would be more environmentally acceptable than coal fired central station power plants. On the other hand it may prove to be a partial solution to the urban waste disposal problem while contributing to total energy resources. As part of integrated waste disposal, power production, district heating, resource recovery, urban subsystem its acceptability might be enhanced. The fossil equivalent of 1000 MW operating at a capacity factor of .7 is 9.7×10^6 bbl of oil or 2.3×10^6 tons of coal. These quantities are 2 and 4 percent of 2000 Reference Case oil and coal demands respectively.

Electric Transmission and Distribution System Efficiency Improvements

Electric energy lost as heat between generating station bus-bars and consumers' premises amounts to 8-10 percent of the amount produced. Electric energy lost in this way is forecast in the Reference Case to be 56.8×10^{12} in 1985 and 77.4×10^{12} Btu in 2000. Fossil fuel equivalents are 26.4×10^6 and 36.0×10^6 bbl of oil in 1985 and 2000 respectively. A one percent improvement in transmission and distribution efficiency would save the oil equivalent of 2.6×10^6 bbl and 3.6×10^6 bbl in those years. These quantities are .5 and .9 percent of Reference Case oil demands in 1985 and 2000 respectively.

Improved Thermal Efficiency in Central Station Power Plants

The subject of this paragraph does not, it is recognized, fit under the heading of an innovative technology. On the other hand it is a matter that is not frequently raised in discussions of energy conservation. In the New York Power Pool's - 149b³⁵ report for 1976, New York State Electric and Gas Corp. alone of the State's utilities, reports a company program to improve thermal efficiency in steam generation. Babcock and Wilcox in "Steam"³⁶ indicates many areas in the operation of steam power plants where maintenance and operating procedures can improve thermal efficiency in central station power plants. The fuel input to the State's electric utilities (excluding hydropower) is forecast for 1985 at 1673×10^{12} Btu. An increase of .2% in efficiency which would be achieved, for example, by reducing the heat rate from 10,000 Btu/Kwh to 9940 Btu/Kwh would save 10×10^{12} Btu, the energy content of 1.6×10^6 bbl of oil. This saving is .3 percent of the Reference Case oil demand in 1985.

Electric Automobiles

Potential for savings in oil exist in the Transportation sector in the development of the electric automobile. The BNL analysis of the NEP estimates a penetration of the passenger automobile market in 2000 by the electric automobile to the extent of 1%. In the Reference Case this saves 6.5×10^{12} Btu of petroleum (gasoline) or 1×10^6 bbl per year in the Transportation sector amounting to .2 percent of the Reference Case oil demand in 2000. The added demand on the electric utility sector amounts to 32×10^{12} Btu for an energy penalty of 15.5×10^{12} Btu. On the other hand if this load which amounts to less than 1% of the utility sector's total output is properly managed it may be supplied from base load coal or nuclear capacity, thus effecting a switch in resource requirements away from petroleum toward coal.

XVII
ELECTRIC UTILITY SECTOR

Alternative Capacity Expansion Plans

In this section we examine the consequences for the New York energy supply-demand situation of restrictions first on the use of nuclear fuels, then of coal and finally on both in the electric utility sector. Such restrictions may arise from diverse reasons. For coal, environmental considerations may limit its use as a utility fuel or the adequacy of supplies (anticipated in our reference case) may not be realized. The use of nuclear fuels in the generation of electric energy may simply become unacceptable in New York State as a result of public policy originating either within the State or the Federal government. Finally, both coal and nuclear energy may be denied the State as a basis from which growing demands for electric energy may be met.

Specifically we shall consider five eventualities. In the first of these we assume that no nuclear power station enters into commercial operation beyond those presently licensed to operate or under construction and that additional base load requirements are met by increased expansion of coal fired generating capacity. For this alternative we retain the assumption of our base case that generation from oil fuel base-load equipment is limited to 64×10^3 GWH. Different results would follow from the view that by 2000 no oil would be permitted as a boiler fuel in the utility sector. In an alternative view of the future of the utility sector we assume that there is no expansion of coal fired capacity beyond what is presently under construction and that no conversion of existing oil fired capacity to coal is undertaken. A final estimate is based on the effects of future events which restrict utility sector capacity expansion to oil-fired units after the completion of nuclear and coal plants presently under construction. For each of these cases we estimate a revised set of fuel demands, their effect on the state's fuel supply-demand balance and changes in the emission of pollutants.

In Tables 62 to 66 the generation mix and fuel demands for the above alternative capacity expansion plans are displayed. These data are summarized in Table 67.

Case I No Growth in Nuclear Capacity; Oil Fired Generation Limited
to 1982 estimates; No Constraints on Coal Generation:

TABLE 62
Generation Mix and Fuel Demands

Mode	1985				2000			
	Energy GWH x 10 ³	Fuel Btu x 10 ¹²	Std.Meas. x 10 ⁶	% Tot. Gen.	Energy GWH x 10 ³	Fuel Btu x 10 ¹²	Std.Meas. x 10 ⁶	% Total Gen.
Oil	64.0	704	112.0 bbl	34.6	64.0	704	112. bbl	25.3
Distillate	2.2	31	5.0 bbl	1.2	3.0	42	7. bbl	1.2
Coal (converted)	24.5	245	9.4 tons	13.2	24.5	24.5	9.4 tons	9.7
Coal	39.6	376	14.4 tons	21.4	106.0	1010 tons	38.5 tons	41.9
Nuclear	30	330	-	16.2	30.0	330	-	11.9
Hydro	<u>24.7</u>	247	-	<u>13.4</u>	<u>25.2</u>	252	-	<u>10.0</u>
Total	185			100.0	252.7			100.0

Case II No Growth in Nuclear Capacity; No Oil-Fired Base-Load Capacity
by 2000, No Constraints on Coal Expansion.

TABLE 63
Generation Mix and Fuel Demands

Mode	1985				2000			
	Energy GWH x 10 ³	Fuel Btu x 10 ¹²	Std.Meas. x 10 ⁶	% Tot. Gen.	Energy GWH x 10 ³	Fuel Btu x 10 ¹²	Std.Meas. x 10 ⁶	% Total Gen.
Oil	64.	704	112.0 bbl	34.6	0	-	-	-
Distillate	2.2	31	5.0 bbl	1.2	3.0	42	7. bbl.	1.2
Coal (converted)	24.5	245	9.4 tons	13.2	24.5	245	9.4 tons	9.7
Coal	39.6	376	14.4 tons	21.4	170.0	1620	61.8 tons	67.3
Nuclear	30.0	330	-	16.2	30.0	330	-	11.9
Hydro	<u>24.7</u>	247	-	<u>13.4</u>	<u>25.2</u>	2520	-	<u>10.0</u>
Total	185			100.0	252.7			

Case III No Growth in Coal Capacity (no conversion); No Constraints on Growth of Nuclear Capacity; No Limits on Oil Fired Generation
No Constraints

TABLE 64
Generation Mix and Fuel Demands

Mode	1985				2000			
	Energy GWH x 10 ³	Btux 10 ¹²	Std.Meas. x 10 ⁶	Tot. Gen.	Energy GWH x 10 ³	Btu x 10 ¹²	Std.Meas. x 10 ⁶	Total Gen.
Oil	88.5	946	150 bbl	47.8	88.5	946x10 ⁶	150 bbl	35
Distillate	3.8	53	8.4 bbl	20	3	42	70 bbl	1.2
Coal (convert)	0	0	0	0	0	0	0	0
Coal	31	295	11.2 tons	16.8	31	295	11.2 tons	12.3
Nuclear	37	370	-	20	105	1050	-	41.6
Hydro	<u>24.7</u>	247	-	<u>13.4</u>	<u>25.2</u>	25.2	-	<u>10</u>
Total	185.0			100.0	252.7			100.1

Case IV No Growth in Coal Capacity (no conversion); No limits on oil fired Generation until 1985; No Base Load oil generation by 2000; No Limits on Nuclear Growth

TABLE 65
Generation Mix and Fuel Demands

Mode	1985				2000			
	Energy GWHx10 ³	Btux10 ¹²	Std.Meas. x 10 ⁶	Tot. Gen.	Energy GWHx10 ³	Btux10 ¹²	Std. Meas. x10 ⁶	Tot. Gen.
Oil	88.5	946	150 bbl	47.8	0	0	0	0
Distillate	3.8	53	8.4 bbl	20	3	42	7 bbl	1.2
Coal (conversion)	0	0	0	0	0	0	0	0
Coal	31	295	11.2 bbl	16.8	31	295	11.2 tons	12.3
Nuclear	37	370	-	20	193.5	1935	-	76.6
Hydro	<u>24.7</u>	247	-	<u>13.4</u>	<u>25.2</u>	252	-	<u>10.0</u>
Total	185.0			100.1	252.7			100.0

Case V No Growth in Coal Capacity; (no conversion) No Growth in Nuclear Capacity; No Limits on Oil Fired Generation

TABLE 66

Generation Mix and Fuel Demands

Mode	1985				2000			
	Energy ₃ GWHx10 ³	Btux10 ¹²	Std.Meas. x 10 ⁶	% Tot. Gen.	Energy ₃ GWHx10 ³	Btux10 ¹²	Std.Meas. x 10 ⁶	% Total Gen.
Oil	95.5	1017	161 bbl	51.6	162.8	1690	268 bbl	646
Distillate	3.8	53	8.4 bbl	2.1	30	42	7 bbl	1.2
Coal (conversion)	0	0	0	0	0	0	0	0
Coal	31	295	11.2 tons	16.8	31	295	11.2 tons	12.3
Nuclear	30	300	-	16.2	30	300	-	11.9
Hydro	<u>24.7</u>	247	-	<u>13.4</u>	<u>25.2</u>	252	-	<u>10.0</u>
Total	185.0			100.0	252.0			100.0

In Table 67 the fuel demands for each capacity expansion alternative are compared.

TABLE 67

Utility Expansion Alternatives - Fuel Demands
Compared with Base Case

Case	1985			2000		
	Oil bbl x 10 ⁶	Coal Tons x 10 ⁶	Nucl. Btu x 10 ¹²	Oil bbl x 10 ⁶	Coal Tons x 10 ⁶	Nucl. Btu x 10 ¹²
Base	112	20	383	8.5	45.0	1035
I	117	23.8	330	119	47.9	330
II	117	23.8	330	7	71.2	330
III	158.4	11.2	370	157	11.2	1050
IV	158.4	11.2	370	7	11.2	1935
V	169.4	11.2	300	275	11.2	300

In Table 68, using the data of Table 67 we estimate the changes in electric energy fuel requirements which arise from the several alternative expansion plans as percent of total Reference Case demands.

TABLE 68
Utility Alternatives: Fuel Demand Changes
as Percent of Total Reference Case Demands

Case	1985			2000		
	<u>Oil</u>	<u>Coal</u>	<u>Nuclear</u>	<u>Oil</u>	<u>Coal</u>	<u>Nuclear</u>
I	+ 1	13	- 14	4	+5	-68
II	+ 1	13	- 14	0	+45	-68
III	+ 9	-30	- 3	6	-.58	+ 1
IV	+ 9	-30	- 3	0	-.58	+87
V	+12	-30	- 22	10	-.58	-71

The emissions in Tables 69 and 70 were estimated on the basis of Best Available Control Technology. For the state-of-the-art this requires the disposal of an estimated .5-.8 acre-feet of ash and sludge from stack gas scrubbin per megawatt-year of coal operation. In Table 71 we display our estimates of required annual incremental sludge pond capacity for the several capacity expansion alternatives described above. These estimates are based on an average value of .65 acre-feet per megawatt year of output.

If one assumes impoundment behind 40 foot dams disposition of sludge and ash would require for the Reference Case the addition of 1-100 acre pond in 1985 rising to 2-3 such ponds in 2000 with annual increments between these values in the intervening years.

For the utility sector the consequences of various constraints on capacity expansion as displayed in Tables 62 to 66 indicate that maximum oil is demanded when both nuclear and coal expansion are constrained. Fossil fuel demands are minimized when nuclear capacity is unconstrained.

Increased oil consumption causes increased emission of SO_x , hydrocarbons, aldehydes and particulates. The Reference Case which equalizes capacity expansion between coal and nuclear minimizes each of the pollutants listed. Sludge is minimized in the high oil cases.

TABLE 69
Electric Utility Sector Environmental Pollutants - 1985

<u>Case</u>	<u>Pollutant</u>					
	<u>Particulates</u>	<u>NO_x</u>	<u>SO_x</u>	<u>Hydrocarbons</u>	<u>CO</u>	<u>Aldehydes</u>
Base	28.2	424.2	291.7	7.9	10.5	2.4
I	31.3	477.8	319.2	8.9	12.8	2.6
II	31.3	477.8	319.2	8.9	12.8	2.6
III	32.4	452.9	358.2	8.6	6.2	3.4
IV	32.4	452.9	358.2	8.6	6.2	3.4
V	34.4	477.8	381.0	9.1	6.2	3.7

TABLE 70
Electric Utility Sector Environmental Pollutants - 2000
Tons x 10³

<u>Case</u>	<u>Pollutant</u>					
	<u>Particulates</u>	<u>NO_x</u>	<u>SO_x</u>	<u>Hydrocarbons</u>	<u>CO</u>	<u>Aldehydes</u>
Base	21.8	418.7	166.5	7.4	23.4	.3
I	42.7	700.4	402.7	12.8	25.8	2.7
II	34.3	667.5	257.2	11.8	38.2	.3
III	32.1	449.1	354.7	8.5	6.2	3.4
IV	6.4	118.0	52.0	2.1	6.1	.2
V	52.4	709.5	592.8	13.6	6.3	5.9

TABLE 71
Electric Utility Sector Annual Incremental
Sludge Pond Capacity
acre-feet x 10³

<u>Capacity Expansion Alternative</u>	<u>Incremental Sludge Pond Capacity</u>	
	1985	2000
Base Case	4.2	9.2
Case I	4.7	9.2
Case II	4.7	14.4
Case III, IV, V	2.3	2.3

XVIII

SUMMARY

In Table 72 the discussions of the preceeding sections are summarized. For each of the eventualities considered the quantity of energy affected is stated in terms of Reference Case fuel demands. This summary is included for the purpose of providing a point of departure for prioritizing RD&D options.

TABLE 72
Effects of Technological Eventualities: Changes
In Fuel Demands Percent of Base Case

	1985				2000			
	<u>Oil</u>	<u>Gas</u>	<u>Coal</u>	<u>Electricity</u>	<u>Oil</u>	<u>Gas</u>	<u>Coal</u>	<u>Electricity</u>
<u>Conservation</u>								
Residential/Commercial End Use Efficiency								
1) No Improvement	3	7	-	2	11	27	-	2
2) Delayed Improvements	3	7	-	2	7	11	-	0
Transportation Unit Demands								
1) No Improvement	16	-	-	-	40	-	-	-
2) Delayed Improvement	16	-	-	-	23	-	-	-
Manufacturing Efficiency/Switch to Coal								
1) No Efficiency Improvement after 1974/No shift to coal	4	4	-2	0	18	18	-5	0
2) Delay Efficiency Improvement/No shift to coal	1	4	0	0	2	3	-5	0
<u>Technological Innovation</u>								
Solar Technology								
1) Delayed Realization	0	1	-	0	0	1	-	1
2) Accelerated Realization	0	-2	-	-1	-1	-3	-	-4
District Heating	-3.4	-	3.9*	-	-15.3	-	12.1*	-
Fuel Cells**	-	-	-	-	-2	-	-2to-10	-
Solid Waste**	-	-	-	-	-.2	-	-.4	-
Electric Automobiles	-	-	-	-	-.2	-	-	+1<
Fluidized Bed Steam Generation	No Energy Change: Affects Environmental Acceptability of Coal Combustion							

TABLE 72 (continued)

	1985					2000				
	<u>Oil</u>	<u>Gas</u>	<u>Coal</u>	<u>Elec.</u>	<u>Nucl.</u>	<u>Oil</u>	<u>Gas</u>	<u>Coal</u>	<u>Elec.</u>	<u>Nucl.</u>
Electric Transmission Efficiency**	-.5	-	-	-	-.9	-	-	-	-	-
<u>Capacity Expansion Alternatives</u>										
Limited Nuclear	1	-	13	-	-14	4	-	5	-	-68
Limited Coal	9	-	-30	-	-3	6	-	-58	-	1
Limited Coal and Nuclear	12	-	-30	-	-22	10	-	-58	-	-71

* Changed coal requirements for electrical generation.

** Savings are for oil or coal.

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APPENDIX A
FUEL DEMAND TABLES

Appendix A

In Section III the organization of the data in the base case was discussed. Here in Appendix A, fuel demand data by subsector for 1974, and estimates for 1985 and 2000 are presented. Terminology employed in these tables is defined below.

1. Subsector for example, in the transportation sector, passenger or freight, or in the residential sector, single family or high-rise dwellings.
2. End-use a specific function of energy demand, for example, in the residential sector, space heating or air conditioning.
3. Unit Demand E_u , is the amount of energy per unit that would be required for a specific end use, assuming a relative system efficiency, e_i , of 100% for each fuel employed
4. Saturation S , is the fraction of the potential demand for a particular energy use actually being fulfilled at a given time. For example, if 95% of all households have refrigerators and the potential demand for refrigerators is taken to be one per house, $S = 0.95$.
5. Basis B , a projection variable which conveniently characterizes change in the subsector; for example, in the commercial sector the principal determinant of energy use is the amount of floorspace, in the residential sector, households.
6. Technology a term descriptive of the technique employed in satisfying the demand posed by the end-use, for water heating, the technology may be, for example gas burner or electric resistance.

7. Technology Fraction	f_i is the number of energy consuming units satisfied by fuel i . $\sum f_i = S \cdot B$.
8. Efficiency	e_i , is the relative effectiveness with which fuel i is used in a demand category. This parameter depends on the utilization technology employed. For space heating, e_i is defined as 1 for existing electrically heated homes. The values of e_i for other structures are given in the fuel mix tables.
9. Fuel Demand	D_i is the quantity of a fuel, i , actual consumed in a specific demand category, such as residential space heating or commercial air conditioning.

By specifying the technology fraction, f_i , and relative system efficiency, e_i , the fuel demand D_i , can be derived by the equation:

$$D_i = E_u \times f_i \div e_i$$

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1974
FUEL DEMAND TABLES
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AGRICULTURE
SCENARIO- BASE CASE YEAR- 1974

SUBSECTOR CROPS
END-USE ALL CROPS
UNIT DEMAND .33 SATURATION 1.000
BASIS 4175.81 1E3 ACRES
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
GAS TECH OIL 4175.81 .20 6952.7

SUBSECTOR GENERAL
END-USE ELECTRICITY
UNIT DEMAND 30.71 SATURATION 1.000
BASIS 47.67 1E3 FARMS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
ELECTRICITY ELECTRICITY 47.67 1.70 1464.4

SUBSECTOR LIVESTOCK
END-USE ALL STOCK
UNIT DEMAND .18 SATURATION 1.000
BASIS 1719.70 1E3 HEAD
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
GAS TECH OIL 1719.70 .20 1607.9

SUBSECTOR GENERAL
END-USE PROPANE
UNIT DEMAND 10.91 SATURATION 1.000
BASIS 47.67 1E3 FARMS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
PROPANE OIL 47.67 .65 800.4

COMMERCIAL
SCENARIO- BASE CASE

YEAR- 1974

SUBSECTOR HOSPITALS				
END-USE AIR COND				
UNIT DEMAND	44.00	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
VAP COMP GAS	GAS	7.51	1.80	183.7
VAP COMP ELE	ELECTRICITY	201.18	3.00	2950.7
SOLAR	SOLAP	.00	1.00	.0

SUBSECTOR HOSPITALS				
END-USE APP-AUX EQUIP				
UNIT DEMAND	54.14	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	208.70	1.00	11299.0

SUBSECTOR HOSPITALS				
END-USE LIGHTING				
UNIT DEMAND	42.40	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
FLUOR-INCAN	ELECTRICITY	208.70	1.00	8848.9

SUBSECTOR HOSPITALS				
END-USE SPACE HEAT				
UNIT DEMAND	182.89	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH OIL	OIL	158.61	.52	55785.7
AGG-TECH GAS	GAS	31.30	.53	10802.6
MISC-TECH	STEAM	18.78	.65	5285.0
SOLAR	SOLAR	.00	1.00	.0
ELEC RESIST	ELECTRICITY	.00	1.00	.0
HEAT PUMP	ELECTRICITY	.80	2.00	.0

SUBSECTOR HOSPITALS				
END-USE WATER HEAT				
UNIT DEMAND	14.10	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
GAS BURNER	GAS	141.91	.70	2858.6
ELEC RESIST	ELECTRICITY	66.78	1.00	941.7
SOLAR	SOLAR	.00	1.00	.0
OIL BURNER	OIL	.00	.63	.0

SUBSECTOR OFFICE					
END-USE AIR COND					
UNIT DEMAND	35.00	SATURATION	1.000		
BASIS	456.20	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
VAP COMP GAS	GAS	16.42	1.80	319.3	
VAP COMP ELE	ELECTRICITY	439.78	3.00	5130.8	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR OFFICE					
END-USE APP-AUX EQUIP					
UNIT DEMAND	14.00	SATURATION	1.000		
BASIS	456.20	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	456.20	1.00	6386.8	

SUBSECTOR OFFICE					
END-USE LIGHTING					
UNIT DEMAND	22.00	SATURATION	1.000		
BASIS	456.20	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	456.20	1.00	10036.4	

SUBSECTOR OFFICE					
END-USE SPACE HEAT					
UNIT DEMAND	142.00	SATURATION	1.000		
BASIS	456.20	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH OIL	OIL	346.71	.52	94678.5	
AGG-TECH GAS	GAS	68.43	.53	18334.1	
MISC-TECH	STEAM	41.06	.65	8970.0	
SOLAR	SOLAR	.00	1.00	.0	
ELEC RESIST	ELECTRICITY	.00	1.00	.0	
HEAT PUMP	ELECTRICITY	.00	2.00	.0	

SUBSECTOR OFFICE					
END-USE WATER HEAT					
UNIT DEMAND	17.00	SATURATION	1.000		
BASIS	456.20	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
GAS BURNER	GAS	310.22	.70	7533.9	
ELEC RESIST	ELECTRICITY	145.98	1.00	2481.7	
SOLAR	SOLAR	.00	1.00	.0	
OIL BURNER	OIL	.00	.63	.0	

SUBSECTOR RETAIL					
END-USE AIR COND					
UNIT DEMAND	38.00	SATURATION	1.000		
BASIS	509.99	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
VAP COMP GAS	GAS	18.36	1.80	387.6	
VAP COMP ELE	ELECTRICITY	491.63	3.00	6227.3	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR RETAIL					
END-USE APP-AUX EQUIP					
UNIT DEMAND	14.00	SATURATION	1.000		
BASIS	509.99	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	509.99	1.00	7139.9	

SUBSECTOR RETAIL					
END-USE LIGHTING					
UNIT DEMAND	22.00	SATURATION	1.000		
BASIS	509.99	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	509.99	1.00	11219.8	

SUBSECTOR RETAIL					
END-USE SPACE HEAT					
UNIT DEMAND	79.00	SATURATION	1.000		
BASIS	509.99	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH OIL	OIL	387.59	.52	58884.2	
AGG-TECH GAS	GAS	76.49	.53	11402.7	
MISC-TECH	STEAM	45.89	.65	5578.5	
SOLAR	SOLAR	.00	1.00	.0	
ELEC RESIST	ELECTRICITY	.00	1.00	.0	
HEAT PUMP	ELECTRICITY	.00	2.00	.0	

SUBSECTOR RETAIL					
END-USE WATER HEAT					
UNIT DEMAND	17.00	SATURATION	1.000		
BASIS	509.99	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
GAS BURNER	GAS	346.79	.70	8422.1	
ELEC RESIST	ELECTRICITY	163.19	1.00	2774.3	
SOLAR	SOLAR	.00	1.00	.0	
OIL BURNER	OIL	.00	.63	.0	

SUBSECTOR SCHOOL	
END-USE	AIR COND
UNIT DEMAND	32.00 SATURATION .200
BASIS	574.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
VAP COMP GAS	GAS 2.29 1.80 40.7
VAP COMP ELE	ELECTRICITY 112.51 3.00 1200.1
SOLAR	SOLAR .00 1.00 .0

SUBSECTOR SCHOOL	
END-USE	APP-AUX EQUIP
UNIT DEMAND	14.00 SATURATION .635
BASIS	574.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
AGG TECH	ELECTRICITY 364.49 1.00 5102.9

SUBSECTOR SCHOOL	
END-USE	LIGHTING
UNIT DEMAND	22.00 SATURATION 1.000
BASIS	574.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
FLUOR-INCAN	ELECTRICITY 574.00 1.00 12628.0

SUBSECTOR SCHOOL	
END-USE	SPACE HEAT
UNIT DEMAND	80.00 SATURATION 1.000
BASIS	574.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
AGG-TECH OIL	OIL 436.64 .52 67175.4
AGG-TECH GAS	GAS 86.62 .53 13074.7
MISC-TECH	STEAM 50.74 .65 6244.9
SOLAR	SOLAR .00 1.00 .0

SUBSECTOR SCHOOL	
END-USE	WATER HEAT
UNIT DEMAND	17.00 SATURATION 1.000
BASIS	574.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
GAS BURNER	GAS 390.23 .70 9477.0
ELEC RESIST	ELECTRICITY 183.77 1.00 3124.1
OIL BURNER	OIL .00 .63 .0

SUBSECTOR SERVICES	
END-USE	AIR COND
UNIT DEMAND	38.00 SATURATION .200
BASIS	780.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
VAP COMP GAS	GAS 3.12 1.80 65.9
VAP COMP ELE	ELECTRICITY 152.88 3.00 1936.5
SOLAR	SOLAR .00 1.00 .0

SUBSECTOR SERVICES	
END-USE	APP-AUX EQUIP
UNIT DEMAND	14.00 SATURATION .965
BASIS	780.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
AGG TECH	ELECTRICITY 752.70 1.00 10537.8

SUBSECTOR SERVICES	
END-USE	LIGHTING
UNIT DEMAND	22.00 SATURATION 1.000
BASIS	780.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
FLUOR-INCAN	ELECTRICITY 780.00 1.00 17160.0

SUBSECTOR SERVICES	
END-USE	SPACE HEAT
UNIT DEMAND	79.00 SATURATION .965
BASIS	780.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
AGG-TECH OIL	OIL 571.85 .52 86877.2
AGG-TECH GAS	GAS 113.13 .53 16862.8
MISC-TECH	STEAM 67.72 .65 8230.6
SOLAR	SOLAR .00 1.00 .0
ELEC RESIST	ELECTRICITY .00 1.00 .0
HEAT PUMP	ELECTRICITY .00 2.00 .0

SUBSECTOR SERVICES	
END-USE	WATER HEAT
UNIT DEMAND	17.00 SATURATION 1.000
BASIS	780.00 1E6 SQ FT
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
GAS BURNER	GAS 530.40 .70 12881.1
ELEC RESIST	ELECTRICITY 249.60 1.00 4243.2
SOLAR	SOLAR .00 1.00 .0
OIL BURNER	OIL .00 .63 .0

GOVERNMENT
SCENARIO- BASE CASE YEAR- 1974

SUBSECTOR	PASS TRANS				
END-USE	AUTOS				
UNIT DEMAND		1.71	SATUPATION	1.000	
BASIS		115.54	1E6 VEH MI		
TECHNOLOGY	FUEL		TECH FRAC	EFF	FUEL DEM
INT COM	OIL		115.54	.20	988.5

SUBSECTOR	OFFICES				
END-USE	AIR COND				
UNIT DEMAND		36.60	SATURATION	1.000	
BASIS		17.80	1E6 SQ FT		
TECHNOLOGY	FUEL		TECH FRAC	EFF	FUEL DEM
VAP COMP GAS	GAS		.64	1.80	13.0
VAP COMP ELE	ELECTRICITY	17.16		3.00	209.4
SOLAR	SOLAR	.00		1.00	.0

SUBSECTOR	OFFICES				
END-USE	APF-AUX EQUIP				
UNIT DEMAND		13.60	SATURATION	1.000	
BASIS		17.80	1E6 SQ FT		
TECHNOLOGY	FUEL		TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	17.80		1.00	242.1

SUBSECTOR	OFFICES				
END-USE	LIGHTING				
UNIT DEMAND		25.50	SATURATION	1.000	
BASIS		17.80	1E6 SQ FT		
TECHNOLOGY	FUEL		TECH FRAC	EFF	FUEL DEM
FLUOR-INCAN	ELECTRICITY	17.80		1.00	453.9

SUBSECTOR	OFFICES				
END-USE	SPACE HEAT				
UNIT DEMAND		142.00	SATUPATION	1.000	
BASIS		17.80	1E6 SQ FT		
TECHNOLOGY	FUEL		TECH FRAC	EFF	FUEL DEM
MISC-TECH	STEAM	1.60		.65	349.5
AGG-TECH GAS	GAS	2.67		.53	715.4
AGG-TECH OIL	OIL	13.53		.52	3694.7
SOLAR	SOLAR	.00		1.00	.0
HEAT PUMP	ELECTRICITY	.00		2.00	.0
ELEC RESIST	ELECTRICITY	.00		1.00	.0

SUBSECTOR	OFFICES				
END-USE	WATER HEAT				
UNIT DEMAND		3.74	SATURATION	1.000	
BASIS		17.80	1E6 SQ FT		
TECHNOLOGY	FUEL		TECH FRAC	EFF	FUEL DEM
ELEC RESIST	ELECTRICITY	5.70		1.00	21.3
GAS BURNER	GAS	12.10		.70	64.6
SOLAR	SOLAR	.00		1.00	.0

MANUFACTURING
SCENARIO- BASE CASE YEAR- 1974

SUBSECTOR SIC 20
END-USE AGG EUSE SIC 20
UNIT DEMAND 10.52 SATURATION 1.000
BASIS 2600.20 \$MIL VAL ACC
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL 18.97 .65 307.0
AGG-TECH GAS GAS 989.07 .65 16007.7
AGG-TECH OIL OIL 907.61 .65 14689.3
AGG-TECH ELE ELECTRICITY 684.55 1.00 7201.5

SUBSECTOR SIC 23
END-USE AGG EUSE SIC 23
UNIT DEMAND 1.74 SATURATION 1.000
BASIS 2902.40 \$MIL VAL ACC
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL .00 .65 .0
AGG-TECH GAS GAS 93.47 .65 250.2
AGG-TECH OIL OIL 255.39 .65 683.7
AGG-TECH ELE ELECTRICITY 2553.55 1.00 4443.2

SUBSECTOR SIC 25
END-USE AGG EUSE SIC 25
UNIT DEMAND 3.78 SATURATION 1.000
BASIS 446.20 \$MIL VAL ACC
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL 2.29 .65 13.3
AGG-TECH GAS GAS 86.07 .65 500.5
AGG-TECH OIL OIL 154.39 .65 897.8
AGG-TECH ELE ELECTRICITY 205.45 1.00 776.6

SUBSECTOR SIC 27
END-USE AGG EUSE SIC 27
UNIT DEMAND 1.35 SATURATION 1.000
BASIS 4695.40 \$MIL VAL ACC
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH GAS GAS 360.05 .65 747.8
AGG-TECH OIL OIL 493.27 .65 1024.5
AGG-TECH ELE ELECTRICITY 3842.08 1.00 5186.8

SUBSECTOR SIC 22
END-USE AGG EUSE SIC 22
UNIT DEMAND 7.73 SATURATION 1.000
BASIS 716.10 \$MIL VAL ADD
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL .00 .65 .0
AGG-TECH GAS GAS 221.04 .65 2628.7
AGG-TECH OIL OIL 205.07 .65 2438.8
AGG-TECH ELE ELECTRICITY 289.99 1.00 2241.6

SUBSECTOR SIC 24
END-USE AGG EUSE SIC 24
UNIT DEMAND 7.05 SATURATION 1.000
BASIS 243.70 \$MIL VAL ADD
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL 2.69 .65 29.2
AGG-TECH GAS GAS 46.09 .65 499.9
AGG-TECH OIL OIL 61.82 .65 670.5
AGG-TECH ELE ELECTRICITY 133.10 1.00 938.4

SUBSECTOR SIC 26
END-USE AGG EUSE SIC 26
UNIT DEMAND 34.28 SATURATION 1.000
BASIS 1089.80 \$MIL VAL ADD
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL 109.65 .65 5782.8
AGG-TECH GAS GAS 64.09 .65 3380.0
AGG-TECH OIL OIL 602.43 .65 31771.2
AGG-TECH ELE ELECTRICITY 313.62 1.00 10750.9

SUBSECTOR SIC 28
END-USE AGG EUSE SIC 28
UNIT DEMAND 87.18 SATURATION 1.000
BASIS 2367.60 \$MIL VAL ADD
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG-TECH COA COAL 162.97 .65 21858.0
AGG-TECH GAS GAS 111.02 .65 14890.3
AGG-TECH OIL OIL 162.03 .65 21732.0
AGG-TECH ELE ELECTRICITY 153.67 1.00 13397.0
PETROCHEM FEEDSTOCK 1777.90 1.00 154997.3

SUBSECTOR SIC 30					
END-USE AGG EUSE SIC 30					
UNIT DEMAND	15.70	SATURATION	1.000		
BASIS	688.40	\$MIL VAL ADD			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	287.98	.65	6955.8	
AGG-TECH GAS	GAS	88.20	.65	2130.4	
AGG-TECH OIL	OIL	71.09	.65	1717.1	
AGG-TECH ELE	ELECTRICITY	241.12	1.00	3785.6	

SUBSECTOR SIC 31					
END-USE AGG EUSE SIC 31					
UNIT DEMAND	1.58	SATURATION	1.000		
BASIS	337.00	\$MIL VAL ADD			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	36.91	.65	89.7	
AGG-TECH GAS	GAS	103.11	.65	250.6	
AGG-TECH OIL	OIL	196.98	.65	478.8	
AGG-TECH ELE	ELECTRICITY	.00	1.00	.0	

SUBSECTOR SIC 32					
END-USE AGG EUSE SIC 32					
UNIT DEMAND	42.25	SATURATION	1.000		
BASIS	924.20	\$MIL VAL ADD			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	168.69	.65	10964.8	
AGG-TECH GAS	GAS	304.12	.65	19767.8	
AGG-TECH OIL	OIL	313.45	.65	20374.2	
AGG-TECH ELE	ELECTRICITY	137.94	1.00	5828.0	

SUBSECTOR SIC 33					
END-USE AGG EUSE SIC 33					
UNIT DEMAND	44.18	SATURATION	1.000		
BASIS	1818.30	\$MIL VAL ADD			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	21.83	.21	4592.6	
AGG-TECH GAS	GAS	415.92	.65	28269.8	
AGG-TECH OIL	OIL	258.33	.65	17558.5	
AGG-TECH ELE	ELECTRICITY	473.66	.75	27901.7	
COKE	FEEDSTOCK	648.57	.26	110207.0	

SUBSECTOR SIC 34					
END-USE AGG EUSE SIC 34					
UNIT DEMAND	6.47	SATURATION	1.000		
BASIS	1884.10	\$MIL VAL ADD			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	17.84	.65	177.6	
AGG-TECH GAS	GAS	704.00	.65	7007.5	
AGG-TECH OIL	OIL	355.20	.65	3535.6	
AGG-TECH ELE	ELECTRICITY	807.07	1.00	5221.7	

SUBSECTOR SIC 35					
END-USE AGG EUSE SIC 35					
UNIT DEMAND	4.46	SATURATION	1.000		
BASIS	3816.90	\$MIL VAL ADD			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	137.49	.65	943.4	
AGG-TECH GAS	GAS	1075.57	.65	7380.1	
AGG-TECH OIL	OIL	1031.85	.65	7060.1	
AGG-TECH ELE	ELECTRICITY	1571.99	1.00	7011.1	

SUBSECTOR		SIC 36			
END-USE		AGG EUSE SIC 36			
UNIT DEMAND		5.13	SATURATION	1.000	
BASIS		3435.40	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	14.44	.65	114.0	
AGG-TECH GAS	GAS	1014.46	.65	8006.4	
AGG-TECH OIL	OIL	543.36	.65	4288.4	
AGG-TECH ELE	ELECTRICITY	1863.14	1.00	9557.9	

SUBSECTOR		SIC 37			
END-USE		AGG EUSE SIC 37			
UNIT DEMAND		8.55	SATURATION	1.000	
BASIS		1597.10	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	114.52	.65	1506.4	
AGG-TECH GAS	GAS	665.90	.65	8759.1	
AGG-TECH OIL	OIL	264.56	.65	3480.0	
AGG-TECH ELE	ELECTRICITY	552.13	1.00	4720.7	

SUBSECTOR		SIC 38			
END-USE		AGG EUSE SIC 38			
UNIT DEMAND		2.92	SATURATION	1.000	
BASIS		4392.00	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	2172.23	.65	9758.3	
AGG-TECH GAS	GAS	668.40	.65	3002.7	
AGG-TECH OIL	OIL	726.39	.65	3263.2	
AGG-TECH ELE	ELECTRICITY	824.98	1.00	2408.9	

SUBSECTOR		SIC 39			
END-USE		AGG EUSE SIC 39			
UNIT DEMAND		3.03	SATURATION	1.000	
BASIS		1211.40	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	71.90	.65	335.2	
AGG-TECH GAS	GAS	160.69	.65	749.1	
AGG-TECH OIL	OIL	184.32	.65	859.2	
AGG-TECH ELE	ELECTRICITY	794.48	1.00	2407.3	

RESIDENTIAL
SCENARIO- BASE CASE

YEAR- 1974

SUBSECTOR	HIGH RISE				
END-USE	AIR COND				
UNIT DEMAND	11000.00	SATURATION	.330		
BASIS	1.52	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
RM VAP COMP	ELECTRICITY	.43	2.00	2365.0	
CNTRL VAP CO	ELECTRICITY	.07	2.50	308.0	
SOLAP	SOLAR	.00	1.00	.0	

SUBSECTOR	HIGH RISE				
END-USE	COOKING				
UNIT DEMAND	3200.00	SATURATION	1.000		
BASIS	1.52	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.13	.38	1162.1	
GAS BURNER	GAS	1.07	.38	9010.5	
ELEC RESIST	ELECTRICITY	.32	1.00	1027.2	

SUBSECTOR	HIGH RISE				
END-USE	LIGHT-APPLI				
UNIT DEMAND	23000.00	SATURATION	.600		
BASIS	1.52	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	.91	1.00	21091.0	

SUBSECTOR	HIGH RISE				
END-USE	SPACE HEAT				
UNIT DEMAND	31000.00	SATURATION	1.000		
BASIS	1.52	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.89	.40	69517.5	
GAS BURNER	GAS	.58	.48	37522.9	
ELEC RESIST	ELECTRICITY	.02	1.00	868.0	
AGG-TECH	OTHER	.02	.35	2037.1	
SOLAP	SOLAR	.00	1.00	.0	
HEAT PUMP	ELECTRICITY	.00	2.00	.0	

SUBSECTOR	HIGH RISE				
END-USE	WATER HEAT				
UNIT DEMAND	16000.00	SATURATION	1.000		
BASIS	1.52	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.74	.63	19022.2	
GAS BURNER	GAS	.65	.57	18442.1	
ELEC RESIST	ELECTRICITY	.12	1.00	1952.0	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR LOW DENSITY					
END-USE AIR COND					
UNIT DEMAND	11000.00	SATURATION	.330		
BASIS	1.46	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
RM VAP COMP	ELECTRICITY	.42	2.00	2332.0	
CNTRL VAP CO	ELECTRICITY	.06	2.50	264.0	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR LOW DENSITY					
END-USE COOKING					
UNIT DEMAND	3200.00	SATURATION	1.000		
BASIS	1.46	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.13	.38	1111.6	
GAS BURNER	GAS	1.02	.38	8656.6	
ELEC RESIST	ELECTRICITY	.30	1.00	985.6	

SUBSECTOR LOW DENSITY					
END-USE LIGHT-APPLI					
UNIT DEMAND	23000.00	SATURATION	.600		
BASIS	1.46	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	.88	1.00	20263.0	

SUBSECTOR LOW DENSITY					
END-USE SPACE HEAT					
UNIT DEMAND	50000.00	SATURATION	1.000		
BASIS	1.46	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.86	.40	107750.0	
GAS BURNER	GAS	.55	.48	58125.0	
ELEC RESIST	ELECTRICITY	.02	1.00	1300.0	
AGG-TECH	OTHER	.02	.35	3142.9	
SOLAR	SOLAR	.00	1.00	.0	
HEAT PUMP	ELECTRICITY	.00	2.00	.0	

SUBSECTOR LOW DENSITY					
END-USE WATER HEAT					
UNIT DEMAND	18000.00	SATURATION	1.000		
BASIS	1.46	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.71	.63	20542.9	
GAS BURNER	GAS	.63	.57	19557.9	
ELEC RESIST	ELECTRICITY	.11	1.00	2106.0	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR LOW RISE					
END-USE AIR COND					
UNIT DEMAND	11000.00	SATURATION	.330		
BASIS	.79	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
RM VAP COMP	ELECTRICITY	.23	2.00	1265.0	
CNTRL VAP CO	ELECTRICITY	.03	2.50	140.8	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR LOW RISE					
END-USE COOKING					
UNIT DEMAND	3200.00	SATURATION	1.000		
BASIS	.79	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.07	.38	606.3	
GAS BURNER	GAS	.55	.38	4682.1	
ELEC RESIST	ELECTRICITY	.16	1.00	534.4	

SUBSECTOR LOW RISE					
END-USE LIGHT-APPLI					
UNIT DEMAND	23000.00	SATURATION	.600		
BASIS	.79	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	.47	1.00	10971.0	

SUBSECTOR LOW RISE					
END-USE SPACE HEAT					
UNIT DEMAND	33000.00	SATURATION	1.000		
BASIS	.79	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.46	.40	38527.5	
GAS BURNER	GAS	.30	.48	20762.5	
ELEC RESIST	ELECTRICITY	.01	1.00	462.0	
AGG-TECH	OTHER	.01	.35	1131.4	
SOLAR	SOLAR	.00	1.00	.0	
HEAT PUMP	ELECTRICITY	.00	2.00	.0	

SUBSECTOR LOW RISE					
END-USE WATER HEAT					
UNIT DEMAND	16000.00	SATURATION	1.000		
BASIS	.79	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.38	.63	9879.4	
GAS BURNER	GAS	.34	.57	9600.0	
ELEC RESIST	ELECTRICITY	.06	1.00	1024.0	
SOLAR	SOLAR	.00	1.00	.0	

SUBSECTOR SINGLE FAMILY
 END-USE AIR COND
 UNIT DEMAND 11000.00 SATURATION .330
 BASIS 2.32 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 RM VAP COMP ELECTRICITY .67 2.00 3707.0
 CNTRL VAP CO ELECTRICITY .09 2.50 409.2
 SOLAP SOLAR .60 1.00 .0

SUBSECTOR SINGLE FAMILY
 END-USE COOKING
 UNIT DEMAND 3200.00 SATURATION 1.000
 BASIS 2.32 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 OIL BURNER OIL .20 .38 1760.0
 GAS BURNER GAS 1.62 .38 13709.5
 ELEC RESIST ELECTRICITY .48 1.00 1561.6

SUBSECTOR SINGLE FAMILY
 END-USE LIGHT-APPLI
 UNIT DEMAND 23000.00 SATURATION .600
 BASIS 2.32 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 AGG TECH ELECTRICITY 1.39 1.00 32085.0

SUBSECTOR SINGLE FAMILY
 END-USE SPACE HEAT
 UNIT DEMAND 69000.00 SATURATION 1.000
 BASIS 2.32 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 OIL BURNER OIL 1.36 .40 235462.5
 GAS BURNER GAS .88 .48 127075.0
 ELEC RESIST ELECTRICITY .04 1.00 2898.0
 AGG-TECH OTHER .03 .35 6702.9
 SOLAP SOLAR .00 1.00 .0
 HEAT PUMP ELECTRICITY .00 2.00 .0

SUBSECTOR SINGLE FAMILY
 END-USE WATER HEAT
 UNIT DEMAND 25000.00 SATURATION 1.000
 BASIS 2.32 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 OIL BURNER OIL 1.13 .63 45198.4
 GAS BURNER GAS 1.00 .57 43859.6
 ELEC RESIST ELECTRICITY .18 1.00 4650.0
 SOLAP SOLAR .00 1.00 .0

TRANSPORT
SCENARIO- BASE CASE

YEAR- 1974

SUBSECTOR AIR FREIGHT
END-USE FREIGHT
UNIT DEMAND 13.06 SATURATION 1.000
BASIS 1209.67 1E6 TON MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG TECH OIL 1209.67 .30 52661.0

SUBSECTOR AIR PASS
END-USE PASS
UNIT DEMAND 4.54 SATURATION 1.000
BASIS 8376.04 1E6 PASS MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG TECH OIL 8376.40 .30 126762.9

SUBSECTOR AUTO
END-USE PASS
UNIT DEMAND 1.49 SATURATION 1.000
BASIS 85460.60 1E6 PASS MI (OR=1.4)
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
INT COM OIL 85460.60 .20 636681.5

SUBSECTOR BUS
END-USE PASS
UNIT DEMAND 2.67 SATURATION 1.000
BASIS 622.11 1E6 PASS MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
DIESEL OIL 441.70 .20 5903.3
INT COM OIL 180.41 .20 2411.2

SUBSECTOR RAIL
END-USE PASS
UNIT DEMAND 1.05 SATURATION 1.000
BASIS 10702.47 1E6 PASS MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
DIESEL OIL 428.09 .30 1501.2
AGG TECH ELECTRICITY 10274.38 1.00 10808.6

SUBSECTOR RAIL FREIGHT
END-USE FREIGHT
UNIT DEMAND .70 SATURATION 1.000
BASIS 4309.22 1E6 TON MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
DIESEL OIL 3912.77 .30 9195.0
AGG-TECH ELE ELECTRICITY 305.96 1.00 215.7
AGG-TECH OIL OIL 90.49 .20 319.0

SUBSECTOR TRUCK
END-USE FREIGHT
UNIT DEMAND .95 SATURATION 1.000
BASIS 28046.00 1E6 TON MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
DIESEL OIL 16575.00 .33 47916.8
AGG TECH OIL 11471.00 .20 54716.7

SUBSECTOR WATER
END-USE FREIGHT
UNIT DEMAND 8.64 SATURATION 1.000
BASIS 1125.24 1E9 TON MI
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
DIESEL OIL 315.06 .20 13625.1
AGG TECH OIL 810.17 .20 35035.9

1985
FUEL DEMAND TABLES
1E09 RTU

SCENARIO- AGRICULTURE
BASE CASE

YEAR. 1985

SUBSECTOR CROPS			
END-USE	ALL CROPS		
UNIT DEMAND		.33 SATURATION	1,000
BASIS	4832,06	1E3 ACRES	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
GAS TECH	OIL	4832,06	,20 8045,4

SUBSECTOR GENERAL			
END-USE	ELECTRICITY		
UNIT DEMAND		30,71 SATURATION	1,000
BASIS	38,11	1E3 FARMS	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
ELECTRICITY	ELECTRICITY	38,11	1,00 1170,7

SUBSECTOR LIVESTOCK			
END-USE	ALL STOCK		
UNIT DEMAND		.18 SATURATION	1,000
BASIS	1982,24	1E3 HEAD	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
GAS TECH	OIL	1982,24	,20 1853,4

SUBSECTOR GENERAL			
END-USE	PROPANE		
UNIT DEMAND		10,91 SATURATION	1,000
BASIS	38,11	1E3 FARMS	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
PROPANE	OIL	38,11	,65 639,9

COMMERCIAL
SCENARIO- BASE CASE

YEAR 1985

SUBSECTOR HOSPITALS			
END-USE	AIR COND		
UNIT DEMAND	44.00	SATURATION	1.000
BASIS	208.70	1E6 SQ FT	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
VAP CCMP GAS	GAS	7.51	3.30 100.1
VAP CCMP ELE	ELECTRICITY	201.18	3.30 2682.5
SCLAR	SOLAR	.00	1.00 .0

SUBSECTOR HOSPITALS			
END-USE	APP-AUX EQUIP		
UNIT DEMAND	75.00	SATURATION	1.000
BASIS	208.70	1E6 SQ FT	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
AGG TECH	ELECTRICITY	208.70	1.00 15652.5

SUBSECTOR HOSPITALS			
END-USE	LIGHTING		
UNIT DEMAND	42.40	SATURATION	1.000
BASIS	208.70	1E6 SQ FT	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
FLUOR-INCAN	ELECTRICITY	208.70	1.00 8848.9

SUBSECTOR HOSPITALS			
END-USE	SPACE HEAT		
UNIT DEMAND	152.00	SATURATION	1.000
BASIS	208.70	1E6 SQ FT	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
AGG-TECH OIL	OIL	158.61	.52 46363.5
AGG-TECH GAS	GAS	31.30	.58 8204.1
MIS-TECH	STEAM	18.78	.65 4393.5
SCLAR	SOLAR	.00	1.00 .0
ELEC RESIST	ELECTRICITY	.00	1.00 .0
HEAT PUMP	ELECTRICITY	.00	2.00 .0

SUBSECTOR HOSPITALS			
END-USE	WATER HEAT		
UNIT DEMAND	14.10	SATURATION	1.000
BASIS	208.70	1E6 SQ FT	
TECHNOLOGY	FUEL	TECH FRAC	EFF FUEL DEM
GAS BURNER	GAS	141.91	.61 3280.2
ELEC RESIST	ELECTRICITY	66.78	1.00 941.7
OIL BURNER	OIL	.00	.63 .0
SCLAR	SOLAR	.00	1.00 .0

SUBSECTOR OFFICE				
END-USE AIR COND				
UNIT DEMAND	35.00	SATURATION	1.000	
BASIS	497.99	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
VAP COMP GAS			3.30	190.1
VAP COMP ELE	ELECTRICITY	480.06	3.30	5091.6
SOLAR	SOLAR	.00	1.00	.0

SUBSECTOR RETAIL				
END-USE AIR COND				
UNIT DEMAND	40.00	SATURATION	1.000	
BASIS	587.74	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
VAP COMP GAS			21.16	1.80
VAP COMP ELE	ELECTRICITY	566.58	3.30	6867.7
SOLAR	SOLAR	.00	1.00	.0

SUBSECTOR OFFICE				
END-USE APP-AUX EQUIP				
UNIT DEMAND	15.00	SATURATION	1.000	
BASIS	497.99	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	497.99	1.00	7469.9

SUBSECTOR RETAIL				
END-USE APP-AUX EQUIP				
UNIT DEMAND	15.00	SATURATION	1.000	
BASIS	587.74	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	587.83	1.00	8817.5

SUBSECTOR OFFICE				
END-USE LIGHTING				
UNIT DEMAND	25.00	SATURATION	1.000	
BASIS	497.99	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
FLUOR-INCAN	ELECTRICITY	497.99	1.00	12449.8

SUBSECTOR RETAIL				
END-USE LIGHTING				
UNIT DEMAND	26.00	SATURATION	1.000	
BASIS	587.74	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
FLUOR-INCAN	ELECTRICITY	587.74	1.00	15281.2

SUBSECTOR OFFICE				
END-USE SPACE HEAT				
UNIT DEMAND	142.00	SATURATION	1.000	
BASIS	497.99	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
AGG-TECH OIL	OIL	316.74	.52	86494.4
AGG-TECH GAS	GAS	45.47	.58	11132.3
MISC-TECH	STEAM	41.06	.65	8970.0
SOLAR	SOLAR	.00	1.00	.0
ELEC RESIST	ELECTRICITY	44.82	1.00	6364.4
HEAT PUMP	ELECTRICITY	49.80	2.00	3535.8

SUBSECTOR RETAIL				
END-USE SPACE HEAT				
UNIT DEMAND	79.00	SATURATION	1.000	
BASIS	587.74	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
AGG-TECH OIL	OIL	353.68	.52	53732.2
AGG-TECH GAS	GAS	76.49	.58	10418.5
MISC-TECH	STEAM	45.89	.65	5577.4
SOLAR	SOLAR	.00	1.00	.0
ELEC RESIST	ELECTRICITY	52.90	1.00	4179.1
HEAT PUMP	ELECTRICITY	58.77	2.00	2321.4

SUBSECTOR OFFICE				
END-USE WATER HEAT				
UNIT DEMAND	17.00	SATURATION	1.000	
BASIS	497.99	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
GAS BURNER	GAS	293.81	.61	8188.1
ELEC RESIST	ELECTRICITY	194.22	1.00	3301.7
OIL BURNER	OIL	.00	.63	.0
SOLAR	SOLAR	9.96	1.00	169.3

SUBSECTOR RETAIL				
END-USE WATER HEAT				
UNIT DEMAND	17.00	SATURATION	1.000	
BASIS	587.74	1E6 SQ FT		
TECHNOLOGY FUEL		TECH FRAC	EFF	FUEL DEM
GAS BURNER	GAS	346.79	.61	9664.6
ELEC RESIST	ELECTRICITY	229.22	1.00	3896.7
OIL BURNER	OIL	.00	.63	.0
SOLAR	SOLAR	11.76	1.00	199.9

SUBSECTOR SCHOOL					
END-USE AIR COND					
UNIT DEMAND		32,00	SATURATION	,300	
BASIS		574,00	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
VAP COMP GAS	GAS	2,29	3,30	22,2	
VAP COMP ELE	ELECTRICITY	169,91	3,30	1647,6	
SOLAR	SOLAR	.00	1,00	.0	

SUBSECTOR SERVICES					
END-USE AIR COND					
UNIT DEMAND		40,00	SATURATION	,300	
BASIS		899,08	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
VAP COMP GAS	GAS	5,39	1,80	119,8	
VAP COMP ELE	ELECTRICITY	264,35	3,30	3204,2	
SOLAR	SOLAR	.00	1,00	.0	

SUBSECTOR SCHOOL					
END-USE APP-AUX EQUIP					
UNIT DEMAND		15,00	SATURATION	1,000	
BASIS		574,00	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	574,00	1,00	8610,0	

SUBSECTOR SERVICES					
END-USE APP-AUX EQUIP					
UNIT DEMAND		15,00	SATURATION	1,000	
BASIS		899,08	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	899,08	1,00	13486,2	

SUBSECTOR SCHOOL					
END-USE LIGHTING					
UNIT DEMAND		22,00	SATURATION	1,000	
BASIS		574,00	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	574,00	1,00	12628,0	

SUBSECTOR SERVICES					
END-USE LIGHTING					
UNIT DEMAND		25,00	SATURATION	1,000	
BASIS		899,08	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	899,08	1,00	22477,0	

SUBSECTOR SCHOOL					
END-USE SPACE HEAT					
UNIT DEMAND		80,00	SATURATION	1,000	
BASIS		574,00	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH OIL	OIL	436,30	.52	6713,1	
AGG TECH GAS	GAS	86,95	.58	1193,1	
MISC TECH	STEAM	50,74	.65	6244,9	
SOLAR	SOLAR	.00	1,00	.0	

SUBSECTOR SERVICES					
END-USE SPACE HEAT					
UNIT DEMAND		79,00	SATURATION	1,000	
BASIS		899,08	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH OIL	OIL	551,67	.52	83811,4	
AGG TECH GAS	GAS	108,87	.58	14828,8	
MISC TECH	STEAM	67,72	.65	8230,6	
SOLAR	SOLAR	.00	1,00	.0	
ELEC RESIST	ELECTRICITY	80,92	1,00	6392,7	
HEAT PUMP	ELECTRICITY	89,90	2,00	3551,4	

SUBSECTOR SCHOOL					
END-USE WATER HEAT					
UNIT DEMAND		17,00	SATURATION	1,000	
BASIS		574,00	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
GAS BURNER	GAS	390,23	.61	10875,3	
ELEC RESIST	ELECTRICITY	183,17	1,00	3113,9	
OIL BURNER	OIL		.63		

SUBSECTOR SERVICES					
END-USE WATER HEAT					
UNIT DEMAND		17,00	SATURATION	1,000	
BASIS		899,08	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
GAS BURNER	GAS	530,40	.61	14781,6	
ELEC RESIST	ELECTRICITY	350,64	1,00	5960,9	
OIL BURNER	OIL	.00	.63	.0	
SOLAR	SOLAR	17,98	1,00	305,7	

----- GOVERNMENT -----
 SCENARIO- BASE CASE YEAR- 1985

 SUBSECTOR PASS TRANS
 END-USE AUTOS
 UNIT DEMAND 1,32 SATURATION 1,000
 BASIS 117,91 1E6 VEH MI
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 INT COM CIL 117,91 ,20 778,2

SUBSECTOR OFFICES
 END-USE AIR COND
 UNIT DEMAND 36,60 SATURATION 1,000
 BASIS 18,16 1E6 SQ FT
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 VAP CCMF GAS GAS ,66 3,30 7,3
 VAP CCMF ELE ELECTRICITY 17,50 3,30 194,1
 SCLAR SOLAR ,00 1,00 ,0

SUBSECTOR OFFICES
 END-USE APP-AUX EQUIP
 UNIT DEMAND 13,60 SATURATION 1,000
 BASIS 18,16 1E6 SQ FT
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 AGG TECH ELECTRICITY 18,16 1,00 247,0

SUBSECTOR OFFICES
 END-USE LIGHTING
 UNIT DEMAND 25,50 SATURATION 1,000
 BASIS 18,16 1E6 SQ FT
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 FLU R-INCAN ELECTRICITY 18,16 1,00 463,1

SUBSECTOR OFFICES
 END-USE SPACE HEAT
 UNIT DEMAND 142,00 SATURATION 1,000
 BASIS 18,16 1E6 SQ FT
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 MISL-TECH STEAM 1,60 ,65 349,5
 AGG-TECH GAS GAS 2,54 ,58 622,1
 AGG-TECH OIL OIL 10,57 ,52 2888,1
 SCLAR SOLAR ,00 1,00 ,0
 ELE RESIST ELECTRICITY 1,64 1,00 232,9
 HEAL PUMP ELECTRICITY 1,63 2,00 129,9

SUBSECTOR OFFICES
 END-USE WATER HEAT
 UNIT DEMAND 3,74 SATURATION 1,000
 BASIS 18,16 1E6 SQ FT
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 ELE RESIST ELECTRICITY 7,10 1,00 26,6
 GAS BURNER GAS 10,70 1,00 40,0
 SCLAR SOLAR ,36 1,00 1,3

MANUFACTURING
SCENARIO- BASE CASE YEAR- 1985

SUBSECTOR SIC 20						SUBSECTOR SIC 22					
END-USE AGG EUSE SIC 20						END-USE AGG EUSE SIC 22					
UNIT DEMAND 10,52 SATURATION 1,000						UNIT DEMAND 7,73 SATURATION 1,000					
BASIS 2907,29 \$MIL VAL ADD						BASIS 888,46 \$MIL VAL ADD					
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM		TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	28,43	,72	415,4		AGG-TECH COA	COAL	,00	,72	,0	
AGG-TECH GAS	GAS	1102,27	,67	17307,3		AGG-TECH GAS	GAS	274,25	,67	3164,1	
AGG-TECH OIL	OIL	1011,19	,72	14774,6		AGG-TECH OIL	OIL	254,43	,72	2731,6	
AGG-TECH ELE	ELECTRICITY	765,40	1,00	8352,0		AGG-TECH ELE	ELECTRICITY	359,78	1,00	2781,1	

SUBSECTOR SIC 23						SUBSECTOR SIC 24					
END-USE AGG EUSE SIC 23						END-USE AGG EUSE SIC 24					
UNIT DEMAND 1,74 SATURATION 1,000						UNIT DEMAND 7,85 SATURATION 1,000					
BASIS 3608,77 \$MIL VAL ADD						BASIS 300,73 \$MIL VAL ADD					
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM		TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	,00	,72	,0		AGG-TECH COA	COAL	4,45	,72	43,6	
AGG-TECH GAS	GAS	116,21	,67	301,8		AGG-TECH GAS	GAS	56,31	,67	592,5	
AGG-TECH OIL	OIL	317,54	,72	767,4		AGG-TECH OIL	OIL	75,72	,72	741,4	
AGG-TECH ELE	ELECTRICITY	3175,02	1,00	5524,5		AGG-TECH ELE	ELECTRICITY	164,25	1,00	1158,0	

SUBSECTOR SIC 25						SUBSECTOR SIC 26					
END-USE AGG EUSE SIC 25						END-USE AGG EUSE SIC 26					
UNIT DEMAND 3,78 SATURATION 1,000						UNIT DEMAND 34,28 SATURATION 1,000					
BASIS 538,93 \$MIL VAL ADD						BASIS 1529,61 \$MIL VAL ADD					
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM		TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH COA	COAL	3,69	,72	19,4		AGG-TECH COA	COAL	206,35	,72	9824,6	
AGG-TECH GAS	GAS	103,02	,67	581,2		AGG-TECH GAS	GAS	63,74	,67	3261,2	
AGG-TECH OIL	OIL	185,17	,72	972,1		AGG-TECH OIL	OIL	819,34	,72	39009,7	
AGG-TECH ELE	ELECTRICITY	247,04	1,00	933,8		AGG-TECH ELE	ELECTRICITY	440,19	1,00	15089,7	

SUBSECTOR SIC 27				
END-USE	AGG EUSE SIC 27			
UNIT DEMAND	1,35	SATURATION	1,000	
BASIS	6260,67	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH GAS	GAS	480,08	,67	967,3
AGG-TECH OIL	OIL	657,71	,72	1233,2
AGG-TECH ELE	ELECTRICITY	5122,89	1,00	6915,9

SUBSECTOR SIC 28				
END-USE	AGG EUSE SIC 28			
UNIT DEMAND	87,18	SATURATION	1,000	
BASIS	3500,97	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	323,12	,72	39124,4
AGG-TECH GAS	GAS	123,10	,67	16017,7
AGG-TECH OIL	OIL	198,53	,72	24038,7
AGG-TECH ELE	ELECTRICITY	227,24	1,00	19810,8
PETROCHEM	FEEDSTOCK	2628,98	1,00	229194,5

SUBSECTOR SIC 30				
END-USE	AGG EUSE SIC 30			
UNIT DEMAND	15,70	SATURATION	1,000	
BASIS	1012,55	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	567,95	,72	12384,5
AGG-TECH GAS	GAS	57,55	,67	1348,6
AGG-TECH OIL	OIL	32,39	,72	706,3
AGG-TECH ELE	ELECTRICITY	354,66	1,00	5988,2

SUBSECTOR SIC 31				
END-USE	AGG EUSE SIC 31			
UNIT DEMAND	1,58	SATURATION	1,000	
BASIS	492,53	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	72,34	,72	158,7
AGG-TECH GAS	GAS	141,50	,67	333,7
AGG-TECH OIL	OIL	278,70	,72	611,6
AGG-TECH ELE	ELECTRICITY	,00	1,00	,0

SUBSECTOR SIC 32				
END-USE	AGG EUSE SIC 32			
UNIT DEMAND	42,25	SATURATION	1,000	
BASIS	1355,05	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	331,62	,72	19459,6
AGG-TECH GAS	GAS	403,76	,67	25461,0
AGG-TECH OIL	OIL	417,42	,72	24494,4
AGG-TECH ELE	ELECTRICITY	202,25	1,00	8545,1

SUBSECTOR SIC 33				
END-USE	AGG EUSE SIC 33			
UNIT DEMAND	44,18	SATURATION	1,000	
BASIS	1952,62	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	23,44	,21	4931,3
AGG-TECH GAS	GAS	446,64	,67	29451,6
AGG-TECH OIL	OIL	277,41	,72	17022,2
AGG-TECH ELE	ELECTRICITY	508,85	,79	28445,8
CCKE	FEEDSTOCK	696,47	,26	118346,3

SUBSECTOR SIC 34				
END-USE	AGG EUSE SIC 34			
UNIT DEMAND	6,47	SATURATION	1,000	
BASIS	2791,94	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	35,44	,72	318,5
AGG-TECH GAS	GAS	1038,71	,67	10030,5
AGG-TECH OIL	OIL	521,85	,72	4689,4
AGG-TECH ELE	ELECTRICITY	1195,94	1,00	7737,7

SUBSECTOR SIC 35				
END-USE	AGG EUSE SIC 35			
UNIT DEMAND	4,46	SATURATION	1,000	
BASIS	4792,10	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	231,45	,72	1433,7
AGG-TECH GAS	GAS	1320,96	,67	8793,3
AGG-TECH OIL	OIL	1266,07	,72	7842,6
AGG-TECH ELE	ELECTRICITY	1973,62	1,00	8802,3

SUBSECTOR SIC 36				
END-USE	AGG EUSE SIC 36			
UNIT DEMAND	5,13	SATURATION	1,000	
BASIS	5058,39	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	28,50	,72	263,1
AGG-TECH GAS	GAS	1490,10	,67	11469,3
AGG-TECH OIL	OIL	796,44	,72	5674,6
AGG-TECH ELE	ELECTRICITY	2743,35	1,00	14073,4

SUBSECTOR SIC 37				
END-USE	AGG EUSE SIC 37			
UNIT DEMAND	8,55	SATURATION	1,000	
BASIS	2196,64	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	211,19	,72	2507,9
AGG-TECH GAS	GAS	889,03	,67	11345,1
AGG-TECH OIL	OIL	337,03	,72	4002,2
AGG-TECH ELE	ELECTRICITY	759,39	1,00	6492,8

SUBSECTOR SIC 38				
END-USE	AGG EUSE SIC 38			
UNIT DEMAND	2,92	SATURATION	1,000	
BASIS	6439,50	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	4270,35	,72	17318,6
AGG-TECH GAS	GAS	437,27	,67	1905,7
AGG-TECH OIL	OIL	522,30	,72	2118,2
AGG-TECH ELE	ELECTRICITY	1209,57	1,00	3531,9

SUBSECTOR SIC 39				
END-USE	AGG EUSE SIC 39			
UNIT DEMAND	3,03	SATURATION	1,000	
BASIS	1776,14	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	141,35	,72	594,8
AGG-TECH GAS	GAS	217,64	,67	984,3
AGG-TECH OIL	OIL	252,29	,72	1061,7
AGG-TECH ELE	ELECTRICITY	1164,86	1,00	3529,5

RESIDENTIAL
SCENARIO- BASE CASE

YEAR- 1985

SUBSECTOR HIGH RISE		END-USE AIR COND		UNIT DEMAND 11000.00 SATURATION 1,660		BASIS 1.60 1E6 HOUSEHOLDS	
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM			
RM VAP COMP	ELECTRICITY	.91	3.30	3033.3			
CNTL VAP CU	ELECTRICITY	.15	3.30	500.0			
SCLAR	SOLAR	.00	1.00	.0			

SUBSECTOR HIGH RISE		END-USE COOKING		UNIT DEMAND 3200.00 SATURATION 1,000		BASIS 1.60 1E6 HOUSEHOLDS	
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM			
OIL BURNER	OIL	.13	.38	1094.7			
GAS BURNER	GAS	1.08	.38	9094.7			
ELEC RESIST	ELECTRICITY	.39	1.00	1248.0			

SUBSECTOR HIGH RISE		END-USE LIGHT-APPLI		UNIT DEMAND 23000.00 SATURATION 1,730		BASIS 1.60 1E6 HOUSEHOLDS	
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM			
AGG TECH	ELECTRICITY	1.16	1.00	26864.0			

SUBSECTOR HIGH RISE		END-USE SPACE HEAT		UNIT DEMAND 31000.00 SATURATION 1,000		BASIS 1.60 1E6 HOUSEHOLDS	
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM			
OIL BURNER	OIL	.80	.52	48169.2			
GAS BURNER	GAS	.46	.58	24853.4			
ELEC RESIST	ELECTRICITY	.14	1.00	4464.0			
AGG TECH	OTHER	.02	.35	2037.1			
SCLAR	SOLAR	.00	1.00	.0			
HEAT PUMP	ELECTRICITY	.16	2.00	2480.0			

SUBSECTOR HIGH RISE		END-USE WATER HEAT		UNIT DEMAND 16000.00 SATURATION 1,000		BASIS 1.60 1E6 HOUSEHOLDS	
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM			
OIL BURNER	OIL	.50	.63	12774.6			
GAS BURNER	GAS	.44	.61	11593.4			
ELEC RESIST	ELECTRICITY	.62	1.00	9984.0			
SCLAR	SOLAR	.03	1.00	496.0			

SUBSECTOR LOW DENSITY
END-USE AIR COND
UNIT DEMAND 11000,00 SATURATION 1,660
BASIS 1,48 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
RM VAP COMP ELECTRICITY ,85 3,30 2833,3
CNTRL VAP CO ELECTRICITY ,12 3,30 400,0
SOLAR SOLAR ,00 1,00 ,0

SUBSECTOR LOW RISE
END-USE AIR COND
UNIT DEMAND 11000,00 SATURATION 1,660
BASIS 1,00 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
RM VAP COMP ELECTRICITY ,59 3,30 1966,7
CNTRL VAP CO ELECTRICITY ,07 3,30 233,3
SOLAR SOLAR ,00 1,00 ,0

SUBSECTOR LOW DENSITY
END-USE COOKING
UNIT DEMAND 3200,00 SATURATION 1,000
BASIS 1,48 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
OIL BURNER OIL ,14 ,38 1178,9
GAS BURNER GAS ,1,03 ,38 3673,7
ELEC RESIST ELECTRICITY ,31 1,00 992,0

SUBSECTOR LOW RISE
END-USE COOKING
UNIT DEMAND 3200,00 SATURATION 1,000
BASIS 1,00 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
OIL BURNER OIL ,07 ,38 589,5
GAS BURNER GAS ,55 ,38 4640,0
ELEC RESIST ELECTRICITY ,37 1,00 1212,8

SUBSECTOR LOW DENSITY
END-USE LIGHT-APPLI
UNIT DEMAND 23000,00 SATURATION 1,730
BASIS 1,48 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG TECH ELECTRICITY 1,08 1,00 24840,0

SUBSECTOR LOW RISE
END-USE LIGHT-APPLI
UNIT DEMAND 23000,00 SATURATION 1,730
BASIS 1,00 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
AGG TECH ELECTRICITY ,73 1,00 16790,0

SUBSECTOR LOW DENSITY
END-USE SPACE HEAT
UNIT DEMAND 50000,00 SATURATION 1,000
BASIS 1,48 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
OIL BURNER OIL ,72 ,52 69230,8
GAS BURNER GAS ,46 ,58 32655,2
ELEC RESIST ELECTRICITY ,13 1,00 5500,0
AGG TECH OTHER ,02 ,35 2857,1
SOLAR SOLAR ,00 1,00 ,0
HEAT PUMP ELECTRICITY ,15 2,00 3750,0

SUBSECTOR LOW RISE
END-USE SPACE HEAT
UNIT DEMAND 33000,00 SATURATION 1,000
BASIS 1,00 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
OIL BURNER OIL ,49 ,52 31096,2
GAS BURNER GAS ,31 ,58 17637,9
ELEC RESIST ELECTRICITY ,09 1,00 2970,0
OTHER OTHER ,01 ,35 1697,1
SOLAR SOLAR ,00 1,00 ,0
HEAT PUMP ELECTRICITY ,09 2,00 1485,0

SUBSECTOR LOW DENSITY
END-USE WATER HEAT
UNIT DEMAND 18000,00 SATURATION 1,000
BASIS 1,48 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
OIL BURNER OIL ,47 ,63 13428,6
GAS BURNER GAS ,41 ,61 12098,4
ELEC RESIST ELECTRICITY ,57 1,00 13240,0
SOLAR SOLAR ,03 1,00 540,0

SUBSECTOR LOW RISE
END-USE WATER HEAT
UNIT DEMAND 16000,00 SATURATION 1,000
BASIS 1,00 1E6 HOUSEHOLDS
TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
OIL BURNER OIL ,32 ,63 8127,0
GAS BURNER GAS ,27 ,61 7082,0
ELEC RESIST ELECTRICITY ,39 1,00 6240,0
SOLAR SOLAR ,02 1,00 320,0

SUBSECTOR SINGLE FAMILY
 END-USE AIR COND
 UNIT DEMAND 11000,00 SATURATION .660
 BASIS 2,79 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 RM VAP COMP ELECTRICITY 1,63 3,30 5433,3
 CNTRL VAP CO ELECTRICITY .21 3,30 700,0
 SOLAR SOLAR .00 1,00 .0

SUBSECTOR SINGLE FAMILY
 END-USE COOKING
 UNIT DEMAND 3200,00 SATURATION 1,000
 BASIS 2,79 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 OIL BURNER CIL .20 .36 1684,2
 GAS BURNER GAS 1,64 .36 13810,5
 ELEC RESIST ELECTRICITY .95 1,00 3040,0

SUBSECTOR SINGLE FAMILY
 END-USE LIGHT-APPLI
 UNIT DEMAND 23000,00 SATURATION .730
 BASIS 2,79 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 AGG TECH ELECTRICITY 2,03 1,00 46690,0

SUBSECTOR SINGLE FAMILY
 END-USE SPACE HEAT
 UNIT DEMAND 69000,00 SATURATION 1,000
 BASIS 2,79 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 OIL BURNER CIL 1,34 .52 177807,7
 GAS BURNER GAS .89 .58 105879,3
 ELEC RESIST ELECTRICITY .25 1,00 17250,0
 AGG TECH CTHR .03 .35 5914,3
 SOLAR SOLAR .00 1,00 .0
 HEAT PUMP ELECTRICITY .28 2,00 9660,0

SUBSECTOR SINGLE FAMILY
 END-USE WATER HEAT
 UNIT DEMAND 25000,00 SATURATION 1,000
 BASIS 2,79 1E6 HOUSEHOLDS
 TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM
 OIL BURNER CIL .88 .63 34920,6
 GAS BURNER GAS .76 .61 31147,5
 ELEC RESIST ELECTRICITY 1,09 1,00 27250,0
 SOLAR SOLAR .06 1,00 1500,0

TRANSPORT
SCENARIO- BASE CASE YEAR- 1985

<p>SUBSECTOR AIR FREIGHT END-USE FREIGHT UNIT DEMAND 10.93 SATURATION 1.000 BASIS 2202.70 1E6 TON MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM AGG TECH CIL 2068.89 .30 75376.8</p>	<p>SUBSECTOR AIR PASS END-USE PASS UNIT DEMAND 4.49 SATURATION 1.000 BASIS 12895.08 1E6 PASS MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM AGG TECH OIL 12895.08 .30 192996.4</p>
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<p>SUBSECTOR AUTO END-USE PASS UNIT DEMAND 1.25 SATURATION 1.000 BASIS 125750.00 1E6 PASS MI (OR=1.4) TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM INT COM CIL 125750.00 .20 723062.5</p>	<p>SUBSECTOR BUS END-USE PASS UNIT DEMAND 2.67 SATURATION 1.000 BASIS 724.89 1E6 PASS MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM DIESEL OIL 476.86 .20 6373.2 INT COM OIL 248.02 .20 3314.8</p>
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<p>SUBSECTOR RAIL END-USE PASS UNIT DEMAND 1.05 SATURATION 1.000 BASIS 13164.2E 1E6 PASS MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM DIESEL CIL 2434.65 .30 8537.5 AGG TECH ELECTRICITY 10729.63 1.00 11287.6</p>	<p>SUBSECTOR RAIL FREIGHT END-USE FREIGHT UNIT DEMAND .70 SATURATION 1.000 BASIS 5300.44 1E6 TON MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM DIESEL OIL 3568.59 .30 8386.2 AGG TECH ELE ELECTRICITY 944.36 1.00 665.8 AGG TECH OIL 787.50 .20 2775.9</p>
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<p>SUBSECTOR TRUCK END-USE FREIGHT UNIT DEMAND .95 SATURATION 1.000 BASIS 31972.21 1E6 TON MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM DIESEL CIL 18258.21 .33 52782.8 AGG TECH CIL 13713.99 .20 65415.8</p>	<p>SUBSECTOR WATER END-USE FREIGHT UNIT DEMAND 8.64 SATURATION 1.000 BASIS 1485.32 1E9 TON MI TECHNOLOGY FUEL TECH FRAC EFF FUEL DEM DIESEL OIL 547.16 .20 23661.9 AGG TECH OIL 938.16 .20 40570.7</p>
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2000
FUEL DEMAND TABLES
1E09 BTU

AGRICULTURE		YEAR 2000		SUBSECTOR CROPS			
SCENARIO- BASE CASE				END-USE ALL CROPS			
UNIT DEMAND		30.71	SATURATION 1,000	UNIT DEMAND		.33	SATURATION 1,000
BASIS		38.11	163 FARMS	BASIS		5546.00	163 ACRES
TECHNOLOGY FUEL		TECH FRAC	EFF	TECHNOLOGY FUEL		TECH FRAC	EFF
ELECTRICITY ELECTRICITY		38.11	1.00	GAS TECH OIL		5546.00	.20
							9234.1

SUBSECTOR GENERAL				SUBSECTOR LIVESTOCK			
END-USE ELECTRICITY				END-USE ALL STOCK			
UNIT DEMAND		30.71	SATURATION 1,000	UNIT DEMAND		.18	SATURATION 1,000
BASIS		38.11	163 FARMS	BASIS		2284.00	163 HEAD
TECHNOLOGY FUEL		TECH FRAC	EFF	TECHNOLOGY FUEL		TECH FRAC	EFF
ELECTRICITY ELECTRICITY		38.11	1.00	GAS TECH OIL		2284.00	.20
							2135.5

SUBSECTOR GENERAL			
END-USE PROPANE			
UNIT DEMAND		10.91	SATURATION 1,000
BASIS		38.11	163 FARMS
TECHNOLOGY FUEL		TECH FRAC	EFF
PROPANE OIL		38.11	.65
			639.9

COMMERCIAL
SCENARIO- BASE CASE YEAR. 2000

SUBSECTOR	HOSPITALS			
END-USE	AIR COND			
UNIT DEMAND	44.00	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
VAP CCMP GAS	GAS	7.51	3.30	100.1
VAP CCMP ELE	ELECTRICITY	201.18	3.60	2459.0
SCLAR	SOLAR	.00	1.00	.0

SUBSECTOR	HOSPITALS			
END-USE	APP-AUX EQUIP			
UNIT DEMAND	75.00	SATURATION	1.000	
BASIS	208,70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	208,70	1.00	15652,5

SUBSECTOR	HOSPITALS				
END-USE	LIGHTING				
UNIT DEMAND	42.40	SATURATION	1.000		
BASIS	208.70	1E6 SQ FT			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	208.70	1.00	8848.9	

SUBSECTOR	HOSPITALS			
END-USE	SPACE HEAT			
UNIT DEMAND	152.00	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH OIL	OIL	158.61	.69	34940.6
AGG-TECH GAS	GAS	31.30	.75	6344.5
MISC-TECH	STEAM	18.78	.65	4393.5
SCLAR	SOLAR	.00	1.00	.0
ELEC RESIST	ELECTRICITY	.00	1.00	.0
HEAT PUMP	ELECTRICITY	.00	2.00	.0

SUBSECTOR	HOSPITALS			
END-USE	WATER HEAT			
UNIT DEMAND	14.10	SATURATION	1.000	
BASIS	208.70	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
GAS BURNER	GAS	141.91	.63	3176.1
ELEC RESIST	ELECTRICITY	66.78	1.00	941.7
OIL BURNER	OIL	.00	.63	.0
SCLAR	SOLAR	.00	1.00	.0

SUBSECTOR OFFICE				
END-USE AIR COND				
UNIT DEMAND	35.00	SATURATION	1.000	
BASIS	552.00	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
VAP COMP GAS	GAS	17.39	3.30	134.4
VAP COMP ELE	ELECTRICITY	529.09	3.80	5143.9
SOLAR	SOLAR	5.52	1.00	133.2

SUBSECTOR RETAIL				
END-USE AIR COND				
UNIT DEMAND	40.00	SATURATION	1.000	
BASIS	683.87	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
VAP COMP GAS	GAS	19.10	1.80	424.4
VAP COMP ELE	ELECTRICITY	657.21	3.60	7302.3
SOLAR	SOLAR	6.84	1.00	273.6

SUBSECTOR OFFICE				
END-USE APP-AUX EQUIP				
UNIT DEMAND	15.00	SATURATION	1.000	
BASIS	552.00	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	552.00	1.00	8280.0

SUBSECTOR RETAIL				
END-USE APP-AUX EQUIP				
UNIT DEMAND	15.00	SATURATION	1.000	
BASIS	683.87	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	683.87	1.00	10258.0

SUBSECTOR OFFICE				
END-USE LIGHTING				
UNIT DEMAND	25.00	SATURATION	1.000	
BASIS	552.00	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	552.00	1.00	13800.0

SUBSECTOR RETAIL				
END-USE LIGHTING				
UNIT DEMAND	26.00	SATURATION	1.000	
BASIS	683.87	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
FLUOR-INCAN	ELECTRICITY	683.87	1.00	17780.6

SUBSECTOR OFFICE				
END-USE SPACE HEAT				
UNIT DEMAND	142.00	SATURATION	1.000	
BASIS	552.00	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH OIL	OIL	294.35	.69	60576.4
AGG-TECH GAS	GAS	45.47	.75	8809.0
MISC-TECH	STEAM	41.06	.65	8970.0
SOLAR	SOLAR	11.04	1.00	1567.7
ELEC RESIST	ELECTRICITY	44.16	1.00	6270.7
HEAT PUMP	ELECTRICITY	115.92	2.00	8230.3

SUBSECTOR RETAIL				
END-USE SPACE HEAT				
UNIT DEMAND	79.00	SATURATION	1.000	
BASIS	683.87	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
AGG-TECH OIL	OIL	355.77	.69	40733.1
AGG-TECH GAS	GAS	70.22	.75	7396.5
MISC-TECH	STEAM	45.89	.65	5577.4
SOLAR	SOLAR	13.67	1.00	1079.9
ELEC RESIST	ELECTRICITY	54.71	1.00	4322.1
HEAT PUMP	ELECTRICITY	143.61	2.00	5672.6

SUBSECTOR OFFICE				
END-USE WATER HEAT				
UNIT DEMAND	17.00	SATURATION	1.000	
BASIS	552.00	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
GAS BURNER	GAS	171.12	.63	4617.5
ELEC RESIST	ELECTRICITY	347.76	1.00	5911.9
OIL BURNER	OIL	.00	.63	.0
SOLAR	SOLAR	33.12	1.00	563.0

SUBSECTOR RETAIL				
END-USE WATER HEAT				
UNIT DEMAND	17.00	SATURATION	1.000	
BASIS	683.87	1E6 SQ FT		
TECHNOLOGY FUEL	TECH FRAC	EFF	FUEL DEM	
GAS BURNER	GAS	212.00	.63	5720.6
ELEC RESIST	ELECTRICITY	430.84	1.00	7324.3
OIL BURNER	OIL	.00	.63	.0
SOLAR	SOLAR	41.04	1.00	697.7

SUBSECTOR SCHOOL					SUBSECTOR SERVICES				
END-USE	AIR COND				END-USE	AIR COND			
UNIT DEMAND	32.00	SATURATION	1.400		UNIT DEMAND	40.00	SATURATION	1.400	
BASIS	574.00	1E6 SQ FT			BASIS	1045.94	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
VAP COMP GAS	GAS	2.29	3.30	22.2	VAP COMP GAS	GAS	3.12	1.80	69.3
VAP COMP ELE	ELECTRICITY	227.31	3.60	2020.5	VAP COMP ELE	ELECTRICITY	410.73	3.60	4563.7
SOLAR	SOLAR	.00	1.00	.0	SOLAR	SOLAR	4.18	1.00	167.3

SUBSECTOR SCHOOL					SUBSECTOR SERVICES				
END-USE	APP-AUX EQUIP				END-USE	APP-AUX EQUIP			
UNIT DEMAND	15.00	SATURATION	1.000		UNIT DEMAND	15.00	SATURATION	1.000	
BASIS	574.00	1E6 SQ FT			BASIS	1045.94	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	574.00	1.00	8610.0	AGG TECH	ELECTRICITY	1045.94	1.00	15689.1

SUBSECTOR SCHOOL					SUBSECTOR SERVICES				
END-USE	LIGHTING				END-USE	LIGHTING			
UNIT DEMAND	22.00	SATURATION	1.000		UNIT DEMAND	25.00	SATURATION	1.000	
BASIS	574.00	1E6 SQ FT			BASIS	1045.94	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
FLUOR-INCAN	ELECTRICITY	574.00	1.00	12628.0	FLUOR-INCAN	ELECTRICITY	1045.94	1.00	26148.5

SUBSECTOR SCHOOL					SUBSECTOR SERVICES				
END-USE	SPACE HEAT				END-USE	SPACE HEAT			
UNIT DEMAND	80.00	SATURATION	1.000		UNIT DEMAND	79.00	SATURATION	1.000	
BASIS	574.00	1E6 SQ FT			BASIS	1045.94	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH OIL	OIL	436.31	.69	50586.7	AGG-TECH OIL	OIL	545.93	.69	62505.0
AGG-TECH GAS	GAS	86.95	.75	9274.7	AGG-TECH GAS	GAS	107.67	.75	11341.2
MISC-TECH	STEAM	50.74	.65	6244.9	MISC-TECH	STEAM	67.72	.65	8230.6
SOLAR	SOLAR	.00	1.00	.0	SOLAR	SOLAR	20.91	1.00	1652.6
					ELEC RESISI	ELECTRICITY	83.67	1.00	6610.3
					HEAT PUMP	ELECTRICITY	219.64	2.00	8676.1

SUBSECTOR SCHOOL					SUBSECTOR SERVICES				
END-USE	WATER HEAT				END-USE	WATER HEAT			
UNIT DEMAND	17.00	SATURATION	1.000		UNIT DEMAND	17.00	SATURATION	1.000	
BASIS	574.00	1E6 SQ FT			BASIS	1045.94	1E6 SQ FT		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
GAS BURNER	GAS	390.83	.63	10546.2	GAS BURNER	GAS	324.24	.63	8749.3
ELEC RESIST	ELECTRICITY	183.17	1.00	3113.9	ELEC RESIST	ELECTRICITY	658.94	1.00	11202.0
OIL BURNER	OIL		.63	.0	OIL BURNER	OIL	.00	.63	.0
					SOLAR	SOLAR	62.76	1.00	1066.9

MANUFACTURING
SCENARIO- BASE CASE YEAR- 2000

SUBSECTOR SIC 20				
END-USE AGG EUSE SIC 20				
UNIT DEMAND	10.52	SATURATION	1.000	
BASIS	3656.33	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	53.34	.80	701.4
AGG-TECH GAS	GAS	1377.47	.73	19850.7
AGG-TECH OIL	OIL	1262.93	.80	16607.5
AGG-TECH ELE	ELECTRICITY	962.60	1.00	10126.6

SUBSECTOR SIC 22				
END-USE AGG EUSE SIC 22				
UNIT DEMAND	7.73	SATURATION	1.000	
BASIS	1125.65	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	1.00	.80	1.0
AGG-TECH GAS	GAS	347.46	.73	3679.3
AGG-TECH OIL	OIL	322.35	.80	3114.7
AGG-TECH ELE	ELECTRICITY	455.83	1.00	3523.6

SUBSECTOR SIC 23				
END-USE AGG EUSE SIC 23				
UNIT DEMAND	1.74	SATURATION	1.000	
BASIS	4612.86	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	.00	.80	.0
AGG-TECH GAS	GAS	148.54	.73	354.1
AGG-TECH OIL	OIL	495.89	.80	882.8
AGG-TECH ELE	ELECTRICITY	4058.42	1.00	7061.7

SUBSECTOR SIC 24				
END-USE AGG EUSE SIC 24				
UNIT DEMAND	7.05	SATURATION	1.000	
BASIS	404.74	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	8.93	.80	78.7
AGG-TECH GAS	GAS	74.31	.73	717.7
AGG-TECH OIL	OIL	100.44	.80	885.1
AGG-TECH ELE	ELECTRICITY	221.06	1.00	1558.5

SUBSECTOR SIC 25				
END-USE AGG EUSE SIC 25				
UNIT DEMAND	3.78	SATURATION	1.000	
BASIS	725.33	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	7.41	.80	35.0
AGG-TECH GAS	GAS	137.43	.73	711.6
AGG-TECH OIL	OIL	247.99	.80	1171.8
AGG-TECH ELE	ELECTRICITY	332.48	1.00	1256.8

SUBSECTOR SIC 26				
END-USE AGG EUSE SIC 26				
UNIT DEMAND	34.28	SATURATION	1.000	
BASIS	2170.38	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	436.76	.80	18715.2
AGG-TECH GAS	GAS	18.46	.73	866.9
AGG-TECH OIL	OIL	1090.58	.80	46731.4
AGG-TECH ELE	ELECTRICITY	624.59	1.00	21410.9

SUBSECTOR SIC 27					SUBSECTOR SIC 28				
END-USE	AGG EUSE SIC 27				END-USE	AGG EUSE SIC 28			
UNIT DEMAND	1.35	SATURATION	1.000		UNIT DEMAND	87.18	SATURATION	1.000	
BASIS	9093.89	\$MIL VAL ADD			BASIS	5681.09	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH GAS	GAS	697.34	.73	1289.6	AGG-TECH COA	COAL	782.15	.80	85234.8
AGG-TECH OIL	OIL	955.35	.80	1612.2	AGG-TECH GAS	GAS	70.85	.73	8481.2
AGG-TECH ELE	ELECTRICITY	7441.22	1.00	10045.6	AGG-TECH OIL	OIL	193.25	.80	21059.4
					AGG-TECH ELE	ELECTRICITY	368.75	1.00	32147.6
					PETROCHEM	FEEDSTOCK	4266.10	1.00	371918.6

SUBSECTOR SIC 30					SUBSECTOR SIC 31				
END-USE	AGG EUSE SIC 30				END-USE	AGG EUSE SIC 31			
UNIT DEMAND	15.70	SATURATION	1.000		UNIT DEMAND	1.58	SATURATION	1.000	
BASIS	1543.41	\$MIL VAL ADD			BASIS	750.75	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	1002.81	.80	19680.1	AGG-TECH COA	COAL	164.49	.80	324.9
AGG-TECH GAS	GAS	.00	.73	.0	AGG-TECH GAS	GAS	188.58	.73	408.2
AGG-TECH OIL	OIL	.00	.80	.0	AGG-TECH OIL	OIL	397.71	.80	785.5
AGG-TECH ELE	ELECTRICITY	540.60	1.00	8487.4	AGG-TECH ELE	ELECTRICITY	.00	1.00	.0

SUBSECTOR SIC 32					SUBSECTOR SIC 33				
END-USE	AGG EUSE SIC 32				END-USE	AGG EUSE SIC 33			
UNIT DEMAND	42.25	SATURATION	1.000		UNIT DEMAND	44.18	SATURATION	1.000	
BASIS	2065.47	\$MIL VAL ADD			BASIS	1991.04	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	754.03	.80	39822.2	AGG-TECH COA	COAL	23.90	.22	4799.6
AGG-TECH GAS	GAS	491.17	.73	28427.3	AGG-TECH GAS	GAS	455.43	.73	27562.9
AGG-TECH OIL	OIL	511.99	.80	27039.5	AGG-TECH OIL	OIL	282.87	.80	15621.5
AGG-TECH ELE	ELECTRICITY	308.29	1.00	13025.3	AGG-TECH ELE	ELECTRICITY	518.66	.87	26338.4
					CCKE	FEEDSTOCK	710.18	.27	116206.5

SUBSECTOR SIC 34				
END-USE	AGG EUSE	SIC 34		
UNIT DEMAND	6.47	SATURATION	1.000	
BASIS	3132.38	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	59.31	.80	479.7
AGG-TECH GAS	GAS	1555.59	.73	10242.0
AGG-TECH OIL	OIL	575.71	.80	4656.1
AGG-TECH ELE	ELECTRICITY	1341.77	1.00	8681.3

SUBSECTOR SIC 35				
END-USE	AGG EUSE	SIC 35		
UNIT DEMAND	4.46	SATURATION	1.000	
BASIS	5312.77	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	382.77	.80	2133.9
AGG-TECH GAS	GAS	1401.40	.73	8562.0
AGG-TECH OIL	OIL	1340.55	.80	7473.6
AGG-TECH ELE	ELECTRICITY	2188.06	1.00	9758.7

SUBSECTOR SIC 36				
END-USE	AGG EUSE	SIC 36		
UNIT DEMAND	5.13	SATURATION	1.000	
BASIS	5251.44	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	44.14	.80	283.0
AGG-TECH GAS	GAS	1539.69	.73	10820.0
AGG-TECH OIL	OIL	819.56	.80	5255.4
AGG-TECH ELE	ELECTRICITY	2848.05	1.00	14610.5

SUBSECTOR SIC 37				
END-USE	AGG EUSE	SIC 37		
UNIT DEMAND	8.55	SATURATION	1.000	
BASIS	2991.36	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	429.01	.80	4585.0
AGG-TECH GAS	GAS	1139.97	.73	13351.7
AGG-TECH OIL	OIL	388.26	.80	4149.5
AGG-TECH ELE	ELECTRICITY	1034.13	1.00	8841.8

SUBSECTOR SIC 38				
END-USE	AGG EUSE	SIC 38		
UNIT DEMAND	2.92	SATURATION	1.000	
BASIS	9815.59	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	7971.85	.80	29097.3
AGG-TECH GAS	GAS	.00	.73	.0
AGG-TECH OIL	OIL	.00	.80	.0
AGG-TECH ELE	ELECTRICITY	1343.72	1.00	5383.7

SUBSECTOR SIC 39				
END-USE	AGG EUSE	SIC 39		
UNIT DEMAND	3.03	SATURATION	1.000	
BASIS	2707.33	\$MIL VAL ADD		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG-TECH COA	COAL	321.40	.80	1217.3
AGG-TECH GAS	GAS	278.77	.73	1157.1
AGG-TECH OIL	OIL	331.59	.80	1255.9
AGG-TECH ELE	ELECTRICITY	1775.57	1.00	5380.0

RESIDENTIAL
SCENARIO- BASE CASE

YEAR- 2000

SUBSECTOR	HIGH RISE
END-USE	AIR COND
UNIT DEMAND	11000.00 SATURATION ,910
BASIS	1.60 1E6 HOUSEHOLDS
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
RM VAP COMP	ELECTRICITY 1.23 3.60 3761.4
CNTL VAP CO	ELECTRICITY .21 3.60 641.7
SCLAR	SOLAR .01 1.00 165.0

SUBSECTOR	HIGH RISE
END-USE	COOKING
UNIT DEMAND	3200.00 SATURATION 1.000
BASIS	1.60 1E6 HOUSEHOLDS
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
OIL BURNER	OIL .14 .38 1178.9
GAS BURNER	GAS 1.12 .38 9431.6
ELEC RESIST	ELECTRICITY .34 1.00 1088.0

SUBSECTOR	HIGH RISE
END-USE	LIGHT-APPLI
UNIT DEMAND	23000.00 SATURATION ,880
BASIS	1.60 1E6 HOUSEHOLDS
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
AGG TECH	ELECTRICITY 1.40 1.00 32384.0

SUBSECTOR	HIGH RISE
END-USE	SPACE HEAT
UNIT DEMAND	31000.00 SATURATION 1.000
BASIS	1.60 1E6 HOUSEHOLDS
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
OIL BURNER	OIL .65 .69 29247.8
GAS BURNER	GAS .43 .75 17773.3
ELEC RESIST	ELECTRICITY .12 1.00 3968.0
AGG TECH	OTHER .02 .35 2037.1
SCLAR	SOLAR .03 1.00 992.0
HEAT PUMP	ELECTRICITY .33 2.00 5208.0

SUBSECTOR	HIGH RISE
END-USE	WATER HEAT
UNIT DEMAND	16000.00 SATURATION 1.000
BASIS	1.60 1E6 HOUSEHOLDS
TECHNOLOGY	FUEL TECH FRAC EFF FUEL DEM
OIL BURNER	OIL .26 .63 6603.2
GAS BURNER	GAS .23 .63 5841.3
ELEC RESIST	ELECTRICITY 1.01 1.00 16160.0
SCLAR	SOLAR .10 1.00 1600.0

SUBSECTOR LOW DENSITY					
END-USE AIR COND					
UNIT DEMAND	11000.00	SATURATION	.910		
BASIS	1.57	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
RM VAP COMP	ELECTRICITY	1.23	3.60	3770.6	
CNTRL VAP CO	ELECTRICITY	.18	3.60	553.2	
SOLAR	SOLAR	.01	1.00	154.0	

SUBSECTOR LOW RISE					
END-USE AIR COND					
UNIT DEMAND	11000.00	SATURATION	.910		
BASIS	1.15	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
RM VAP COMP	ELECTRICITY	.89	3.60	2737.8	
CNTRL VAP CO	ELECTRICITY	.14	3.60	427.8	
SOLAR	SOLAR	.01	1.00	110.0	

SUBSECTOR LOW DENSITY					
END-USE COOKING					
UNIT DEMAND	3200.00	SATURATION	1.000		
BASIS	1.57	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.15	.38	1263.2	
GAS BURNER	GAS	1.10	.38	9283.2	
ELEC RESIST	ELECTRICITY	.32	1.00	1024.0	

SUBSECTOR LOW RISE					
END-USE COOKING					
UNIT DEMAND	3200.00	SATURATION	1.000		
BASIS	1.15	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.10	.38	842.1	
GAS BURNER	GAS	.81	.38	6821.1	
ELEC RESIST	ELECTRICITY	.24	1.00	768.0	

SUBSECTOR LOW DENSITY					
END-USE LIGHT-APPLI					
UNIT DEMAND	23000.00	SATURATION	.880		
BASIS	1.57	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	1.38	1.00	31786.0	

SUBSECTOR LOW RISE					
END-USE LIGHT-APPLI					
UNIT DEMAND	23000.00	SATURATION	.880		
BASIS	1.15	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	ELECTRICITY	1.01	1.00	23276.0	

SUBSECTOR LOW DENSITY					
END-USE SPACE HEAT					
UNIT DEMAND	50000.00	SATURATION	1.000		
BASIS	1.57	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.64	.69	46811.6	
GAS BURNER	GAS	.41	.75	27800.0	
ELEC RESIST	ELECTRICITY	.12	1.00	6300.0	
AGG TECH	OTHER	.02	.35	2857.1	
SOLAR	SOLAR	.03	1.00	1550.0	
HEAT PUMP	ELECTRICITY	.33	2.00	5250.0	

SUBSECTOR LOW RISE					
END-USE SPACE HEAT					
UNIT DEMAND	33000.00	SATURATION	1.000		
BASIS	1.15	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.47	.69	22621.7	
GAS BURNER	GAS	.30	.75	13288.0	
ELEC RESIST	ELECTRICITY	.09	1.00	3036.0	
AGG TECH	OTHER	.01	.35	1677.1	
SOLAR	SOLAR	.02	1.00	759.0	
HEAT PUMP	ELECTRICITY	.24	2.00	3993.0	

SUBSECTOR LOW DENSITY					
END-USE WATER HEAT					
UNIT DEMAND	18000.00	SATURATION	1.000		
BASIS	1.57	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.26	.63	7428.6	
GAS BURNER	GAS	.23	.63	6571.4	
ELEC RESIST	ELECTRICITY	.99	1.00	17820.0	
SOLAR	SOLAR	.09	1.00	1620.0	

SUBSECTOR LOW RISE					
END-USE WATER HEAT					
UNIT DEMAND	16000.00	SATURATION	1.000		
BASIS	1.15	1E6 HOUSEHOLDS			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
OIL BURNER	OIL	.19	.63	4825.4	
GAS BURNER	GAS	.17	.63	4317.5	
ELEC RESIST	ELECTRICITY	.72	1.00	11520.0	
SOLAR	SOLAR	.07	1.00	1120.0	

SUBSECTOR SINGLE FAMILY				
END-USE AIR COND				
UNIT DEMAND	11000.00	SATURATION	.910	
BASIS	3.43	1E6 HOUSEHOLDS		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
RM VAP COMP	ELECTRICITY	2.72	3.60	8314.2
CNTRL VAP CO	ELECTRICITY	.37	3.60	1130.6
SOLAR	SOLAR	.03	1.00	330.0

SUBSECTOR SINGLE FAMILY				
END-USE COOKING				
UNIT DEMAND	3200.00	SATURATION	1.000	
BASIS	3.43	1E6 HOUSEHOLDS		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
OIL BURNER	CIL	.30	.38	2526.3
GAS BURNER	GAS	2.41	.38	20294.7
ELEC RESIST	ELECTRICITY	.72	1.00	2304.0

SUBSECTOR SINGLE FAMILY				
END-USE LIGHT-APPL				
UNIT DEMAND	23000.00	SATURATION	.880	
BASIS	3.43	1E6 HOUSEHOLDS		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
AGG TECH	ELECTRICITY	3.02	1.00	69460.0

SUBSECTOR SINGLE FAMILY				
END-USE SPACE HEAT				
UNIT DEMAND	69000.00	SATURATION	1.000	
BASIS	3.43	1E6 HOUSEHOLDS		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
OIL BURNER	CIL	1.48	.69	148000.0
GAS BURNER	GAS	.88	.75	61328.0
ELEC RESIST	ELECTRICITY	.27	1.00	18906.0
AGG TECH	OTHER	.03	.35	5914.3
SOLAR	SOLAR	.06	1.00	4761.0
HEAT PUMP	ELECTRICITY	.72	5.00	24840.0

SUBSECTOR SINGLE FAMILY				
END-USE WATER HEAT				
UNIT DEMAND	25000.00	SATURATION	1.000	
BASIS	3.43	1E6 HOUSEHOLDS		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM
OIL BURNER	CIL	.56	.63	22222.2
GAS BURNER	GAS	.50	.63	15841.3
ELEC RESIST	ELECTRICITY	2.16	1.00	54000.0
SOLAR	SOLAR	.21	1.00	5250.0

TRANSPORT
SCENARIO- BASE CASE

YEAR- 2000

SUBSECTOR AIR FREIGHT					
END-USE	FREIGHT				
UNIT DEMAND	10.93	SATURATION	1.000		
BASIS	4301.09	1E6 TON MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	CIL	4301.09	.30	156703.0	

SUBSECTOR AIR PASS					
END-USE	PASS				
UNIT DEMAND	4.49	SATURATION	1.000		
BASIS	23223.00	1E6 PASS MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
AGG TECH	OIL	23223.00	.30	347570.9	

SUBSECTOR AUTO					
END-USE	PASS				
UNIT DEMAND	.76	SATURATION	1.000		
BASIS	165778.00	1E6 PASS MI	(CR=1.4)		
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
INT COM	CIL	165778.00	.20	646534.2	

SUBSECTOR BUS					
END-USE	PASS				
UNIT DEMAND	2.16	SATURATION	1.000		
BASIS	953.69	1E6 PASS MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
DIESEL	OIL		.20	6773.8	
INT COM	OIL	326.49	.20	3526.1	

SUBSECTOR RAIL					
END-USE	PASS				
UNIT DEMAND	1.05	SATURATION	1.000		
BASIS	14865.73	1E6 PASS MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
DIESEL	CIL	2749.32	.30	9640.9	
AGG TECH	ELECTRICITY	12116.41	1.00	12746.5	

SUBSECTOR RAIL FREIGHT					
END-USE	FREIGHT				
UNIT DEMAND	.70	SATURATION	1.000		
BASIS	6463.83	1E6 TON MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
DIESEL	OIL	4352.20	.30	10227.7	
AGG-TECH ELE	ELECTRICITY	1151.29	1.00	811.7	
AGG-TECH OIL	OIL	960.34	.20	3385.2	

SUBSECTOR TRUCK					
END-USE	FREIGHT				
UNIT DEMAND	.62	SATURATION	1.000		
BASIS	41227.33	1E6 TON MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
DIESEL	CIL	23891.64	.33	59367.1	
AGG TECH	CIL	17335.69	.20	71076.3	

SUBSECTOR WATER					
END-USE	FREIGHT				
UNIT DEMAND	8.64	SATURATION	1.000		
BASIS	1946.67	1E9 TON MI			
TECHNOLOGY	FUEL	TECH FRAC	EFF	FUEL DEM	
DIESEL	OIL	717.11	.20	31011.4	
AGG TECH	OIL	1229.56	.20	53172.3	

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APPENDIX B
SUMMARY TABLES

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ENERGY DEMAND AND FUEL MIX
1E09 BTU
SCENARIO- BASE CASE YEAR- 1974

	NATURAL GAS	OIL	COAL	1974 ELECTRICITY	STEAM OTHER & FOSTCK	SOLAR	
AGRICULTURE							
ALL CROPS		6952.7					6952.7
ALL STOCK		1607.9					1607.9
ELECTRICITY				1464.4			1464.4
PROPANE		800.4					800.4
SUBTOTAL		3361.0		1464.4 ⁽ⁱ⁾			10825.5
COMMERCIAL							
AIR COND	997.1			17445.4		.0	18442.5
APP-AUX EQUIP				40466.3			40466.3
LIGHTING				59893.1			59893.1
SPACE HEAT	70476.8	363400.9		.0	34309.0 ⁽¹⁾	.0	468186.8
WATER HEAT	41172.8	.0		13565.0		.0	54737.7
SUBTOTAL	112646.7 ^(c)	363400.9		131369.8 ^{(e) (h)}	34309.0	.0	641726.4
GOVERNMENT							
AIR COND	13.0			209.4		.0	222.4
APP-AUX EQUIP				242.1			242.1
AUTOS		988.5					988.5
LIGHTING				453.9			453.9
SPACE HEAT	715.4	3694.7		.0	349.5 ⁽¹⁾	.0	4759.6
WATER HEAT	64.6	.0		21.3		.0	86.0
SUBTOTAL	793.0 ^(c)	4683.2		926.6 ^(e)	349.5	.0	6752.4
MANUFACTURING							
AGG EUSE SIC 20	16007.7	14689.3	307.0	7201.5			38205.5
AGG EUSE SIC 22	2628.7	2438.8	.0	2241.6			7309.1
AGG EUSE SIC 23	250.2	683.7	.0	4443.2			5377.0
AGG EUSE SIC 24	499.9	670.5	29.2	938.4			2137.9
AGG EUSE SIC 25	500.5	897.8	13.3	776.6			2188.3
AGG EUSE SIC 26	3380.0	31771.2	5782.8	10750.9			51684.9

	NATURAL GAS	OIL	COAL	1974 ELECTRICITY	STEAM OTHER & FDSCK	SOLAR	TOTAL DIRECT USE
AGG EUSE SIC 27	747.8	1024.5		5186.8			6959.1
AGG EUSE SIC 28	14890.3	21732.0	21858.0	13397.0	154997.3 ⁽²⁾		226874.6 ^(k)
AGG EUSE SIC 30	2130.4	1717.1	6955.8	3785.6			14588.9
AGG EUSE SIC 31	250.6	478.8	89.7	.0			819.2
AGG EUSE SIC 32	19767.8	20374.2	10964.8	5828.0			56934.9
AGG EUSE SIC 33	28269.8	17558.5	4592.6	27901.7	110207.0 ⁽³⁾		188529.6
AGG EUSE SIC 34	7007.5	3535.6	177.6	5221.7			15942.4
AGG EUSE SIC 35	7380.1	7080.1	943.4	7011.1			22414.6
AGG EUSE SIC 36	8006.4	4288.4	114.0	9557.9			21966.7
AGG EUSE SIC 37	8759.1	3480.0	1506.4	4720.7			18466.2
AGG EUSE SIC 38	3002.7	3263.2	9758.3	2408.9			18433.1
AGG EUSE SIC 39	749.1	859.2	335.2	2407.3			4350.7
SUBTOTAL	124228.6 ^(b)	136542.8	63428.1	113778.8 ^(e)	265204.3		703182.7
RESIDENTIAL							
AIR COND				10791.0		.0	10791.0
COOKING	36058.9	4640.0		4108.8			44807.7
LIGHT-APPLI				84410.0			84410.0
SPACE HEAT	243485.4	451257.5		5528.0	13014.3 ⁽⁴⁾	.0	713285.2
WATER HEAT	91859.6	94642.9		9732.0		.0	196234.5
SUBTOTAL	371404.0 ^(c)	550540.4		114569.8 ^(g)	13014.3	.0	1049528.5
TRANSPORT							
FREIGHT- PASS		213469.4 773260.1		215.7 10808.6			213685.1 784068.7
SUBTOTAL		986729.5		11024.3 ^(f)			997753.9
TOTAL FUEL CONSUMPTION	609072.4 ^(a)	2051257.9	63428.1 ^(j)	373133.8 ^(d)	4-STM 34658.5 2-PCM 154997.3 3-COK 110207.0 ^(j) 4-OTH 13014.3	.0	3409769.3

Footnotes To 1974 Summary Tables

- a. National Economic Research Associates, Inc. (NERA), "A Long Range Planning Study for New York Gas Utilities," (Nov. 1976).
N.Y. Natural Gas Total = 632×10^{12} Btu
- b. NERA Manufacturing Gas Total = 124×10^{12} Btu
- c. NERA Residential + Commercial + Government Gas Total = 480 (BNL = 480)
- d. New York Power Pool (NYPP), Electric Total = 368×10^{12} Btu.
- e. NYPP Industrial + Commercial + Government Electric Total = 245
(BNL = 262)
- f. NYPP and Financial Statistics of Utilities 1974: Transportation electric demand = 10.6×10^{12} Btu.
- g. NYPP Residential electrical demand = 112×10^{12} Btu.
- h. NYPP - (estimated from company data) commercial electrical demand = 133×10^{12} Btu.
- i. Cornell University, Agricultural Engineering Bulletin, 406, July 1976.
- j. 1974 Census of Manufacturers Special Fuel Series:
Industry coal demand = 63×10^{12} Btu
Industry coke demand = 6×10^{12} Btu (estimated from 1971 and 1974 data)
Total 69×10^{12} Btu
U.S. Bureau of Mines, Division of Fossil Fuels, "Bituminous Coal and Lignite. Distribution Calendar Year 1974", April 1975.
N.Y.S. Total Coal = 390×10^{12} Btu
Less Utilities = 195×10^{12} Btu
 195×10^{12} Btu
Less Residential = -13×10^{12} Btu
heating use
Total 182×10^{12} Btu
- k. Includes Feedstocks.

ENERGY DEMAND AND FUEL MIX
1EG9 BTU
SCENARIO- BASE CASE YEAR- 1985

	NATURAL GAS	OIL	COAL	1985 ELECTRICITY	STEAM OTHER & FDSICK	SOLAR	TOTAL DIRECT USE
AGRICULTURE							
ALL CROPS		8045.4					8045.4
ALL STOCK		1853.4					1853.4
ELECTRICITY				1170.7			1170.7
PROPANE		639.9					639.9
SUBTOTAL		10538.6		1170.7			11709.3
COMMERCIAL							
AIR COND	982.5			19493.6		.0	20396.1
APP-AUX EQUIP				54036.1			54036.1
LIGHTING				71684.9			71684.9
SPACE HEAT	56576.8	337524.5		26344.8	33416.4	(1)	453862.6
WATER HEAT	46789.9	.0		17214.9		.0	64679.7
SUBTOTAL	104269.2	337524.5		186774.3	33416.4	674.9	664659.4
GOVERNMENT							
AIR COND	7.3			194.1		.0	201.4
APP-AUX EQUIP				247.0			247.0
AUTOS		778.2					778.2
LIGHTING				463.1			463.1
SPACE HEAT	622.1	2688.1		362.8	349.5	(1)	4222.5
WATER HEAT	40.0			26.6		.0	67.9
SUBTOTAL	669.4	3666.3		1293.5	849.5	1.3	5980.1
MANUFACTURING							
AGG EUSE SIC 20	17387.3	14774.6	415.4	6052.0			40549.3
AGG EUSE SIC 22	3164.1	2731.6	.0	2731.1			8676.8
AGG EUSE SIC 23	301.8	767.4	.0	5524.5			6593.7
AGG EUSE SIC 24	562.5	741.4	43.6	1153.0			2535.5
AGG EUSE SIC 25	561.2	972.1	19.4	933.8			2566.5
AGG EUSE SIC 26	3261.2	19009.7	9824.6	15089.7			67185.2

	NATURAL GAS	OIL	COAL	1985 ELECTRICITY	STEAM OTHER ^ FDSTCK	SOLAR	TOTAL DIRECT USE
AGG EUSE SIC 27	967,3	1233,2		6915,9			9116,4
AGG EUSE SIC 28	16017,7	24038,7	39124,4	19810,8	(2) 229194,5		328186,1
AGG EUSE SIC 30	1348,6	706,3	12354,5	5568,2			20007,5
AGG EUSE SIC 31	333,7	611,6	158,7	,0			1104,0
AGG EUSE SIC 32	25461,0	24494,4	19459,6	8545,1			77960,1
AGG EUSE SIC 33	29451,6	17022,2	4931,3	28445,6	(3) 118346,3		198197,2
AGG EUSE SIC 34	10030,5	4689,4	318,5	7737,7			22776,1
AGG EUSE SIC 35	8793,3	7842,6	1433,7	8802,3			26871,9
AGG EUSE SIC 36	11409,3	5674,6	203,1	14073,4			31360,4
AGG EUSE SIC 37	11345,1	4002,2	2507,9	6492,8			24348,0
AGG EUSE SIC 38	1905,7	2118,2	17318,6	3531,9			24874,5
AGG EUSE SIC 39	904,3	1061,7	594,8	3529,5			6170,3
SUBTOTAL	143256,1	152492,0	108738,1	146992,5	347540,8		899019,5

RESIDENTIAL

AIR COND				15100,0		,0	15100,0
COOKING	36218,9	4547,4		6492,8			47259,1
LIGHT-APPLI				115184,0			115184,0
SPACE HEAT	188025,9	326303,8		48559,0	(4) 12505,7	,0	575394,4
WATER HEAT	61921,3	49250,8		53734,0		2856,0	187762,1
SUBTOTAL	286166,1	400102,0		239069,8	12505,7	2856,0	940699,6

TRANSPORT

FREIGHT		268970,1		665,8			269635,9
PASS		934284,4		11287,6			945572,0
SUBTOTAL		1203254,6		11953,3			1215207,9

TOTAL FUEL CONSUMPTION	534360,8	2107578,0	108738,1	589254,2	1-STM 33766,0	3532,3	3737276,0
					2-PCM 229194,5		
					3-COK 118346,3		
					4-OTH 12505,7		

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ENERGY DEMAND AND FUEL MIX
1989 BTU
SCENARIO- BASE CASE YEAR- 2000

	NATURAL GAS	OIL	COAL	2000 ELECTRICITY	STEAM OTHER & FOSTON	SOLAR	TOTAL DIRECT USE
AGRICULTURE							
ALL CROPS		9234.1					9234.1
ALL STOCK		2175.5					2175.5
ELECTRICITY				1170.7			1170.7
PROPANE		639.9					639.9
SUBTOTAL		12049.5		1170.7			13180.2
COMMERCIAL							
AIR COND	800.6			21489.4		634.1	22924.1
APP-AUX EQUIP				58489.6			58489.6
LIGHTING				79206.0			79206.0
SPACE HEAT	42965.0	24974.8		39752.1	33416.4	4300.2	369866.4
WATER HEAT	32809.6	.0		25493.7		2337.6	63631.1
SUBTOTAL	76576.2	24934.8		227460.9	33416.4	7202.0	594057.3
MANUFACTURING							
AIR COND	4.7			185.2		7.0	196.6
APP-AUX EQUIP				258.0			258.0
AUTOS		346.9					346.9
LIGHTING				483.7			483.7
SPACE HEAT	357.8	1975.7		498.4	349.5	53.8	3235.3
WATER HEAT	34.9			44.7		4.3	83.9
SUBTOTAL	397.4	2522.6		1476.1	349.5	55.0	4864.7
MANUFACTURING							
AGG EUSE SIC 20	19450.7	10407.5	701.4	10126.6			47286.2
AGG EUSE SIC 22	7570.3	3114.7	.0	3523.6			10317.5
AGG EUSE SIC 27	354.1	332.8	.0	7061.7			8296.5
AGG EUSE SIC 24	717.7	885.1	74.7	1558.5			3239.9
AGG EUSE SIC 25	711.6	1171.0	35.6	1256.6			3175.2
AGG EUSE SIC 26	566.9	45731.4	19715.2	21410.9			87724.3

2000

	NATURAL GAS	OIL	COAL	ELECTRICITY	STEAM OTHER & FOSTOK	SOLAR	TOTAL DIRECT USE
AGG FUSE SIC 27	1289.0	1612.2		10045.0			12947.4
AGG FUSE SIC 28	8401.2	21059.4	85234.8	32147.6	371918.6		518821.7
AGG FUSE SIC 30	.0	.0	19630.1	5497.4			28167.0
AGG FUSE SIC 31	408.2	785.5	324.9	.0			1518.5
AGG FUSE SIC 32	28427.0	27039.9	39822.2	13025.3			108314.2
AGG FUSE SIC 33	27562.9	15621.5	4799.6	26332.4	110236.5		190528.6
AGG FUSE SIC 34	10242.0	4656.1	479.7	8661.3			24059.0
AGG FUSE SIC 35	9562.0	7477.6	2133.9	9758.7			27928.2
AGG FUSE SIC 36	10820.0	5255.4	283.0	14610.5			30969.0
AGG FUSE SIC 37	13351.7	4149.5	4189.0	3841.8			30928.1
AGG FUSE SIC 38	.0	.0	29097.3	5363.7			34460.9
AGG FUSE SIC 39	1157.1	1255.9	1217.3	5360.0			9010.3
SUBTOTAL	136462.1	153301.6	207186.1	197636.2	468125.1		1177715.3
RESIDENTIAL							
AIR COND.				21336.9		759.0	22095.9
COOKING	45810.5	5010.5		5194.0			56005.1
LIGHT-APPLI.				156906.9			156906.0
SPACE HEAT	140199.3	240691.2		74501.0	12505.7	8062.0	481939.2
WATER HEAT	76571.4	41079.4		99500.0		9590.0	166740.8
SUBTOTAL	222571.2	293571.1		357427.9	12505.7	18411.0	904487.0
TRANSPORT							
FREIGHT		364943.1		911.7			365754.8
PASS		1014045.9		12745.5			1026792.4
SUBTOTAL		1393989.0		13558.1			1412547.1
TOTAL FUEL CONSUMPTION	359057.0	2114735.7	207186.1	738726.0	1-STM 33756.0 2-FCM 371918.6 3-COK 115206.5 4-OTH 12505.7	25738.0	4106791.6