27-30-78

BNL 22677
INFORMAL REPORT

AN ENERGY INFORMATION AND ANALYTIC SYSTEM FOR NEW YORK STATE

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August 9, 1976

Prepared under a contract with the New York State Energy Research and Development Authority with supplemental support from the U.S. Energy Research and Development Administration.

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Abstract

It is vitally important that each level of government have at its command the information and analytical framework required to make intelligent energy decisions. At the state level, an Energy Information/Analytic System must be able to analyze the implications for the state not only of legislative and executive decisions made by the state, but also of possible federal policies. Ultimately, the aim of the system is to make decisions taken at both the state and federal level more consistent with the interests of the citizens of New York State.

Our review of energy information needs and activities in the State of New York and in twenty other states provides background for the types of policy issues and data critical to the design of an energy information/analytic system. The basic conceptual framework employed in the design is similar to that of the regional versions of the Brookhaven Reference Energy System. This framework is similar to that used in many state systems, for example, in proposed systems for the States of Nebraska and New Jersey and in existing systems in Maryland, Wisconsin, California, and New England. This framework is sufficiently general to permit the examination of a wide range of state energy policy issues and will provide an integrated picture of the state's energy supply-distribution-demand system which can be utilized by technical staff and policy makers to gain insight into the complex interaction between economic, technological, social, and environmental factors. The system is structured as a set of four basic elements--a broad base of state-specific data and information, a computerized retrieval system with easy terminal access to national data bases, adaptation of useful analytical models, and a modular construction which will allow sequential development of full capabilities of the total system. Finally, an action plan describes the sequence of tasks and costs required to implement a working system. This action plan serves to establish a base of data and report capability to deliver to decision makers a comprehensive overview of the state energy system, disaggregated fuel flows to specific end use sectors, flows to geographic regions in the state, trends in energy supply and consumption patterns, and other basic energy information.

SUMMARY

It is becoming increasingly apparent that decisions relating to energy are of primary importance at all levels of government. Dislocations in the energy system over past years have made it clear that energy plays a critical role in the economic wellbeing of the nation and state. It is thus vitally important that each level of government have at its command the information and analytical framework required to make intelligent energy decisions. At the state level, an Energy Information/Analytic System must be able to analyze the implications for the state not only of legislative and executive decisions made by the state, but also of possible federal policies. Ultimately, the aim of the system is to make decisions taken at both the state and federal level more consistent with the interests of the citizens of New York State.

Not all energy policy issues are of equal concern at any one time. Indeed, the focus of energy planning is continually changing. Consequently, an Energy Information/Analytic System must be able to respond quickly to supply reliable analyses on a wide variety of policy issues as they become politically important. To do so, data and analytical techniques must be constructed in anticipation of future issues of concern as well as in response to current issues. At the same time, it would be impractical to invest large amounts of time and funds into the construction of a general and universal system that would only be available after a considerable length of time and, even then, perhaps incapable of answering unanticipated questions. A sensible approach to development would thus be to construct the most important basic information and analytical tools in a framework which can accept, digest, and utilize information with ease. This implies a dynamic, growing, and increasingly effective information/analytic system.

An Energy Information/Analytic System should be designed to respond to the variety of policy interests of the energy community in the State of New York. However, in our discussions with staff of various New York State agencies and other elements of the energy community, it was difficult to find a broad coherent set of policy interests. At present few agencies have a direct interest in energy issues and seem primarily to have responded to outside requests to prepare specific types of energy information. Few of the agencies have identified in-house staff who work on a regular basis with energy issues with the exception of the Public Service Commission and elements of other agencies with direct mandated responsibilities in the energy field. From the varied and diffuse set of questions posed by individuals within agencies, we prepared a list of general policy questions which serve to guide the design. We also examined energy issues in other states, both with respect to types of policy issues which arise in the energy field in those states and types of energy information systems constructed to both respond to issues at hand and prepare to respond to future energy issues as they arise.

The review of energy information activities in other states began with conversations with directors and staff of energy offices in some twenty states. Subsequently, we explored in-depth with at least two users of such systems in their states, the types of policy issues posed to the system, the types of data required in response to issues, and overall impressions of the energy information systems and their use. Without exception other states defined only a diffuse set of policy issues, similar to the situation in the State of New York. Consequently, energy information systems in general had been designed to consist of building blocks to be added as policy issues arise, and the implementation of such systems has occurred in steps in response to specific energy policy questions in the state. This review of energy information/analytic systems in other states forms a context within which to approach the design of a system for the State of New York.

One distinct common thread appears in the design of all of the energy information systems. Every such system has two specific components in general use - first, energy flow accounts which depict the flow and distribution of energy throughout the state, and second, a projection model which permits the estimation of patterns of energy supply and demand within the state. These two elements are found, for example, in proposed systems for the States of Nebraska and New Jersey and in existing systems in Maryland, Wisconsin, the RAND Corporation in California, the New England Energy Management Information System, and the like. The design issue is then: how best to construct a set of energy flow accounts, an energy projection model, and supporting data and information.

The flow accounts and projection model which lie at the heart of the energy information/analytic system may be constructed quickly and easily by adaptation from among the many systems in other states and at the national level. For example, the Reference Energy System, which was developed at Brookhaven National Laboratory in the late sixties, has been widely used at the nation, state, and regional levels for energy supply technology and energy demand studies. It includes sufficiently detailed end uses to be compatible with a broad variety of data and models and the needs of state agencies and other groups. However, for use at the state level, a redefinition of the end use categories to those more descriptive and appropriate of state energy consumption is necessary, as well as a modification of energy supplies and technology descriptions more appropriate to New York State, which has relatively few indigenous energy resources. The adaptation of energy information systems from other states also presents problems. For example, in Wisconsin, the agricultural sector in the energy projection module is described in general terms with energy use as one component. This has advantages for the study of agriculture itself, but is less convenient for detailed look at energy use in agriculture and in the state as a whole. Finally, while other state systems have generally not been adapted from one place to another, the Reference Energy System has been utilized at the national, regional, and state level, which indicates its flexibility and ease of adaptation and implementation in a broad variety of applications.

The basic conceptual framework employed in the design is similar to that of the regional versions of the Brookhaven Reference Energy System. This framework is similar to that used in all state systems which were judged by the users to have performed successfully. This framework is sufficiently general to permit the examination of a wide range of state energy policy issues and will provide an integrated picture of the state's energy supply-distribution-demand system which can be utilized by technical staff and policy makers to gain insight to the complex interaction between economic, technological, social, and environmental factors. The system is structured as a set of four basic elements - a broad base of state-specific data and information, a computerized retrieval system with easy terminal access to national data bases, adaption of useful analytical models, and a modular construction which will allow sequential development of full capabilities of the total system. While the Reference Energy System provides a starting point for efficient and economical development of an energy information system for the state, it is augmented by other components directed toward the variety of specific needs of the New York energy community. The analytic structure is described in detail including the breakdown of end use into agriculture, commercial, government, manufacturing, residential, transportation sectors, and techniques for estimating energy demand and fuel consumption within these sectors. The underlying base of energy data and information is described as well as a detailed listing of both state and federal agency sources for information in the state data base. Requirements for computer hardware and software to support the operation of the energy information/analytic system includes the use of commercial data base management systems which are well suited to state needs and will minimize the costs of operating the system. Finally, an action plan describes the sequence of tasks required to implement a working system. This action plan serves to establish a base of data and report capability to deliver to decisionmakers a comprehensive overview of the state energy system, disaggregated fuel flows to specific end use sectors, flows to geographic regions in the state, trends in energy supply and consumption patterns, and other basic energy information.

CONTENTS

I. INTRODUCTION

A. Aims of the Study

This report presents the results of a study to design an Energy Information and Analytic System for the State of New York.

It is becoming increasingly apparent that decisions related to energy are of primary importance at all levels of government. The vicissitudes of the energy system over the past two years have made it clear that energy plays a critical and vulnerable role in the economic wellbeing of the nation and the states that compose it. It is thus vitally important that each level of government have at its command the information and analytical framework required to make intelligent energy decisions. At the state level an Energy Information/Analytic System must be able to analyze the implications for the state not only of legislative and executive decisions made by the state but also possible federal policies. Ultimately the aim of the System is to make decisions taken at both the state and federal level more consistent with the real interests of the citizens of New York State.

There should no longer be any question as to the importance of energy to the individual and collective health and welfare of the citizens of New York State. With virtually no indigenous energy resources in the State, its industry has been burdened over the last few years with rapidly rising fuel costs, further exacerbating recent historical trends whereby the State has lost industrial initiative to other regions of the country. The cost of living in the State has also been increased significantly by energy price rises. The high population densities of the State means that the health impacts of energy systems are felt with particular strength here. Careful attention to energy issues must clearly take high priority for New York State Government.

The primary considerations in arriving at a design for a New York Energy Information/Analytic System were the issues that such a system must be able to address and the role that the system will be called on to play in policy making and planning in New York State. Our emphasis therefore is on designing a capability as much as a system on which that capability is based. It must be realized from the beginning that energy issues are too dynamic and too complex to be captured by a computerized information system. Thus, in the remainder of this introduction,we discuss our conception of the role of the system in policy formulation, and the nature of the issues that the system must be designed to deal with. Although we do not deal explicitly with the institutional question of just where the Energy Information/Analytic System should be located in State government, we shall discuss some basic concerns that should be considered in making that choice. Since similar issues must be dealt with in both the legislative and executive branches it would be well if a single system could serve both elements of State government. We recognize, however, that such "bilateral" implementation presents considerable practical difficulties.

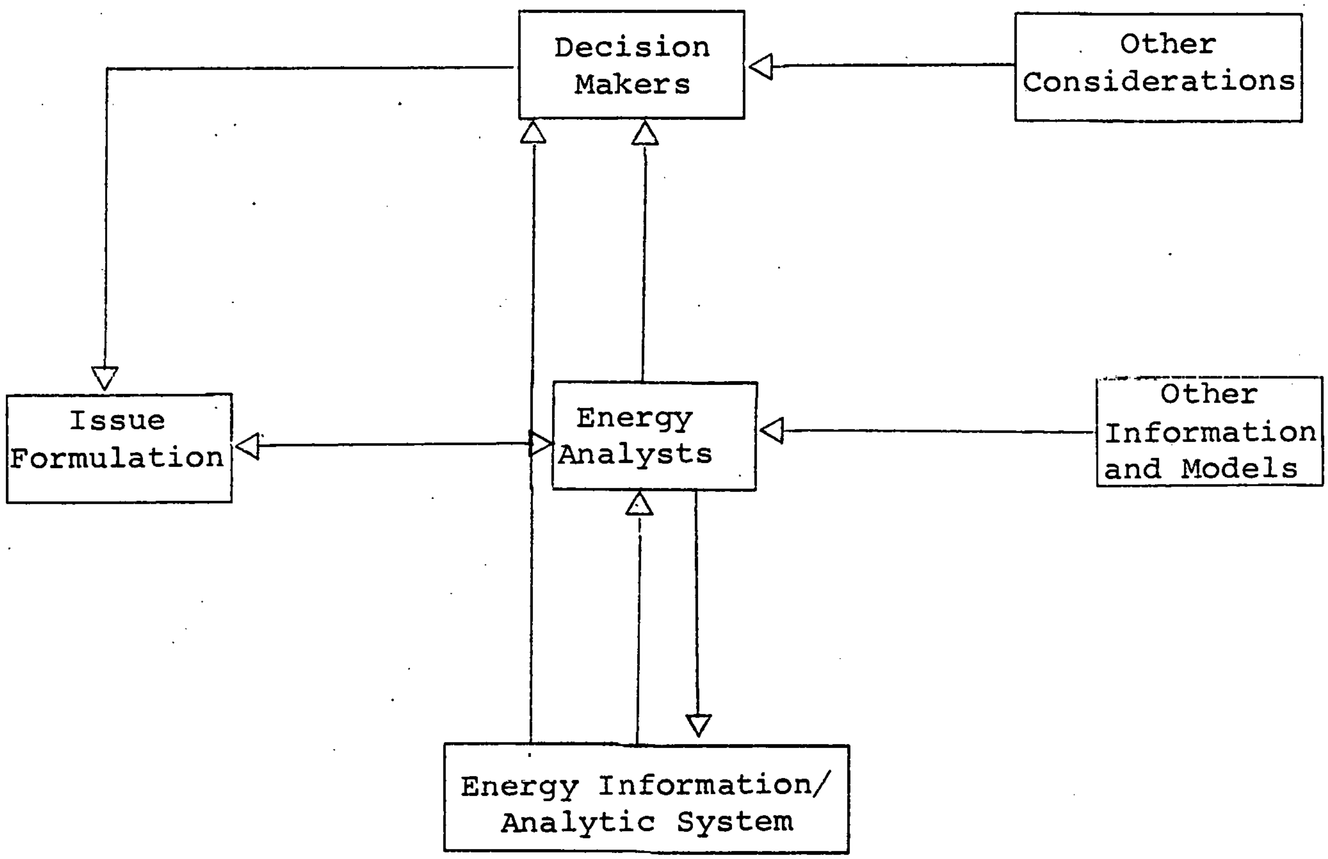
B. Basic Conception and Role of the Energy Information and Analytic System

Data banks and computer programs do not solve energy problems. They do provide important information and a set of tools that can be used by analysts to examine the implications of alternative energy decisions. Thus, in designing the New York Energy Information/ Analytic System one must start with a conception of how such a system fits into the decision making process of government.

The relationship between the System and its users is indicated in Figure 1. The basic conception is that the Information/Analytic System, and the assessments performed by the analysts that are using

FIGURE 1

SCHEMA OF ROLE OF THE NEW YORK
ENERGY INFORMATION/ANALYTIC SYSTEM



the system are objective and politically neutral. Issues or questions are formulated by the users or by the staff of the analytical group. In some cases there will be a relatively simple flow of information from the System to the questioner (in response, for example, to the question, "how much oil was consumed for space heating in single family dwellings in 1974?"). In other cases, and the more important ones, an assessment will have to be performed. In general the aim of that assessment will be to analyze the impacts of alternative policies. For example, alternative incentive systems for homeowners to install solar heating systems would be compared in terms of the direct cost to the state (say in reduced tax revenues), effects on industrial and commercial activity, effect on employment, and impact on the state's environment. The analysis may incorporate information that is not part of the System (such as experience in other states with similar policies).

The analysis then supplies the decisionmaker with a set of evaluated options regarding the policy in question. Even in the simple example chosen, the analysis may not be able to identify the "best" policy, for that requires a comparison between very different criteria. The trade-off between environment and jobs, for example, is a political decision. Furthermore, there may be non-technical considerations that enter the decision making process. For the solar incentive case, for example, the existence of an active public interest group supporting in solar energy might enhance the feasibility of certain types of incentives.

As shown in Figure 1, issues may be formulated by the users of the system or they may be formulated by the analytical group. The analytical group, or an office to which it is attached, may also be given the responsibility of preparing on a regular basis reports on aspects of energy in the State. For example, an annual report on the overall energy situation in the State could be a very useful document.

The point to be emphasized in this discussion is that in all of these modes of operation the system can be operated in an objective, non-political manner. Policy analysis can be distinguished from policy making and the effectiveness of an Energy Information and Analytic System will be significantly increased if that distinction is maintained in its design and implementation.

C. The Nature of Energy Policy Issues

The design of a New York Energy Information and Analytic System must be based on the issues that the system must address and the criteria used to evaluate those issues. Some representative issues or questions that the System might be required to address are:

1. What would be the effect on the State (in terms of fuel availability, industrial activity and revenues, jobs, etc.) of alternative federal policies on natural gas price regulation?

2. Should the State encourage natural gas production from Lake Erie and if so under what conditions?

3. Under conditions of another oil embargo what petroleum product allocation scheme produces least impact on the overall State welfare?

4. What would be the effect on the State of a moratorium on the construction of new nuclear power plants?

5. What would be the effect on energy costs and availability within the State of proposed changes in federal environmental regulations (amendments to the Clean Air Act)?

6. What are the most important areas for the State to invest in energy research and development?

7. What effect would mandatory lighting efficiency standards for public buildings have on projected 1980 energy consumption?

8. What would be the effect of alternative residential and commercial building codes?

9. What regions of the State would be most affected by natural gas curtailments and what policies are available to reduce those impacts?

10. What benefits and costs would accrue to the State from investment in alternatives to automotive transport?

11. What are the possibilities for, the impacts of, and barriers to increased coal use in the State?

12. What is the potential for combined waste-coal fluidized bed boilers in New York City?

13. What effect would an LNG terminal in New York harbor have on the availability and cost of natural gas to the State?

14. What effect would development of Atlantic Outer Continental Shelf (OCS) gas and oil resources have on State supplies? What Federal and State regulations regarding OCS development are of most benefit to the State?

These issues are broadly representative of the types of questions that the System may be called upon to address. Some of the issues are fairly narrow and relatively easily dealt with. Others, to be properly addressed, require extensive in-depth analysis. Question No. 6, for example, is the basis for determining the program of the Energy Research and Development Authority. Answering that simple question requires careful and extensive analysis, drawing on a wide range of expertise and is central to the planning function of the Authority. The analysis of Issue No. 7 is one element of a State energy conservation plan as called for if the State is to receive Federal funding under the State Energy Conservation Program administered by the Federal Energy Administration.*

In addressing these issues one must deal with a range of criteria for judgement that derive from basic goals of the State. Among these are:

1. Low energy costs to all consumers
2. Environmental quality
3. State economic health including high employment levels and income.
4. State fiscal health
5. Social equity

It is in the nature of energy policy issues not only to include diverse aspects of society's activities but also to affect a wide range of concerns, such as those indicated above. Many energy policy issues involve complex trade-offs between these various criteria or goals.

It should also be noted that these criteria traditionally constitute the purview of separate state agencies. Furthermore, many of the individual sectors of the energy system are represented by separate agencies such as the Public Service Commission and the Department of Transportation. Thus, while many pieces of the energy problem are located in a number of places in State government, there is no place where anything like a full set of information exists, not to mention an analytical system, that allows the kind of integrative analysis that is required for energy policy formulation.

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*As defined in the Energy Policy and Conservation Act of 1975, Public Law 94-163.

The range of issues and the basic concerns to be dealt with can be represented schematically as in Figure 2. This scheme is based on the observation that New York's energy situation derives from its geographic and other relationship to the country as a whole,* while communities, businesses and individuals experience varying effects depending on their spacial location within the State. It also reflects three basic analytic concerns: effects on energy supply-demand, economic activity, and environmental quality. These categories define the structure into which energy policy issues fall and through which they must be analyzed.

D. System Design Criteria and Development Strategy

In designing an Energy Information/Analytic System to deal effectively with the issues discussed above, certain basic criteria must be considered:

1. Responsiveness: the System must be able to respond quickly to the needs of various parties in the State who are responsible for energy related decisions.

2. Inclusiveness: the System must be able to deal in adequate depth with the wide range of issues and effects that are of potential concern.

3. Cost: the System should be implemented at lowest possible cost to the State.

Since these simple criteria are almost mutually exclusive, the design and implementation of the system must consider the best means of accommodating them.

*In the category of U.S. data special emphasis should be placed on information related to the Northeast. The benefits of regional cooperation in establishing and carrying out energy programs can be substantial in certain areas.

FIGURE 2

NEW YORK STATE ENERGY POLICY

ISSUE MATRIX

	Geographical Focus		
Effect Focus	US/New York State Relations	New York State as an Entity	Regions Within New York State
Energy Supply/Demand			
Economic Activity and Welfare			
Environmental Quality			

Obviously not all energy policy issues are of equal concern at any one time. In fact, the focus of energy planning is continually changing. Newspaper headlines in the past few years have declared a succession of crises; gasoline shortages, electricity prices, natural gas supplies, offshore oil development, energy conservation, and nuclear power have succeeded each other in the public and political consciousness. Clearly, an Energy Information/Analytic System must be able to respond quickly to supply reliable analyses on a wide variety of issues as they become politically important. In order to accomplish that, however, data and analytical techniques must be constructed in anticipation of future issues of concern and not in response to current issues. At the same time, it would be impractical to invest large amounts of time and funds into the construction of a completely general and universal system that would only be available after some considerable length of time and then probably be incapable of answering some previously unanticipated question. The sensible approach to the development of the system would thus be to put together the most important basic information and analytic tools and then to introduce further information and methods as required to address central continuing policy issues. This implies that the system must be designed to accept, digest, and utilize new information with ease. It implies a dynamically growing, increasingly effective system.

Although an Energy Information/Analytic System has great potential for improving the decisions of State government in areas with important economic consequences, it's development must be approached in a cost-conscious manner. The development approach suggested above would satisfy that criterion. Another important strategy will be to make maximum use of existing information and systems within the State and outside. To this end, and as general background for the design of the System, we review in the next chapter the range of available energy analysis methodologies with an eye toward selection of the best elements of existing frameworks for integration into the New York System. Following that, we present a critical review of the experience of other states in the construction and operation of energy policy analysis units. That review will provide more detailed guidelines for the development of corresponding energy activities here. Finally, the design of a system is described which makes maximum use of existing systems within and outside of New York State and provides a flexible instrument for energy policy analysis in the State.

II. EXISTING INFORMATION/ANALYTIC SYSTEMS

In this section of the report, we briefly review existing information systems, data bases, and analytic capabilities available at national and state levels which might be effectively utilized in the context of energy policy analysis in the State of New York. While available tools may not be capable of direct integration into the New York System, the types of information/analytic structures developed elsewhere and found applicable to policy issues offer useful design guidance. Finally, we take a careful look at existing energy activities within the State of New York itself, with an eye toward their potential contributions to developing state energy analysis capabilities.

A. Information Systems and Data Bases

Energy Information Resources of the Federal Government

The Federal Government, in pursuance of its many functions, develops and codifies an enormous amount of diverse information. The primary purpose of such data collection activities is to provide the collecting agency with the information required to fulfill its legislative mandate. As such, the selection of information collected and the way it is codified is defined by the agency almost completely in terms of its own needs. Some agencies--an example would be the Census Bureau in the Department of Commerce--are required by law to make their data generally available to anyone who wishes access to them. This is done through regular publications, subscription services, computerized data bases, etc., and knowledgeable users can readily gain access to exactly the specific data they require. Most reference librarians quickly become familiar with available Federal data resources pertinent to their local community of users.

The Science and Technology Division of the Library of Congress maintains a National Referral Center which is designed to function simply as the "information desk" of the scientific and technical community. The Center provides a single place to which anyone may turn for advice on where to obtain information on specific topics in science and technology. It does not provide technical details in answer to inquiries, nor does it furnish bibliographic assistance. Functioning as an intermediary, it directs those who have a question concerning a particular subject to organizations or individuals with specialized knowledge of that subject. The Center is concerned with all fields of science and technology: the physical, biological, social and engineering sciences, and the many technical areas relating to them. Similarly, it is concerned with all levels of information resources, wherever they exist: in government, in industry, and in the academic and professional world. This Center provides a highly useful referral function for those who are dealing with scientific or technical fields in which they have had little or no prior experience. (The Center is located on the fifth floor of the Library of Congress Annex, Second Street and Independence Avenue, S.E. in Washington, D.D. The zip code for writing is 20540 and the telephone number for referral services is (202) 426-5670.)

In the field of energy, the primary Federal data resource is the Federal Energy Administration (FEA). Pursuant to Section 20(a)(4) of Public Law 93-275, the FEA established the National Energy Information Center (NEIC) in June of 1974 to provide "a central clearinghouse for Federal agencies and State governments seeking energy information and assistance from the Federal Government." The NEIC has been designed to perform the basic functions of the type of clearinghouse known as an information center, which is, by definition, "to provide in-depth information services in a prescribed subject field and to synthesize information on request." As noted, the NEIC is directly mandated to service the information needs of state governments at the same level as it services the needs of other agencies of the Federal Government. As a primary user, requests from state agencies are given the highest priority, and the system is monitored to determine how well it is functioning with respect to such primary users. The NEIC information base and research functions have recently been expanded and refined to provide improved services, based on the experience gained in the first two years of operation.

The current organization of the National Energy Information Center is designed to optimize all of NEIC's extensive capability to respond to user requirements by consolidating major Center activities in five functional components:

1. <u>Intergovernmental Coordination Office</u>
   Responsible for the planning and implementation of energy information programs between and among Federal and state users.

2. <u>Referral Services Unit</u>
   Responsible for routing of user inquires (from both public and private sectors) to proper NEIC component or to other information sources.

3. <u>Technical Services Division</u>
   Responsible for development and maintenance of an integrated base of energy information (in documentary, microform, and automated media) and for implementation of NEIC publication activities.

4. <u>Research Services Division</u>
   Responsible for analysis of user requirements and for the compilation and generation of base data publications and specialized information products.

5. <u>Systems Services Division</u>
   Responsible for the design and operation of data acquisition and transfer mechanisms and for the administration of automated files in the NEIC information base (including all FEA data, whether or not releasable through NEIC).

Of these five components, two are particularly important to state government inquirers--the Intergovernmental Coordination Office, the point of state-FEA contact, and the Research Service Division, the point of FEA response. (The Referral Services Unit is in the process of formation and will eventually take over the response function.) Because of their central role for potential state level use, it seems worthwhile to detail their responsibilities and current tasks.

The Intergovernmental Coordination Office (ICO) staff is responsible for providing impetus and direction to Federal and state activities concerned with development of a comprehensive, consistent, and nationally interactive energy information system; for establishing and maintaining liaison with all identifiable elements of NEIC's governmental user community; and for evolving and promulgating policies and mechanisms which will enhance NEIC's usefulness as the national clearinghouse for energy information. The staff has the responsibility for providing the objective oversight necessary to insure that NEIC operations are oriented not only to the requirements of FEA offices, but also to the needs of state and other Federal users. Tasks now being addressed by the ICO staff include:

1. Administrative direction and technical support of the Federal Interagency Council on Energy Information
2. Development and implementation of policies and procedures for coordination of regional and state programs
3. Development and implementation of a comprehensive program for informing Federal and state agencies of the capabilities and interests of the NEIC in its role as the national clearinghouse for energy information.
4. Supervision of arrangements for the acquisition of energy data bases maintained by other Federal and state agencies.
5. Monitoring of and participation in the design, development, and implementation of data systems supporting FEA program office requirements impacting on other Federal or state agencies.

The Research Services Division (RSD) is responsible for conducting in-depth analyses of program and statistical information to determine application of the data to particular user requirements; for integrating and compiling data derived from the NEIC data base or obtainable from FEA and other energy organizations; and for preparing base data publications for issuance by the NEIC. Tasks now being addressed by the RSD staff include:

1. Development and implementation of an ongoing program for the determination of current and foreseeable user requirements and for the assessment of the utility of the NEIC information base relative to such requirements.

2. Preparation, in conjunction with affected FEA offices, of publications that describe ongoing FEA programs and provide compilations of basic energy data.

3. Preparation of basic data sheets on energy-related subjects.

4. Preparation of a comprehensive Referral Register that cites both FEA and non-FEA contact points that can provide discipline expertise concerning particular kinds of energy information.

The appropriate contact is Neal Moerschel (Head of the Intergovernmental Coordination Office) at the Federal Energy Administration, Washington, D.C. 20461. Mr. Moerschel's phone number is (202) 961-8465, and he is located in Room 1409 of the Old Post Office Building at 1100 Pennsylvania Avenue, N.W. A partial listing of the computerized file presently (May 1976) contained in the NEIC information base is given in Table I.

In addition to its referral role, the NEIC disseminates energy information by means of numerous periodicals and special reports designed to provide technical information on the energy situation. Periodicals include the Weekly Petroleum Statistics Report, the Monthly Asphalt Situation Report, Trends in Refinery Capacity and Utilization, and the Monthly Energy Review. Special reports--for example, on Market Shares--are published from time to time.

B. Analytic Models

The class of energy models is extremely large. Much of the early thrust of energy models focused upon the economics of supply and demand in specific fuels and such models were developed by and for public and private producers. Examples are electric utility forecasting models which attempt to assess strategies for capacity expansion, and models of oil company optimal allocation of crude

Table 1

NEIC INFORMATION BASE

Automated Files

Currently On-Line

FEA Data Bases

Coal
Market Shares
(Refiners-Importers only)
Petroleum Reporting
(Integrated Names & Addresses only)
Refiner Pricing
Transfer Pricing
(An additional 54 FEA data bases are scheduled for loading.)

Non-FEA Data Banks
(Selected from more than 100 files available.)

Statistical

Abstracted Business Information (25,000)
American Statistics Index (Congressional Information Service) (20,000)
Chemical and Equipment Market Abstracts (80,000)
Chemical Industry Notes (100,000)
Domestic and International Financial Reports (500,000)
Domestic Statistics (60,000)
Industrial Plant Statistics (100,000)
International Statistics (120,000)

Technical

Battelle Energy Information Center (20,000)
Cataloging and Indexing Database of National Agriculture Library (692,000)
Central Abstracting/Indexing Service of American Petroleum Institute (230,000)
Chemical Abstracts Condensates of Chemical Abstracts Service (1,880,000)
Chemical and Chemically Related Patents (350,000)
DOT-Sponsored NTIS Reports (4,500)
EDB Energy Database (TIC) (66,000)
ED2 Energy Database (TIC-CDS) (15,000)
ENG Energy Database (EISO) (15,000)
Engineering Index (COMPENDEX) (360,000)
ERI Energy R&D Projects (EISO) (8,500)
Geological Reference File (AGI) (263,000)
Mechanical Engineering (30,000)
Metals Abstracts (220,000)
Meteorological Abstracts (22,000)
Nuclear Science Abstracts (525,700)
Oceanic Abstracts (483,000)
Oil and Gas Files (University of Tulsa) (153,000)
Pollution Abstracts (37,700)
Science Abstracts (700,000)
Smithsonian Science Information Exchange (130,000)
Water Resources Abstracts (90,000)

Congressional

Congressional Information Service Index (50,000)

General

Abstracts of Instructional and Research Material (9,000)
Comprehensive Dissertation Index (500,000)
DOT Work in Progress (2,200)
Foundation Directory (2,500)
Government Reports Announcements (NTIS) (400,000)
Information Bank of N.Y. Times (includes 58 periodicals)
Library of Congress Catalog (1,000,000)
National Referral Center (6,800)

(A study is now in process of state banks to be added.)

Document Collection

Microform

oil products between sources, refineries, and final demands at specified future dates.

More recently, modeling efforts have been directed toward national policy issues. There are several conceptual tracks followed by such models, and each offers a different perspective on the energy system. Generalized systems modeling, for example, has been applied to the issue of interfuel substitutions. Simulation of flows of energy resources to end use demands is based upon formulations of energy system costs, investment decisions, and constraints upon supplies of resources. These models create a set of energy prices, quantities, and utilization of energy resources over time. Network and linear programming formulations of the energy system have been used extensively in technology assessment. All steps in the energy chain, including extraction, refining, conversion, storage, transmission, distribution, and end use device are represented. Each such process is described by conversion efficiency, capital and operating cost, and pollutant emissions. These models are then used to assess energy-economic-environmental impacts of new technologies for future dates. Input-output analysis of energy in the national economy also proves valuable. Here, the dollar transaction matrix, at differing levels of disaggregation, is augmented with energy consumption per unit of output. This permits study of the direct and indirect energy costs of consumer products, time trends of these energy coefficeints, and even shifts in the employment-energy intensity of industry over time. Analyses of fuel demand in response to a detailed, comprehensive forecast of the economy have also been prepared. Modified macro-economic models have been used in the same context. There is also considerable interest in coupling energy system models to national economic models, to draw upon the best features of each. Interfuel substitutions in the network representation of the energy system imply changes in technological coefficients in the input-output matrix. For example, the Brookhaven Energy System Optimization Model is run in conjunction with the University of Illinois input-output model to refine projected energy flows and assure compatibility between energy availability and national GNP.

The range of modeling efforts is far wider than might be imagined from this brief review. The models, described above do reflect, however, the major lines of inquiry and those that have found wide application. From the group of energy models (including energy-economic models) applicable at national and state levels, we have selected a number of the more widely used and policy-oriented analytic tools for a detailed review.

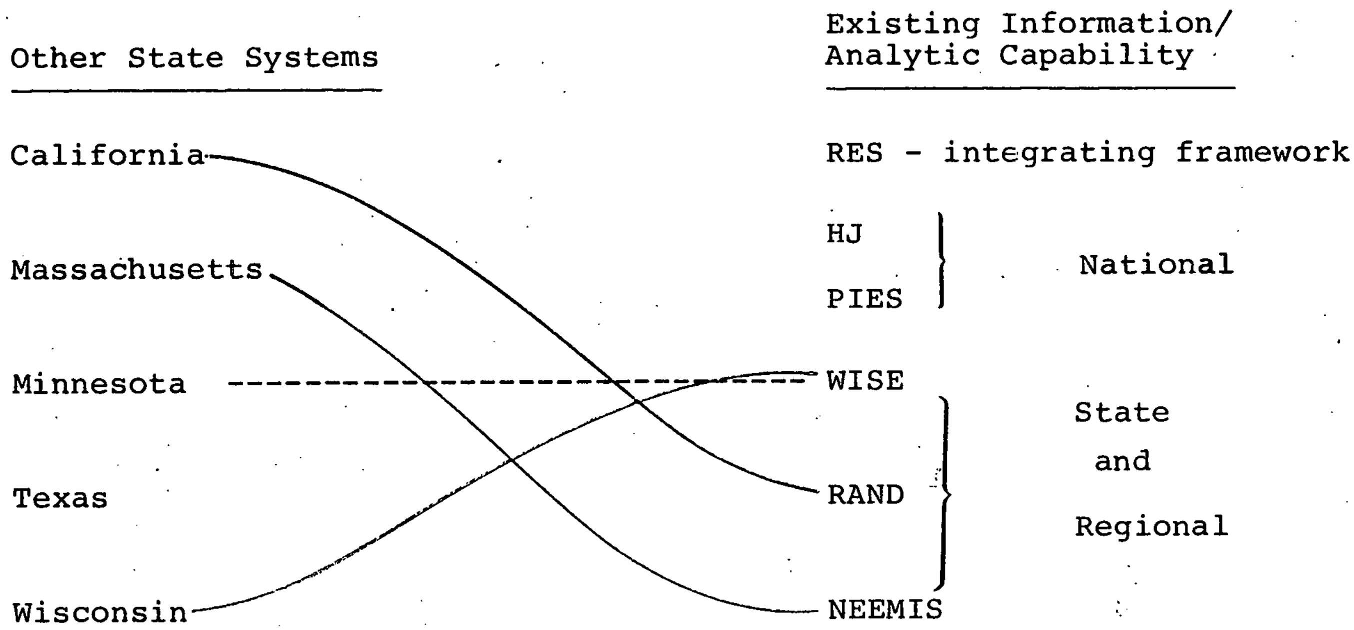
The following models are most representative of the type of analytic capability of greatest potential use within the New York State context:

- The Brookhaven National Laboratory Energy Model (BNL Model)
- The Project Independence Evaluation System (PIES)
- The Hudson Jorgenson Model (HJ)
- The Wisconsin Energy Model (WISE)
- The RAND Model
- New England Energy Management Information System (NEEMIS)

The relationship between state energy policy office activities discussed later and some of the more widely used analytic models is shown in Figure 3. It is not surprising that of the models selected as representative of types of structures useful in the New York State context and which have found wide application to policy decisions, many were developed to support the work of a state energy office. For example, the New England Energy Management Information System (NEEMIS) developed in response to the oil shortage problems in the New England region a few years back, has continued to expand its capabilities in response to policy needs of the states within the region. Even where not directly related to state issues, the models selected are policy tools. The Reference Energy Systems of BNL, for example, have been widely used by the Office of Planninga and Analysis Energy Research and Development Administration for national R&D assessment.

Of particular interest is the ability of each of the six models noted above to respond to policy issues involving supply, distribution, demand, economic impacts, environmental impacts, and technological change. A brief summary of the level of detail of responses

FIGURE 3


Other State Systems
Existing Information/ Analytic Capability
California
Massachusetts
Minnesota
Texas
Wisconsin
RES - integrating framework
HJ
PIES
National
WISE
RAND
NEEMIS
State and Regional

to such issues is shown in Table 2. In general the models have been designed to respond to one, or several, policy areas, since the formulation of a single model capable of spanning the whole range of policy issues becomes unwieldy.

The short discussion of models below evaluates several aspects of their structure:

- Policy Issues - What important aspects of energy policy are captured in the model?
- Utilization - Why was this model devised? For whom was it devised? Who uses or has used this model? What has resulted from utilization (if documented)? On what level is this model used (state, local, national)?
- Type of Model - Is the model predictive, analytical, informative? How is the information stored and retrieved (if applicable)? What techniques are used in these models (input-output analysis, econometric equations, linear programming, etc.)?
- Applicability to N.Y. State - What facets of the model have particular appeal for use in New York?

The Brookhaven National Laboratory Energy Models - Two models (Basic and Modified) with eight components that were developed for purposes of technology assessment and energy policy analysis. A key element of the BNL models is the Reference Energy System (RES) which describes energy flow from extraction to end use, including intermediate processes such as refining and conversion.

Policy Issues

- Deals with the following sectors: Transportation, Residential, Commercial, Industrial, Decentralized conversion.
- "Optimal" allocation of energy supplies to meet specified energy demands.

TABLE 2 **POLICY ISSUES**

MODEL	Supply	Distribution	Demand	Economic Impact	Environmental Impact	Impact of Technological Change
BNL	Detailed in sectors aggregate & Regional by enduse	SAME AS SUPPLY COLUMN 1	—	—	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1
HJ	Aggregate	Aggregate	Aggregate	Detailed Aggregate	Detailed Aggregate	—
PIES	Aggregate & regional by sector	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	—
WISE	Wisconsin by sector	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	—
RAND	Electric Utilities in California	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	State of California by sector		—
NEEMIS	Sector for New England its States and Large Cities	SAME AS SUPPLY COLUMN 1	SAME AS SUPPLY COLUMN 1	By New England and its State	—	—

Explanation of Terms:

1) Aggregate - National Total

2) Regional - A large region defined by 3 or more states or a large geographical area without reference to boundaries.

3) Sector - Transportation, residential, commercial, industrial, decentralized conversion, government, agricultural The scope of each model's sectoral coverage is under "Policy Issues".

4) End-use - The final use of energy (e.g., space heating).

- Analysis of various energy research and development options in terms of measuring their total social benefit.
- Energy flow with economic, environmental, and supply constraints.
- Determination of which federal energy R&D programs can satisfy national needs.
- Analysis of future energy system developments and interfuel substitution patterns resulting from fuel supply constraints.
- Yearly collection of data for U.S. energy system (environmental effects, total resource consumption, costs) and projections for these areas.

Utilization

- Used on a national basis as a network description of the energy system in which the technical, economic, and environmental characteristics of all processes involved in the supply and utilization of resource and fuels are identified.
- RES framework is used by other nations in energy modeling.
- By use of the RES, federal policy-makers have evaluated the impact of new technologies and environmental standards on projected energy utilization.
- RES was the framework and forecasting tool for the regional N.Y. City energy model that was used to evaluate technological and energy policy options in N.Y. City.
- Has been used in energy-land use studies in Nassau and Suffolk Counties and other substate locales.

Type of Model

- Informative and analytic aggregate energy system model with techniques for environmental impact assessment.

- Non-economic. Economic parameters are provided exogenously. Not price sensitive.

- Dynamic RES allows the evaluation of supply and demand changes with changes in the RES coefficients (e.g., sensitivity of demand to a change in end-use efficiency) or introduction of a new technology (e.g., solar energy). Impact evaluation through linear programming simulation and optimization models.

Applicability to N.Y. State

- The RES is a framework that is excellent for integrating energy-flows on local and state levels, and has proven its abilities on a local level.
- Model may be formulated for regional or interregional analysis.
- Of particular interest would be the construction of a data bank with an RES applicable to N.Y. State.
- Environmental impacts and technological change, as well as interfuel substitution effects could be derived.
- Interregional fuel competition and coupling of input-output techniques may prove functional.

The Hudson-Jorgenson (HJ) Model - is an econometric energy model that utilizes macroeconomic growth and input-output analysis. Energy is viewed as both a driving force and constraint on economic development, i.e., there exists a strong relationship between energy and the economy.

Policy Issues

- Sectors covered: Transportation, Residential, Commercial, Decentralized conversion, Industry, Agriculture.
- Prediction of energy supply and demand using input-output techniques incorporating price change effects on production processes.

- Relates energy supply and demand to economic growth via macroeconomic models.
- Gives alternative forecasts for economic policies that directly affect fuel prices (e.g., tax schemes).
- Accounts for interrelationships between the relative demand for energy and the demand for capital and labor services and non-energy inputs.
- Considers interfuel competition by determining relative shares of each of the energy sectors comprising the energy aggregate.

Utilization

- Was designed as a national model capable of combining supply and demand projections to give an energy use and price forecast by sector for forthcoming years.
- Undertakes a comprehensive economic impact analysis concerning the effect of the energy sector on such variables as employment, income, consumption and the general price level.
- Interfuel competition and total demand as a function of fuel prices may be estimated through the interaction of the interindustry and macroeconomic growth model (e.g., impact of alternative Btu tax policies on energy demand).

Type of Model

- Analytic and predictive integrated energy-economic model.
- Basis is macroeconomic and interindustry models that use econometric and input-output analysis.
- Scope is national and contains aggregate data for all economic and energy sectors.
- Has regional potential via built-in flexibility.

Applicability to N.Y. State

- The model has flexibility to include new input-output and economic data.

- Potentially useful to ascertain in-depth the economic impacts of energy policy in N.Y. State.
- Data needs may be expensive at the state level.
- Leakage problems at the state level complicate implementation of the model.

The Project Independence Evaluation System (PIES)- Is a model developed by the Federal Energy Administration to assist in analyzing alternative strategies for achieving national energy independence. It is an objective tool for measuring and evaluating various policies regarding energy strategies.

Policy Objectives

- Sectors covered: Transportation, Residential, Commercial, Decentralized conversion, Industrial.
- Investigation of broad strategic options (e.g., increasing domestic energy supply, conserving and managing energy demand, establishing emergency programs).
- Evaluation of policy impacts on:
    - development of energy sources
    - vulnerability to import disruptions
    - economic growth, inflation, unemployment
    - environmental effects
    - regional and social effects
    - investigation and analysis of eight scenarios for the U.S. energy situation in 1985 via four policy options.

Utilization

- Developed on the basis of three underlying considerations:
    - Importance of making explicit the dependence of supply, demand, and policy alternatives on price.
    - The need to consider domestic supply and demand constraints on a regional rather than national basis.
    - The desirability of structuring the overall energy system in one cohesive, analytical framework.

- The comprehensive PIES is in large measure a model of the national energy system with disaggregation for analysis at the Census Regional level.
- PIES has been used on numerous occasions by the FEA on both the national and regional level for the afore mentioned types of policy analysis.
- Introduction and evaluation of energy technology development has been analyzed in the PIES model.
- Interregional analysis of such issues as fuel supplies and competition are being conducted.

Type of Model

- Dynamic, analytic, and predictive
- Techniques include demand estimates by econometric equations and input- output analysis; and linear programs for determination of fuel market shares and competition.
- There are four basic submodels: A macroeconomic model, an industrial production model, an annual demand model, and an input-output data base.

Applicability to N.Y. State

- PIES model is not easily adapted to regional application. Data needs are large. The structure of "regions" in the model is not suitable for state application.
- Can be utilized for policy analyses and impact assessments in energy flow, economic issues, and environmental issues.

Wisconsin Energy Model (WISE) - is a state model developed by the Energy Systems and Policy Research Group at the Institute for Environmental Studies, University of Wisconsin-Madison for the purpose of developing quantitative tools for energy policy analysis.

Policy Issues

- Sectors covered: Transportation, Residential, Industrial, Commercial, Agricultural, Decentralized conversion

- Final demand and electric generation aspects of energy in the state of Wisconsin.
- Environmental impacts estimated by an environmental impact submodel.

Utilization

- WISE was developed to quantify possible future energy demands.
- Its use is for the state of Wisconsin and is currently the functional energy model used in that state.

Type of Model

- Simulation of future demand and environmental impact via user parameter specifications.
- Disaggregation into independent sectors.
- Non-economic and lack of built-in flexibility and sensitivity to the national energy market.

Applicability to N.Y. State

- Is a functioning policy tool used on the state level.
- Can facilitate, if modified, microscale analyses of such estimates as economic, social, and environmental consequences of energy policy.
- Parameter sensitivity to policy and technological change could facilitate policy analyses.
- Deals separately with the agricultural sector, also an important sector in N.Y. State.

The RAND Model - is part of the Rand Research Program on "The Growing Demand for Energy." The focus is on the underlying cause of the conflict between energy and the environment--the rapid increase in demand for energy in all its forms and the implications of this growth on the supply system. It deals with sectors as separate entities in separate reports and only electrical energy is discussed.

Policy Issues

- Sectors Covered: Decentralized conversion, Residential, Commercial, Industrial
- Preparation of estimates of future electrical demands for California under various scenarios.
- Planning for power plant siting in California.
- Separate reports on each sector's future electrical demand in California.
- Analyze the effectiveness and impact of policies for Slowing the growth in electricity consumption in California.
- Reduction of noxious emissions while meeting increased electricity demands.

Utilization

- Developed as an electrical demand model in the state of California.
- Separate RAND models were used in addressing the above policy questions.
- Forecasts of electric energy demand and environmental impact in California.

Type of Model

- Econometric demand forecast model attempting to project demand based sector growth rates and energy prices.
- An evaluation tool for electrical energy conservation and price structure policies.

Applicability to N.Y. State

- A good estimator of the electrical demand component.
- Functional on a state level.
- Allows policy analysis from the demand perspective under various scenarios of electrical production.

- Has an environmental impact submodel that facilitates analysis of environmental effects directly related to electrical production.

New England Energy Management Information System (NEEMIS) - was constructed for the New England Regional Commission (NERCOM) by IBM and MIT. The large energy data bank is stored in a computer. NEEMIS is an interactive model for presentation of data and analyses.

Policy Issues

- Sectors covered: Transportation, Residential, Commercial, Industrial, Government, Decentralized conversion
- Analyzes regional and municipal consumption of energy in New England.
- Does demand analyses by sector and fuel as well as demand projections.
- Traces petroleum flow throughout New England.
- Calculates economic impacts on regional, state, and subsector levels of various external effects by computer simulation.

Utilization

- Developed to disseminate energy data for New England states in the most efficient and least costly manner possible.
- Designed for use by the New England Regional Commission in which all the New England states are participants.
- Can be used by the entire region, states, and municipalities of New England.
- Has been used by all states and certain cities to answer energy-related policy questions.

Type of Model

- Computer facility capable of: Data management (storing, retrieving, protecting, and validating data). Analytical capability on data. Presenting Results of analysis and projections via simulation.

- Is both informative and analytic, requiring functional input from the user and using no other models for predictive capabilities.

Applicability to N.Y. State

- Has been a successful tool for information and analysis.
- N.Y. has energy requirements and utilization patterns somewhat similar to New England.
- Has built-in flexibility for changing conditions and policies.
- Is a structured information and data base.

III. OTHER STATE ENERGY INFORMATION AND ANALYTICAL SYSTEMS

There are a wide variety of activities in other states relating to the supply of information and analyses bearing on energy policy. In reviewing these activities our interest focussed not primarily on their individual design, but on their ability to serve the needs of their executive agencies and legislative committees. In particular, we wished to assess the experiences in these states of such systems providing practical information to these client groups.

The survey of state energy information systems prepared by the Economic Development Administration list some twenty-four states which have in existence a formal mechanism for the transference and utilization of output from state energy information systems by policy-makers. The state energy offices in each of these was contacted to determine both the capabilities of their systems and its accessibility to state officials and their staffs. Of these twenty-four states five were singled out as possessing both comprehensive systems and mechanisms which satisfied the criteria discussed in the Introduction. These received more detailed study and evaluation.

Before discussing the results of this survey it is worth noting that state energy information systems have been designed and utilized for a variety of purposes. For example a number of state regulatory agencies employ systems to answer questions with respect to electrical supply and demand. In other cases, energy information and analysis was centered in a office which itself operated as a policy-making unit in matters dealing with fuel allocation. In still others, energy information/analytical systems were constructed and implemented for the purpose of providing input to state energy policy councils and/or executive agency advisory councils. Finally, in some states the energy office which operates the information/analytical system functions as a planning agency whose output is used by other state agencies as the basis of their own energy-related policy-making activities.

The capabilities of the state energy information systems vary, as one might expect, with their function. They range from simple systems which guide the user to available data sources to sophisticated computer models which require substantial staffing with trained technicians. In the case of these more elaborate systems, state's energy offices often operate with the support of groups outside state governments, e.g., universities and non-profit groups.

A. Survey of State Energy Information/Analytical Systems

The following questions were posed to representatives of state energy offices or their equivalents in the twenty-four states where energy information and analysis was used in the policy-making process.

- How often is the system used and by whom?
- Is the output judged to be satisfactory by the user groups and if not, why not?
- Does the state energy office perform its own analysis on the energy data and if so is it "soft" analysis or does it involve the use of computer models?
- Is statewide energy-related data centered in the energy office and if so is it a data referral service, an energy data library or is it centered in a computer file?
- Are reports made by request of outside agencies or only on initiation of the State Energy Office itself?
- Does the State Energy Office subcontract analysis to private firms?
- How many professionals are employed in the State Energy Office?
- Is there a link between the State Energy Office and outside support groups?

The results of questions 3-8 above are given in Table 3. The answers to questions 1 and 2 are more difficult to present in tabular form. Although they reveal both a wide range of users and a wide

TABLE 3

	State	Agency	Approx. Professional Staff	University Link	Reports & Studies	Subcontracting	Data & Information	Analytic Capability
	Arizona	Fuel & Energy Off.	6	No	Agency	No	Referral	Soft Analysis
⇒	California	Energy Resources Conservation & Dev. Commission	50	No	Agency	No	Referral	Computer Models
	Connecticut	Dept. of Planning & Energy Policy	32	No	Agency	NEEMIS	Computer File	Computer Models
	Florida	State Energy Office	5	No	Agency	No	Library	Soft Analysis
	Georgia	State Energy Office	3	No	Agency	No	Library	Soft Analysis
	Hawaii	Dept. of Planning & Economic Development	6	Yes	Agency	No	Library	None
	Iowa	Energy Policy Council	7 1/2	No	On Request	No	Referral	Soft Analysis
	Kentucky	Dept. of Energy	13	No	Agency	No	Referral	Soft Analysis
	Maine	Office of Energy Resources	6	No	Agency	NEEMIS	Computer File	Computer Models
⇒	Massachusetts	Energy Office	12	No	On Request	NEEMIS	Computer File	Computer Models
⇒	Minnesota	Minnesota Energy Agency	35	Yes	On Request	No	Computer File	Computer Models
	New Jersey	State Energy Office	7	No	Agency	No	Referral	Soft Analysis
	New Mexico	Energy Resources Board	20	No	Agency	No	Referral	Soft Analysis
	New York	Emergency Fuel Office	6	No	On Request	Yes	Referral	Soft Analysis
	North Carolina	State Energy Division (Dept. of Military & Veteran Affairs)	8	No	On Request	No	Library	Soft Analysis
	Oklahoma	Dept. of Energy	8	Yes	Agency	No	Library	None
	Oregon	Dept. of Energy	21	Yes	Agency	No	Computer File	Computer Models
	Pennsylvania	Energy Council	3	No	Agency	No	Referral	Soft Models
	South Carolina	Energy Management Office	7	Yes	Agency	No	Library	Computer Models
	South Dakota	Office of Energy Policy	3	Yes	On Request	No	Referral	Soft Analysis
⇒	Texas	Governor's Energy Advisory Council	35	Yes	On Request	No	Computer File	Computer Models
	Vermont	State Energy Office	6	No	Agency	NEEMIS	Computer File	Computer Models
	Washington	State Energy Office	16	No	Agency	No	Referral	Soft Analysis
⇒	Wisconsin	Office of Emergency Energy Assistance	11	Yes	On Request	No	Computer File	Computer Models

range of use, in general the systems judged to have been the most effective, both by those who provided the information and analyses and those who utilized the output, were those which employed computer assisted models coupled with a technical staff who were able to produce special reports on request from state agencies. Massachusetts, Minnesota, Texas, and Wisconsin employ systems with both of these characteristics. California is also included in this group although the California Energy Resources Conservations and Development Commission, the state agency responsible for energy, operates in a somewhat different fashion. As noted above, the systems in these five states were the subject of further study.

B. <u>Survey of Energy Information/Analytical System Users</u>

Two user groups in each of these five states were identified and posed the following questions:

- Do the contributions made by the energy information system have an impact on decisions within the state government?
- Is the energy information system responsive to your needs?
- Are the results obtained from the system timely?
- Is it easy to communicate the user's needs to the energy information system?
- Do you intend to request information and/or analysis from the system again?
- Can you identify some questions and issues posed to the system?

1. <u>California - Energy Resources Conservation and Development Commission</u>

The Energy Resources Conservation and Development Commission was established to develop and assess statewide energy policy. The Commission is made up of five members appointed by the Governor. The Commission reviews pending energy legislation and is instrumental in decisions effecting both energy supply and use in California. They are required to produce quarterly reports on consumption of fuels by regions and forecasts of electric generating capacities for the state. Two users of the California system, the Public Unitities Commission and the Air Resources Board, were questioned.

(a) Public Utilities Commission - The Energy Resources Conservation and Development Commission supplied data for the development of conservation oriented building standards for new residential construction. This data was used as direct input on pending decisions of the PUC. The system's output although judged to be responsive was judged less satisfactory for their timeliness. The Public Utilities Commission found it easy to relate their needs to the Energy Resources Conservation and Development Commission output although they noted they would find it even more satisfactory if they were better informed of the extent of the energy data available. They intend to use the Commission energy information again.

(b) Air Resources Board - The project in which they called upon the Commission system involved the establishment of guidelines for the review of the air pollution characteristics associated with power plant siting. The analysis provided by the Commission did not have an impact on decisions because of jurisdictional problems even though they found the information responsive and timely. The Air Resources Board found it very easy to relate their needs to the Commission information base and they intend to use it again in the future.

2. Massachusetts - Energy Policy Office

The Energy Policy Office acts as staff to the Energy Task Force, which is made up of the Massachusetts cabinet of executive agencies. The Energy Policy Office is the state agency responsible for the development and review of executive energy policy. Massachusetts relies mainly on the New England Energy Management Information System (NEEMIS) for their energy-related data and analysis. All state policy-makers rely on this office to fulfill energy data needs. The Joint Legislative Committee on Government Regulations and the Department of Public Utilities have requested and obtained data and analysis from the Energy Policy Office.

(a) Joint Legislative Committee on Government Regulations - The project for which this Committee required analysis from the Energy Policy Office was the determination of economic impacts of uniform electricity rates throughout the state. They report that this analysis did have an impact on the final decisions taken. They felt they were responsive to the Committee's needs. Had the NEEMIS system been able to supply them with information on employment consequences arising from a change in electricity rates they felt it would have been even more useful.

The results obtained were judged to have been timely and there was an easy communication between the two offices even in the face of political obstacles inherent in the relationship between an executive office and a legislative committee. The Committee representative felt they would use the energy policy offices services again.

(b) Department of Public Utilities - The Department of Public Utilities required energy data to assess the impacts of energy costs on the elderly. They received there data from the Energy Policy Office and though these data had no final impact on the decisions involved they felt the Energy Policy Office provided a timely response. The Department said it was easy to communicate their needs to the Energy Policy Office and they would use its services in the future.

3. Minnesota - Energy Agency

The Minnesota Energy Agency was established by and is overseen by the Legislative Energy Commission. Its original function was to review pending energy legislation but it has evolved into an energy information system for the State. Much of its analytic capability and extensive data files are attributable to its close ties with the University of Minnesota. It has provided energy analysis to the Public Service Commission and the Minnesota Department of Economic Development.

(a) Public Service Commission - The Public Service Commission required analysis from the energy agency on the energy aspects of the impact of the Northern National Gas Company's gas curtailment policy. Although it is too soon to know if this analysis will have impact on decisions the Energy Agency output was judged to be responsive and the results provided were timely. They found it easy to communicate analysis requirements to the Agency and the Public Service Commission would request anslysis from it again.

(b) Department of Economic Development - The project involved the determination of energy aspects of an overview of the Minnesota economy. The Department requested data from the Energy Agency. The agency provided a timely response. The data provided did have an impact on decisions within the State government. The Department found it easy to communicate their needs to the Energy Agency and intend to use their services again.

4. Texas - Governor's Energy Advisory Council

The Energy Advisory Council has been in existence since September 1975. The Council members are made up of the heads of the executive and legislative branches of state government. They are the center of statewide energy data and make use of computer models designed specifically for Texas. Much of their analysis is done in collaboration with the University of Houston. The Energy Advisory Council provided data to two legislative committees in the Texas legislature; the House Ways and Means Committee and the House Energy Resources Committee.

(a) House Ways and Means Committee - The Committee required data to determine the impact of restructuring the Natural Gas Tax on consumer energy costs. The Energy Advisory Council provided a timely response. It is too soon to know if these data will have impact on decisions within the Committee. The Committee found it very easy to communicate data needs to the Advisory Council and they would definitely use their services again.

(b) House Energy Resources Committee - This project involved analyzing the impact of well head price controls on the intra-state natural gas market. The data provided by the Energy Advsiory Council had impacts on Committee decisions. The Council was responsive and the data they provided were timely. It was easy for the Committee to relay their data needs to the Energy Advisory Council and they said they would use the Council again, within the limits of the Advisory Council's capabilities.

5. Wisconsin - Office of Emergency Energy Assistance

This office is the center of statewide related data. Its considerable analytic capability is largely due to its link to the University of Wisconsin. The University has constructed a statewide forecasting model named WISE (Wisconsin Regional Energy Model) and provides computer analysis for the Office of Emergency Energy Assistance. The Office is required to review all pending energy legislation and to provide data and analysis to state agencies on request. Two users of the Office are the Department of Industry, Labor and Human Relations and the Public Service Commission.

(a) Department of Industry, Labor and Human Relations - The Office of Emergency Energy Assistance provided analysis for this Department on the energy saving impact of proposed building rules for public structures. The analysis did have an impact on decisions with the Wisconsin State government. The Office was responsive and the results provided were timely. The Department found it easy to communicate their needs to the Office of Emergency Energy Assistance and they said they wouldn't hesitate to request analysis from them again.

(b) Public Service Commission - The Office of Emergency Energy Assistance provided data for a study on natural gas supplies and petroleum product flows into and through the State of Wisconsin. The data provided to the Commission had impact on decisions and the Office was responsive to the Public Service Commission's needs. The results provided were timely and the Commission found it easy to communicate their data needs to the Office of Emergency Energy Assistance. The Commission said they would use the Office's services again.

IV. DESIGN ELEMENTS OF THE NEW YORK STATE ENERGY INFORMATION SYSTEM

It was noted earlier in this report that a satisfactory energy information system must be able to respond quickly to the needs of a variety of state agencies; must include a sufficiently diverse set of data and information to allow it to be called upon to deal with a wide range of energy-related issues; and, at the same time, entail moderate set-up costs and operating expenses. The system design described below is capable of meeting all these objectives. It consists of four basic elements -

- a broad base of state-specific data and information
- a computerized retrieval system with easy terminal access to national data bases
- adaptations of useful analytical models
- a modular construction which will allow sequential development of the full capabilities of the total system.

To minimize the time, effort, and costs involved in implementing the information system, we have relied heavily on existing computer software, energy data bases, and analytical models. We have also based our design on the information obtained from other state energy agencies concerning both the nature of their systems and the experience gained in utilizing these systems, which was reviewed in an earlier chapter.

The basic conceptual framework employed in the design is similar to that of the regional versions of the Brookhaven Reference Energy System. This framework is also similar to that used in all state systems which were judged by the users to have performed successfully. At the same time, it offers a number of other advantages as a basis for designing the New York State system.

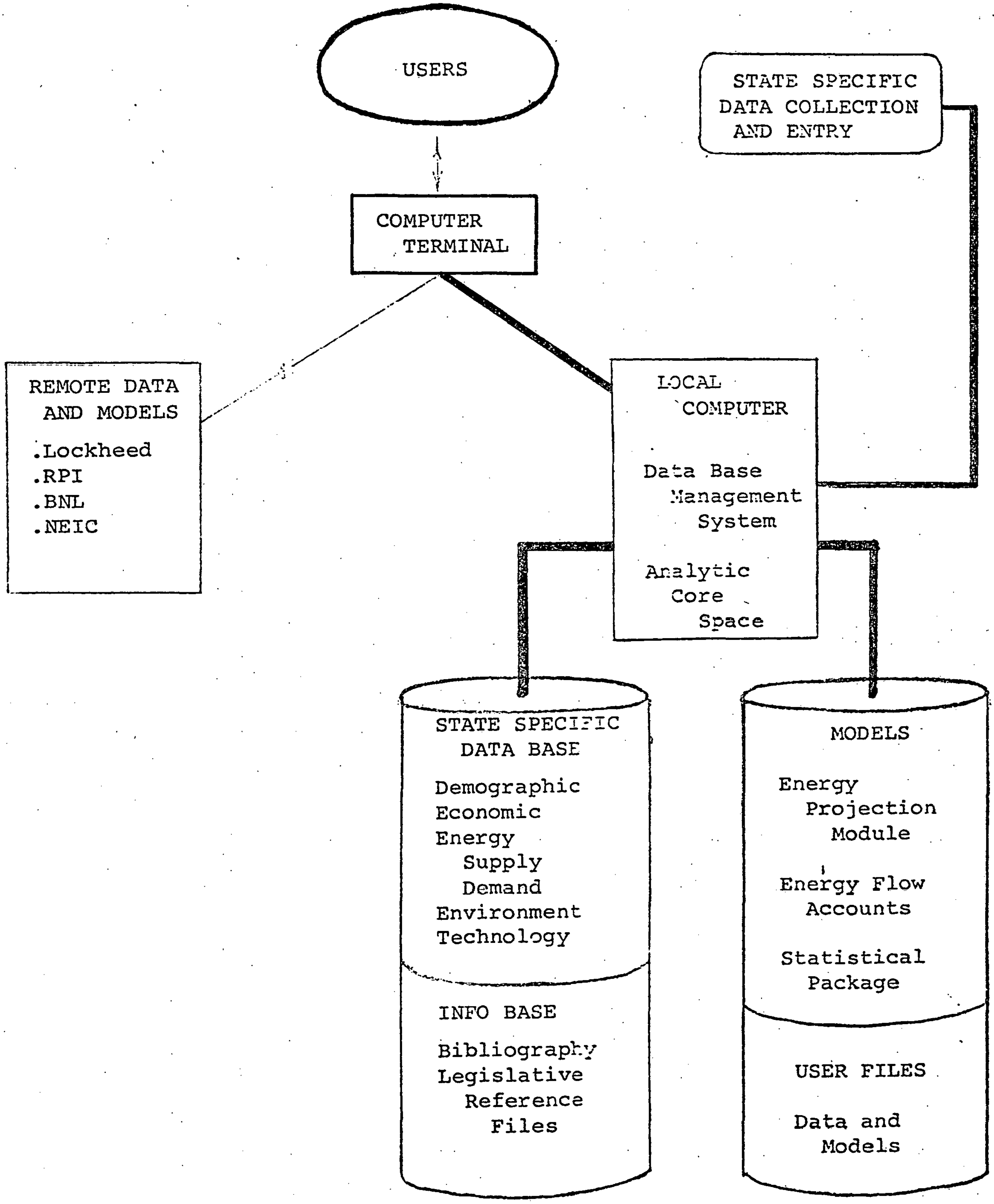
- It is sufficiently general in its formulation to permit the examination of a wide range of state energy policy issues

- It provides an integrated picture of the State's energy supply-distribution-demand system which can be utilized by both technical staff and policy-makers to gain insight into the complex interaction between economic, technological, social, and environmental factors.
- It is consistent with both the models and data bases which have been developed for assessment of national and regional energy policies.
- It makes use of data available for the most part from existing state and national sources and other accessible data bases; and where data are unknown (and in some cases unknowable) it permits the incorporation of judgmental input.
- It can be easily adapted to sub-state geographic areas such as regions, counties, or individual municipalities.
- It can be extended to include non-energy factors such as employment, socio-economic impacts, and land use development.
- It permits the use of engineering, economic, and statistical sub-models in cases where specific data and information is not readily available.
- The framework can be used at a simplified level initially, and more detailed sophistication and computerization added as required.

While the Reference Energy System provides a starting point for efficient and economic development of an energy information system for the State, it must be augmented by other components directed toward the variety of specific needs of the New York energy community noted earlier.

A. An Overview of the Energy Information System

A diagramatical layout of the information is shown in Figure 4. User interaction with the system will occur though portable computer terminals, which can be connected to standard telephones. To gain access to the computer, the user need only call a computing facility specified number and type proper


USERS
STATE SPECIFIC DATA COLLECTION AND ENTRY
COMPUTER TERMINAL
REMOTE DATA AND MODELS
.Lockheed
.RPI
.BNL
.NEIC
LOCAL COMPUTER
Data Base Management System
Analytic Core Space
STATE SPECIFIC DATA BASE
Demographic
Economic
Energy
Supply
Demand
Environment
Technology
INFO BASE
Bibliography
Legislative
Reference
Files
MODELS
Energy Projection Module
Energy Flow Accounts
Statistical Package
USER FILES
Data and Models

identification information on the terminal. Most major computing facilities within the state and nation can be accessed in this manner.

This information system will respond to a wide variety of user's needs ranging from simple information retrieval queries to more complicated statistical and analytical problems. Information access is fast, convenient, and has been designed to be simple enough for use by a staff without substantial computing background. Statistical and analytic studies will take place within a framework flexible enough to supply expansion of capability as new policy issues arise. The computer-based system can be justified in terms of the reduced cost, increased capability, speed, and ease of access and use relative to more conventional manual information retrieval and analysis systems.

The major components of the information system consists of (1) pertinent energy, economic, environmental, bibliographic and other data and information, (2) analytical models for utilizing the data, and (3) commercially available computer software which will serve as an interface between the user, the data, and the analytic models. The DATA BASE MANAGEMENT SYSTEM not only provides services related to technical management of the system (updating, security, archiving, etc.), but also provides a simple English "query language" for retrieving specific data or aggregates of information from the system and a report generating capability for accessing longer lists of data and tables, doing simple computations, and printing these in an easily readable format. In addition, the DATA BASE MANAGEMENT SYSTEM will catalog all information files, data bases, energy models and user files maintained and currently available within the overall energy information and analytic system. Thus, for example, the user with a question on natural gas utilization in the State of New York, but no knowledge of the system contents, could obtain a single listing of relevant data files and/or energy models with a general description of their content and capability.

The central information/analytic capability is to be found in each of four input components of the system. The INFORMATION BASE contains a general annotated bibliography of reports, papers, etc., which are of wide interest as background to studies or which are major sources of data relevant to the New York State energy system and the national energy system. The most important of these references should be contained in hard-copy form in a library associated with the information system. For example, the Legislative Reference File will contain current lists of energy legislation in New York, and major national and other state legislation of interest to our state. The DATA BASE will consist of a broad series of files of specific data required in the description and analysis of energy flows and their interaction with economic and environmental factors in the State of New York. The MODELS FILE will include statistical packages and energy projection analysis tools which can be utilized for energy planning and management for the state. The USER FILES will permit individual user groups to augment the system capabilities with data and/or models of more specific use.

The information system is also designed to take advantage of existing federal and regional information and data files. For example, as noted earlier the National Energy Information Center provides access to files on industrial plant statistics, energy production and consumption data and other pertinent information. These data files can be accessed over long-distance telephone lines through the computer terminal.

B. Operational Framework

The overview above provides simply a picture of the physical structure of the energy information system and the organization of various information and analytic components within the system. This forms a broad perspective within which to place the specific discussion of individual elements of the system and the links between them. Most important is the way in which the MODELS and DATA BASE noted above are designed to represent the New York State energy system and provide the ability to assess economic and environmental consequencies of energy consumption patterns in the state. That is, the analysis of various policy issues involving the state energy system will be carried out within an operational framework which portrays the appropriate utilization of physical components of the energy information system.

The operational framework of the proposed New York State Energy Information System is shown in Figure 5. It consists of the following components:

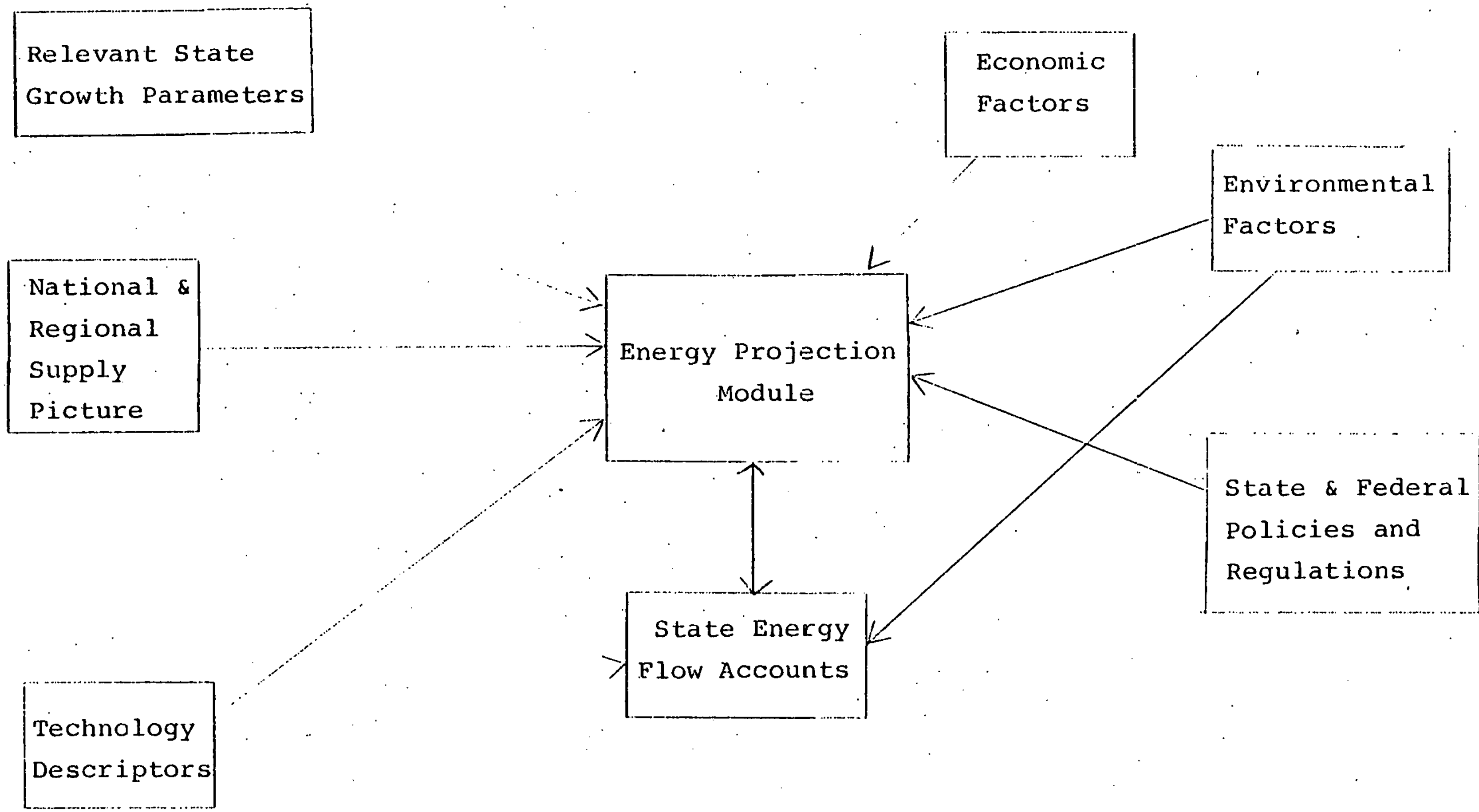
1. Relevant State Growth Parameters

The single most important driving force that will influence the future development of the state energy system is the energy-relevant state growth parameters. These parameters serve to determine not only the level of supplies that will be required, but the mix of fuels, their geographical distribution, and the nature of the end-use demand. These include projected levels and distribution of population in the state, mix of industries, agricultural product output, transportation requirements, etc. These parameters may be derived either from projections based on a continuation of current trends or targeted goals obtained from planning units within state agencies such as the Economic Development Board or the Department of Transportation. These growth parameters are also linked to energy-sensitive economic and environment factors as shown in the diagram. The energy information and anlytical systems cannot capture all the factors that will influence state growth and development nor is it intended to do so. It is concerned only with those which are directly tied to the production, distribution, and utilization of energy in the state. This means that certain factors which are known to have impact on energy consumption patterns, such as changing life-styles of state residents, will have to be estimated in terms of their influence on such direct informational inputs as the energy consumption per dwelling unit or the mode shifts in the transportation sector of the energy demand. Alternatively, they may be inserted by altering economic factors such as land use development or per capita incomes, industrial sales, etc.

Typical of the information in the system that will be required on a current and projected basis are:

Figure 5

OPERATIONAL FRAMEWORK OF
THE ENERGY INFORMATION SYSTEM



(i) Population growth and distribution

(ii) Mix of manufacturing, agricultural, and service industries, and the levels of output

(iii) Transportation data on use of public transportation and private vehicles

(iv) Land use development throughout the state in terms of numbers of types of dwelling units, commercial floorspace, industrial land usages, etc.

2. <u>National Energy Supply Pictures</u>

The state depends to a large extent on the import of fuels from its domestic and overseas suppliers. Data and information are required from both national and international sources to establish a projected picture of the nature of this supply. This includes estimates of the current and future availability, price of each of the primary fuels and the system for delivering these fuels. This information can be derived from estimates prepared by federal agencies such as FEA, FPC, DOT, ERDA. It also requires the inclusion of information from domestic suppliers in the private sector. As in the case of the projection of the state growth parameters this information can be derived either on the basis of a continuation of existing trends or on the basis of scenarios regarding the development of new national sources and/or federal legislation and regulations. In either case, it is essential that the forecasts be developed in a manner that is consistent with ongoing federal efforts to project national supplies. Illustrative of the data and informational needs in this category are:

(i) National and area projected levels of coal production

(ii) Capacity of coal delivery systems

(iii) Synthetic gas and liquid production projections

(iv) Domestic oil and gas supply

(v) National distribution of domestic supplies

(vi) Uranium resource availability

(vii) Foreign sources of liquid natural gas

(viii) Projected supplies from solar,wind, and biogas sources.

3. <u>Energy Projection Module</u>

The energy projection module serves two purposes in the overall system. First, it is utilized to estimate energy requirements for input to the energy accounts based upon state growth projections above (population, manufacturing value-added, etc.). Second, utilizing the fuel supply forecast from the national energy picture in combination with these projected state needs, certain large scale shifts in energy consumption patterns brought about by transportation policies, industrial growth, and the like can be identified.

The designation of supply and demand categories for State energy demand is chosen to display the major patterns of energy consumption in the State and their impact upon economic activity. Appropriate end use sectors are:

- Agriculature (Crops, Livestock)
- Manufacturing (SIC Group)
- Commercial (Office, Retail)
- Government (Buildings, Fleet)
- Transportation (Auto, Transit, Freight)
- Residential (Structural Type)

Energy demands are estimated by projecting driving variables (e.g., value-added per capita) and combining these with energy intensity factors (e.g., Btu per dollar value-added) which reflect both current energy consumption and trends in these intensity factors due to imposition of energy policy, technology changes, and price-sensitive aspects of energy utilization. Energy supply projections are incorporated from national estimates partitioned to New York. Both direct fuel (gas, oil, coal) and intermediate form (gasoline, electricity, stem) energy supplies are entered.

The construction of energy demand forecasts and supply projections in the projection module is similar to the types of projections currently being carried out in many state agencies, which affords opportunities for easy links between development of the Information System and existing state agency activities.

There is another critical input into the projection module which relates to its output. These are the judgements of both experts and policy makers at the state and federal level. This need derives from the intrinsic uncertainties in both the input data and the analytical relationships embodied in the projection module. The model developed for this part of the system should take into account these uncertainties by estimating ranges of supply and demand which are based on a number of judgmental assumptions. The purpose of the module is thus not only to obtain supply and demand projections from the input information and data, but to identify judgmental assumptions, explicitly and insure an internal consistency between assumptions input data, and output.

4. Energy Flow Accounts

This element of the information system is intended to represent the geographic distribution of fuels within the State energy system and detailed sectorial use of primary fuels and electricity. The energy flow accounts can be used to insure that critical end users of energy are provided an adequate supply of energy in its most desirable form, to display trends in the shift of fuel use, and to reveal the effects of introducing new policies or changing environmental and economic factors. The energy flow accounts also serve as one of the most useful formats in providing the decision-maker with a comprehensive overview of the State's energy system either as it exists at present of as it would exist under the presence of a varying set of external conditions. Typical of the data that would be listed in the energy accounts are:

a. Types of fuels and quantities imported into state with locations of import facilties.

b. Fuels converted to intermediate energy forms within state and region, amounts, location of facility.

c. Mode of transport of energy with amounts specified by mode.

d. Storage facilities by capacity and location.

e. Amount and fuel types used in different end-use sectors, disaggregated on a multi-county basis.

Whereas the Energy Projection Module is capable of constructing supply and demand projections for the state as a whole, and only for aggregate activity sectors such as Agriculture, the energy accounts would show the flows from supply points to demand and include end use purposes which serve to define energy consumption patterns in sufficient detail to examine impacts of state policy, technology change, economic and environmental, and other factors.

5. Environmental and Economic Factors

There is clearly a large body of information and data in the environmental and economic area that bear on energy options. To limit these, we restrict the input in these categories to those directly tied to energy production and end-use. For example, among the environmental factors to be listed are the direct emissions associated with the production and use of energy. Thse emissions (e.g., NO_x,SO_x, particulates) are those most likely to interact with maintaining acceptable levels of air and water quality. They are expressed in tons of pollutants per unit flow of energy. Other environmental factors that could be included here are air and water quality levels throughout the state, characteristics of prevailing wind patterns, damage functions, etc, depending on the degree of sophistication desired.

The primary purpose of the economic informational factors is to carry out economic impact analyses of changes in the energy system. For example, the employment figures and area distributions among energy-sensitive industries are needed to evaluate impacts of a changed situation in fuel availability or energy prices. Socio-economic data on energy use among different income groups are required to assess the impacts on these groups of higher fuel cost and environmental loading or the introduction of new end use technologies. Information on tax revenues derived to local governments and the state from energy production and conversion and end use are required to evaluate, for example, the impact of new locations for energy facilty siting, or the introduction of tax abatement legislation intended to foster the introduction of solar energy.

Models and methodologies for preparing estimates of the economic impact of changes in the energy system utilizing the type of information discussed above have been developed for use at the national level, and the cost and time required for implementing similar models and their utility at the state level should be evaluated. It should be noted, however, that this methods represent approximations to evolving a more detailed analytical model for the interaction between the state's energy system and its economy.

6. Technology Descriptors

At all points in the energy system, existing and developing technologies play an important role in determining flows. For example, centralized conversion electric generation is characterized by conversion efficiencies (heat rate), environmental control technologies, and availability. Residential space heat installations involving solar energy are described by their own engineering parameters as well as power requirements imposed on existing utility systems. In general, engineering, economic, and energy utilization variables in supply, transport, conversion, and utilization technologies are important determinants of the types and amounts of fuels allocated throughout the energy system network. This information is for the most part available from national data sources.

7. Institutional and Regulatory Factors

The maze of institutional and regulatory constraints upon the energy system often limits the range of policy initiatives open for consideration. Where such restrictions play an important role in limiting or directing energy flows, they must be identified and built into the analysis framework in such a way as to allow for their variation. For example, issues of public right-of-way and interconnection to existing utility systems are, at present, serious barriers to the development of large-scale total energy systems or centralized collection and distribution of solar energy. Most often, such constraints will be incorporated into economic and environmental analysis issues, but in some cases they may be integrated into the central analytic framework itself. The structuring of this part of the information system will require a separate effort involving both legislative committees, executive agencies, and the Public Service Commission.

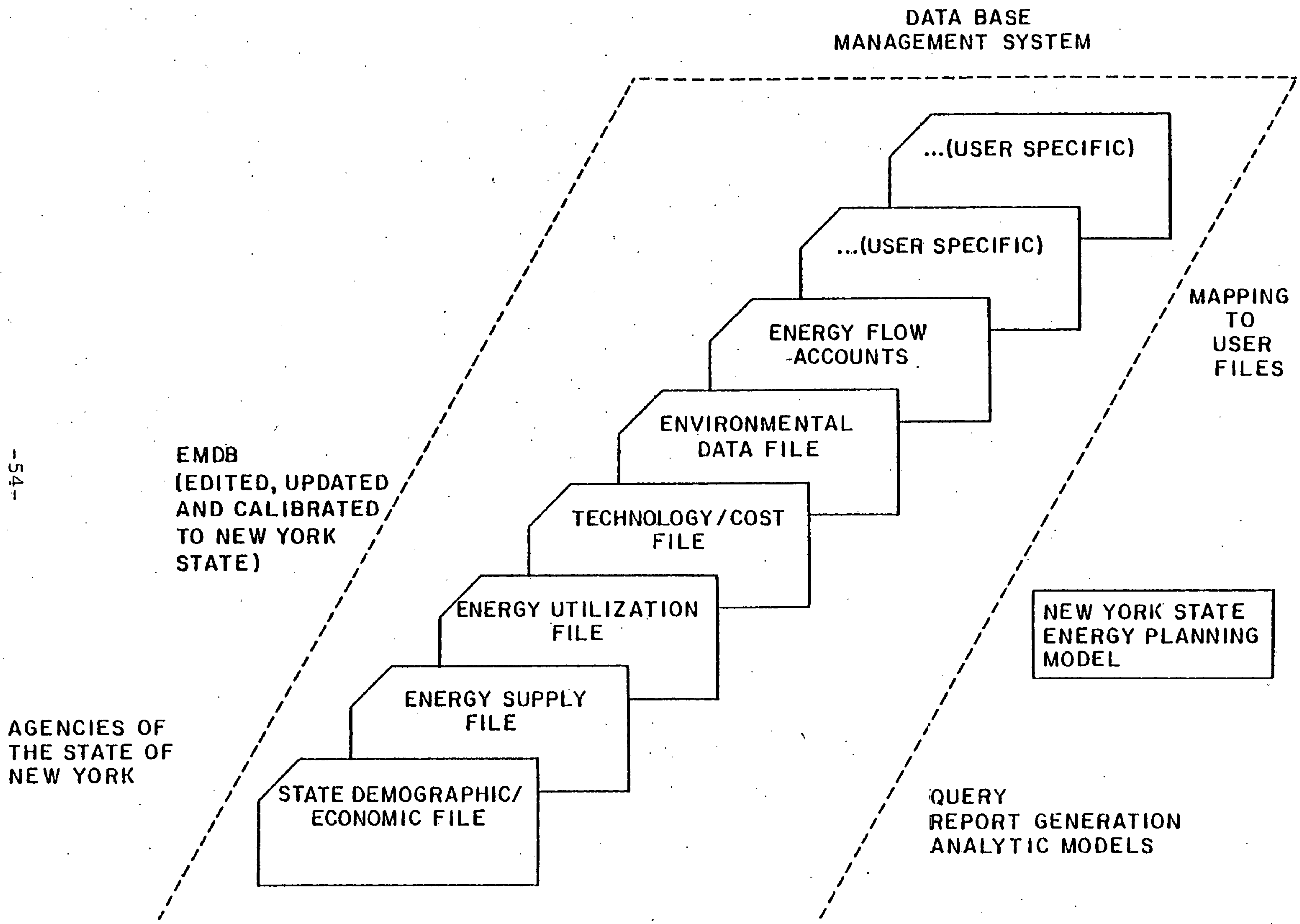
C. State-specific Data Base

The base of state-specific data on the New York State energy system and energy-related activities in the state should be designed to satisfy requirements of the energy projection module and energy flow accounts, as well as other analytic models which will be utilized in connection with the energy information system. At the same time, the data base should contain a broad base of more general energy systems data for state agency staff analyses where there is primary interest in information retrieval per se. To permit adequate response to these areas of system application, the data base should have both a well-defined structure for the storage of data relating to each component of the energy supply-distribution-demand system and convenient, simplified formats for entry and retrieval of these data.

The construction of the data files outlined below and in Figure 6, includes the range of information requirements noted in the operational framework for the energy information system

STATE DEMOGRAPHIC/ECONOMIC FILE
ENERGY SUPPLY FILE
ENERGY UTILIZATION FILE
ENVIRONMENTAL DATA FILE
TECHNOLOGY/COST FILE
USER SPECIFIC FILE (as needed)

Figure 6


DATA BASE
MANAGEMENT SYSTEM
...(USER SPECIFIC)
...(USER SPECIFIC)
ENERGY FLOW
ACCOUNTS
ENVIRONMENTAL
DATA FILE
TECHNOLOGY / COST
FILE
ENERGY UTILIZATION
FILE
ENERGY SUPPLY
FILE
STATE DEMOGRAPHIC/
ECONOMIC FILE
MAPPING
TO
USER
FILES
EMDB
(EDITED, UPDATED
AND CALIBRATED
TO NEW YORK
STATE)
NEW YORK STATE
ENERGY PLANNING
MODEL
AGENCIES OF
THE STATE OF
NEW YORK
QUERY
REPORT GENERATION
ANALYTIC MODELS

This data base contains the data relating to each component of the energy supply-distribution-demand system in a consistent set of units and with appropriate documentation of source. Also residing in the system are data series relating to specific subjects or studies on a highly disaggregate level. Whereas raw data of this type are generally not useful in direct printed form, the computer is capable of summarizing, averaging, or tabulating such data, giving the user quick access to figures that are not obtainable in published energy data summaries.

In the layout of the data files there is a need to establish a simplified "table" format to facilitate easy retrieval and portrayal of data. More importantly, this type of format simplifies the task of the staff responsible for entering and updating file contents. In addition, the file organization should be standardized to assure flexibility in data entry from sources both within and without the state. The data series and their organization below reflect these concerns by construction of a "standard" data base similar to the Energy Model Data Base (see Appendix B) widely used to support national and regional studies. However, that data structure is modified to de-emphasize the technical aspects of modeling and highlight the information and formats most appropriate for state energy policy analysis.

Each of the files represents tables of data stored by SECTOR of energy supply, distribution, conversion, or utilization and by DESCRIPTOR which names a major variable which describes energy consumption patterns in that sector. In Tables 4,5,6, and 7, the selection of sectors spans the whole of the energy-supply-distribution-demand system and economic-environmental impacts noted in the operational framework. The descriptors chosen are those most commonly used as major energy determinants. A series of DATA ELEMENTS, values of the descriptors, for selected time periods and geographic regions within the state, form the actual entries to the files. Most of the data required to establish the state-specific data base is available from the sources noted in the tables. More importantly, most of the data are readily available in appropriate formats and summaries or can be easily

TABLE 4

STATE DEMOGRAPHIC/ECONOMIC FILE

SECTOR	DESCRIPTOR	DATA ELEMENT Time Series-Geographic Series	FEDERAL-STATE DATA SOURCES
AGRICULTURE . CROPS . LIVESTOCK	. PRODUCT VALUE . PRODUCT QUANTITY . EMPLOYMENT	. 1970 DOLLAR VALUE BY PRODUCT TYPE . CHANGES IN EMPLOYMENT IN CROPS & LIVESTOCK OVER PAST DECADE . QUANTITY OF PRODUCT PRODUCED BY COUNTY . EMPLOYMENT IN CROPS & LIVESTOCK IN DIFFERENT REGIONS	. U.S. DEPT. OF AGRICULTURE . U.S. CENSUS OF AGRICULTURE . N.Y.S. DEPT. OF AGRICULTURE . N.Y.S. DEPT. OF LABOR
COMMERCIAL . BUSINESS CATEGORIES	. REVENUE . EMPLOYMENT . FLOORSPACE (TYPE OF BLDG)	. PROJECTED DOLLAR INVESTMENT IN NEW COMMERCIAL CONSTRUCTION . REGIONAL FLOORSPACE IN ESTABLISHMENTS . SALES & EMPLOYMENT BY REGION	. U.S. CENSUS OF RETAIL TRADE . U.S. CENSUS OF WHOLESALE TRADE . N.Y.S. DEPT. OF COMMERCE . N.Y.S. DEPT. OF LABOR . N.Y.S. DEPT. OF TAXATION & FINANCE
GOVERNMENT . BUILDINGS . FLEET	. EMPLOYMENT . FLOORSPACE(TYPE OF BLDG) . VEHICLE-MILES	. EMPLOYMENT TRENDS . FLOORSPACE TRENDS . FLEET MIX & SIZE . FLOORSPACE BY REGION . EMPLOYMENT BY REGION	. U.S. CENSUS OF GOVERNMENT . U.S. DEPT. OF TRANSPORTATION . U.S. CENSUS OF TRANSPORTATION
MANUFACTURING . S.I.C.-19 . . . 31	. EMPLOYMENT . VALUE ADDED . QUANTITY PRODUCED . REVENUE	. PROJECTED DOLLAR INVESTMENT FOR ADDITIONAL CAPITAL & NEW FACILITIES . CHANGES IN VALUE-ADDED OVER TIME . TONS OF PRODUCT BY REGION & S.I.C. . CURRENT EMPLOYMENT BY REGION & S.I.C.	. U.S. BUREAU OF MINES . U.S. CENSUS OF MANUFACTURERS . N.Y.S. DEPT. OF LABOR . N.Y.S. DEPT. OF COMMERCE . N.Y.S. DEPT. OF TAXATION & FINANCE
RESIDENTIAL . SINGLE FAMILY . SMALL MULTI-FAMILY . LARGE MULTI-FAMILY	. POPULATION . FLOORSPACE . HOUSING MIX . NUMBER OF HOUSEHOLDS	. STATE & COUNTY POPULATION PROJECTIONS . PROJECTED HOUSING MIX CHARACTERISTICS . NUMBER OF NEW HOUSING STARTS & DOLLAR VALUE BY COUNTY	. U.S. BUREAU OF THE CENSUS . N.Y.S. DEPT. OF LABOR . ECONOMIC DEVELOPMENT BOARD . DIVISION OF HOUSING & COMMUNITY RENEWAL . N.Y.S. DEPT. OF TAXATION & FINANCE
TRANSPORTATION . PASSENGER . FREIGHT	. HIGHWAY & GASOLINE TAX REVENUES . FLEET REGISTRATIONS . VEHICLE MILES . MILES PER GALLON . DOLLAR VALUE OF VEHICLE	. PROJECTIONS OF FLEET MIX . MILE PER GALLON ESTIMATE FOR VEHICLES IN FUTURE . TRENDS IN VEHICLE OWNERSHIP . DOLLAR VALUE OF FREIGHT SHIPPED IN STATE REGIONS . VEHICLE-MILES BY TYPE OF VEHICLE IN SPECIFIC COUNTIES	. U.S. ENVIRONMENTAL PROTECTION AGENCY . U.S. DEPT. OF TRANSPORTATION . U.S. BUREAU OF THE CENSUS . N.Y.S. DEPT. OF MOTOR VEHICLES . N.Y.S. DEPT. OF TRANSPORTATION . N.Y.S. DEPT. OF TAXATION & FINANCE

TABLE 5

ENERGY SUPPLY FILE

FUEL TYPE	DISTRIBUTION/CONVERSION DESCRIPTORS	DATA ELEMENTS	DATA SOURCES UNITED STATES	NEW YORK STATE
COAL	. TRANSPORT . ELECTRIC GENERATION . DIRECT SUPPLY	. TONS IN FLUX . PROCESSING EFFICIENCY . DISTRIBUTION FRACTION . DISTRIBUTION LOSS . CONVERSION EFFICIENCY	. U.S. BUREAU OF MINES . INTERSTATE COMMERCE COMMISSION . CENSUS OF TRANSPORTATION . U.S. CUSTOMS BUREAU	. DEPARTMENT OF TRANSPORTATION . PORT AUTHORITY OF NEW YORK . PUBLIC SERVICE COMMISSION . DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIESEL	. TRANSPORT . STORAGE . REFINING . DISTRIBUTION	. BBL INFLUX . PROCESSING EFFICIENCY . DISTRIBUTION FRACTION . DISTRIBUTION LOSS	. U.S. BUREAU OF MINES . INTERSTATE COMMERCE COMMISSION . CENSUS OF TRANSPORTATION . U.S. CUSTOMS BUREAU	. DEPARTMENT OF TRANSPORTATION . PORT AUTHORITY OF NEW YORK . PUBLIC SERVICE COMMISSION . DEPARTMENT OF ENVIRONMENTAL CONSERVATION
GASOLINE	. TRANSPORT . REFINING . STORAGE . DISTRIBUTION	. BBL INFLUX . PROCESSING EFFICIENCY . DISTRIBUTION FRACTION . DISTRIBUTION LOSS	. U.S. BUREAU OF MINES . INTERSTATE COMMERCE COMMISSION . CENSUS OF TRANSPORTATION . U.S. CUSTOMS BUREAU	. DEPARTMENT OF TRANSPORTATION . PORT AUTHORITY OF NEW YORK . PUBLIC SERVICE COMMISSION . DEPARTMENT OF ENV. CONSERVATION . DEPARTMENT OF TAXATION & FINANCE
HYDROPOWER	. ELECTRIC GENERATION . DISTRIBUTION	. BTU INFLUX . CONVERSION EFFICIENCY . DISTRIBUTION FRACTION . DISTRIBUTION LOSS	. FEDERAL POWER COMMISSION	. PUBLIC SERVICE COMMISSION . NEW YORK POWER POOL
NATURAL GAS	. TRANSPORT . REFINING . STORAGE . DIRECT SUPPLY . ELECTRIC GENERATION	. MCF INFLUX . PROCESSING EFFICIENCY . CONVERSION EFFICIENCY . DISTRIBUTION FRACTION . DISTRIBUTION LOSS	. U.S. BUREAU OF MINES . INTERSTATE COMMERCE COMMISSION . CENSUS OF TRANSPORTATION . U.S. CUSTOMS BUREAU	. DEPARTMENT OF TRANSPORTATION . PORT AUTHORITY OF NEW YORK . PUBLIC SERVICE COMMISSION . DEPARTMENT OF ENVIRONMENTAL CONSERVATION
NUCLEAR	. TRANSPORT . REFINING . STORAGE . ELECTRIC GENERATION . DISTRIBUTION	. BTU INFLUX . PROCESS EFFIENCY . CONVERSION EFFICIENCY	. U.S. BUREAU OF MINES . FEDERAL ENERGY ADMINISTRATION . NUCLEAR REGULATORY COMMISSION	. N.Y. STATE E.R.D.A. . DEPARTMENT OF ENVIRONMENTAL CONSERVATION . PUBLIC SERVICE COMMISSION
OIL	. TRANSPORT . REFINING . STORAGE . DIRECT SUPPLY . DISTRIBUTION	. BBL INFLUX . CONVERSION EFFICIENCY . PROCESSING EFFICIENCY . DISTRIBUTION FRACTION . DISTRIBUTION LOSS	. U.S. BUREAU OF MINES . INTERSTATE COMMERCE COMMISSION . CENSUS OF TRANSPORTATION . U.S. ARMY CORPS OF ENGINEERS	. DEPARTMENT OF TRANSPORTATION . DEPARTMENT OF ENVIRONMENTAL CONSERVATION . PUBLIC SERVICE COMMISSION
SOLAR	. COLLECTION . STORAGE . DISTRIBUTION	. BTU INFLUX . CONVERSION EFFICIENCY . STORAGE EFFICIENCY	. FEDERAL ENERGY ADMINISTRATION . ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	. N.Y. STATE E.R.D.A. . DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WIND	. COLLECTION . STORAGE . ELECTRIC GENERATION . DISTRIBUTION	. BTU INFLUX . CONVERSION EFFICIENCY . STORAGE EFFICIENCY	. FEDERAL ENERGY ADMINISTRATION . ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	. N.Y. STATE E.R.D.A. . DEPARTMENT OF ENVIRONMENTAL CONSERVATION

TABLE 6

ENERGY UTILIZATION FILE

SECTOR	PROCESS	DATA ELEMENTS (per measure)	DATA SOURCES UNITED STATES	 NEW YORK STATE
AGRICULTURE . CROPS . LIVESTOCK	. PROCESSING . SPACE HEATING . MISC. ELECTRIC . VEHICLE	. BTU DEMAND . RELATIVE EFFICIENCY OF END USE DEVICES . FUEL FRACTION . FUEL DEMAND	. U.S. DEPARTMENT OF AGRICULTURE . CENSUS OF AGRICULTURE . FEDERAL ENERGY ADMIN.	. N.Y. DEPARTMENT OF AGRICULTURE
COMMERCIAL . BUSINESS CATEGORIES	. SPACE HEATING . LIGHTING . AIR CONDITIONING	. BTU DEMAND . RELATIVE EFFICIENCY OF END USE DEVICES . FUEL FRACTION . FUEL DEMAND	. U.S. BUREAU OF MINES . CENSUS OF RETAIL TRADE	. N.Y. DEPARTMENT OF COMMERCE . PUBLIC SERVICE COMMISSION
GOVERNMENT	. SPACE HEATING . FLEET . AIR CONDITIONING . LIGHTING	. BTU DEMAND . RELATIVE EFFICIENCY OF END USE DEVICES . FUEL FRACTION . FUEL DEMAND	–	. EACH STATE AGENCY
MANUFACTURING . SIC 19 . SIC 20	. INDUSTRIAL PROCESS. . SPACE HEATING . LIGHTING	. BTU DEMAND . RELATIVE EFFICIENCY OF END USE DEVICES . FUEL FRACTION . FUEL DEMAND	. U.S. BUREAU OF MINES . CENSUS OF MANUFACTURERS	. N.Y. DEPARTMENT OF COMMERCE . DEPARTMENT OF ENVIRON-MENTAL CONSERVATION . PUBLIC SERVICE COMMISSION
RESIDENTIAL . TYPE OF HOUSING STRUCTURE	. SPACE HEATING . COOKING . AIR CONDITIONING . LIGHTING - Fluorescent - Incandescent . MISC. APPLIANCES	. BTU DEMAND . RELATIVE EFFICIENCY OF END USE DEVICES . FUEL FRACTION . FUEL DEMAND	. U.S. BUREAU OF MINES . FEDERAL POWER COMMISSION . BUREAU OF THE CENSUS	. PUBLIC SERVICE COMMISSION . N.Y. POWER POOL . DIVISION OF HOUSING AND COMMUNITY RENEWAL
TRANSPORTATION . PASSENGER . FREIGHT	. VEHICLE TYPE . MOTIVE POWER	. BTU DEMAND . RELATIVE EFFICIENCY OF END USE . FUEL FRACTION . FUEL DEMAND	. U.S. BUREAU OF MINES . U.S. ENVIRONMENTAL PRO-TECTION AGENCY . CENSUS OF TRANSPORTATION	. DEPARTMENT OF TAXATION AND FINANCE . DEPARTMENT OF TRANS PORTATION . N.Y. DEPARTMENT OF COMMERCE

TABLE 7

ENVIRONMENTAL FILE

SECTOR	PARAMETERS	DATA ELEMENTS (Per Measurable Unit)	DATA SOURCES: UNITED STATES	DATA SOURCES: NEW YORK STATE
SOME EXAMPLES FROM UTILIZING SECTOR				
AGRICULTURE . CROP . LIVESTOCK	. WATER . SOLID WASTE	. B. O. D. . ORGANIC WASTE EFFLUENTS	. U.S. DEPARTMENT OF AGRICULTURE . U.S. ENVIRONMENTAL PROTECTION ADMINISTRATION	. N.Y. DEPARTMENT OF AGRICULTURE . N.Y. DEPARTMENT OF ENVIRONMENTAL CONSERVATION
MANUFACTURING . SIC 19 . SIC 20 . . .	. AIR . WATER . LAND USE . HEALTH DATA	. EMISSIONS COMPOSITION . ORGANIC & INORGANIC EFFLUENTS . B. O. D. . TOXIC COMPOUNDS	. U.S. ENVIRONMENTAL PROTECTION ADMINISTRATION . U.S. FEDERAL ENERGY AGENCY . U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	. N.Y. DEPARTMENT OF ENVIRONMENTAL CONSERVATION . COUNTY & LOCAL ENVIRONMENTAL DEPARTMENTS
TRANSPORTATION . PASSENGER . FREIGHT	. LAND USE . AIR . HEALTH DATA	. EMISSIONS COMPOSITION . TOXIC COMPOUNDS	. U.S. ENVIRONMENTAL PROTECTION ADMINISTRATION . U.S. FEDERAL ENERGY AGENCY . U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	. N.Y. DEPARTMENT OF ENVIRONMENT . COUNTY & LOCAL ENVIRONMENTAL DEPARTMENTS
SOME EXAMPLES FROM SUPPLY SECTOR				
COAL	. AIR . HEALTH DATA	. CHEMICAL EMISSION COMPOSITION TOXIC COMPONENTS	. U.S. ENVIRONMENTAL PROTECTION ADMINISTRATION . U.S. FEDERAL ENERGY AGENCY . U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	. N.Y. DEPARTMENT OF ENVIRONMENT . COUNTY & LOCAL ENVIRONMENTAL DEPARTMENTS
OIL	. AIR . WATER . CONTROL TECHNOLOGIES . HEALTH DATA	CHEMICAL EMISSION COMPOSITION TOXIC COMPONENTS OIL SPILL DATA	. U.S. ENVIRONMENTAL PROTECTION ADMINISTRATION . U.S. FEDERAL ENERGY AGENCY . U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	. N.Y. DEPARTMENT OF ENVIRONMENT . COUNTY & LOCAL ENVIRONMENTAL DEPARTMENTS
NUCLEAR	. AIR . WATER . LAND USE . HEALTH DATA . DISPOSAL	. RADIOACTIVE EMISSIONS . THERMAL DISCHARGE	. U.S. ENVIRONMENTAL PROTECTION AGENCY . U.S. FEDERAL ENERGY AGENCY . U.S. ENERGY RESEARCH & DEVELOPEMENT ADMINISTRATION . NUCLEAR REGULATION COMMISSION	. N.Y. DEPARTMENT OF ENVIRONMENT . COUNTY & LOCAL ENVIRONMENTAL DEPARTMENTS
DISTRIBUTION/ CONVERSION SECTOR				
ELECTRICAL GENERATION AND TRANSMISSION	. AIR . WATER . LAND USE . HEALTH DATA	. TRANSMISSION LINE AREAS . THERMAL DISCHARGE	. U.S. ENVIRONMENTAL PROTECTION AGENCY . U.S. FEDERAL ENERGY AGENCY . U.S. ENERGY RESEARCH & DEVELOPEMENT ADMINISTRATION . FEDERAL POWER COMMISSION	. N.Y. DEPARTMENT OF ENVIRONMENTAL CONSERVATION . PUBLIC SERVICE COMMISSION . N.Y. POWER POOL

adapted from existing energy data bases.

D. Hardware, Software, and Costs

Estimates of hardware and software requirements and the computing and personnel costs for the proposed energy information system will be discussed in general
estimates would require detailed knowledge of the type of computer to be used, the operating system for the machine, the load on the computing facility, and the charge accounting formulae at the computer facility. Personnel costs would be dependent upon the character and level of utilization by state agencies and legislative staff as well as the technical features mentioned. However, both the development and use of energy information systems in other states and the elements of the New York State system outlined earlier provide technical and cost guidelines for the design considerations of supporting computer hardware, software, and staffing requirements.

The computer hardware requirements for the New York State Energy Information/Analytic System should be in excess of 65K decimal words memory available directly to the user and 10 million characters mass storage. This will permit the basic informational/analytic capability to be developed and the addition of user-specific capabilities. For example the S2K data base management system would require a maximum of 60K words operating on Control Data facilities. The IMS (Information Management System) package from IBM would require less, depending on the version involved. Optimization procedures on energy systems models would require 45K words under the MPS (Mathematical Programming System) packages - available commercially. These are relatively small demands to set for computing requirements. Most large computers with terminal access including the State central computing facility and other major agency and university computers in the state, would provide upwards of 250K words of different memory types and 500 million characters and mass storage.

written codes for such a system. The commercial versions are widely available at major computing facilities which would save both first cost ($40,000-$90,000) and the time required to code a data base management system. In addition, while no software is error-free, these commercial systems have experienced broad use in the field. The experience of other user groups is helpful in avoiding software pitfalls, and technical support is available from manufacturers.

The requirements of the New York State energy information system are well met by products such as IMS, S2K, and TOTAL. The software selected should include the following features:

1. Structuring and keying of information
2. Updating
3. Report generation
4. Query response
5. Security
6. Archives

The main function of the data base management system is to structure information in the computer in a way that facilitates updating and retrieval of information. Updating capability should be available interactively for small numbers of changes, or in a batch mode. Retrieval capability should include both output of data in large quantities in easily read formats (Report generation), and interactive response to simple requests for small amounts of information (Query response). The query language should be easily accessable to personnel without technical training. Security devices are necessary to prevent the unauthorized or accidental access and destruction of information on the system. Archiving capability enables the user to easily key back-up copies of the data base on tape to protect it from system failure.

Rough estimates of the access and computing costs for the energy information system are shown in Table 9. Direct machinery costs are small. Computing time and cost requirements for major runs of energy system models and for report generation to respond to agency requests for large-scale analysis become more substantial but are still relatively small. However, for these latter questions, a relatively sophisticated programmer-analyst would be required to discuss with agency personnel their needs and to translate these needs into machine requests. The budget for such a staff person would likely exceed the total of direct computing costs.

TABLE 9

APPROXIMATE OPERATING COSTS

	Approximate Unit Cost	Approximate Annual Cost
Terminal (rental)	\$ 150/mo.	\$ 1800.
Disk Space (rental)	\$ 300/mo.	\$ 3680.
WATS Line	30¢/min. used	\$ 1000.
Local Line	--	--
Set-Up & Run Multiple Modeling Scenarios, multi-access long-term statistics	\$1000/job	\$ 5000.
Major Report Generation	\$100/job	\$ 2000.

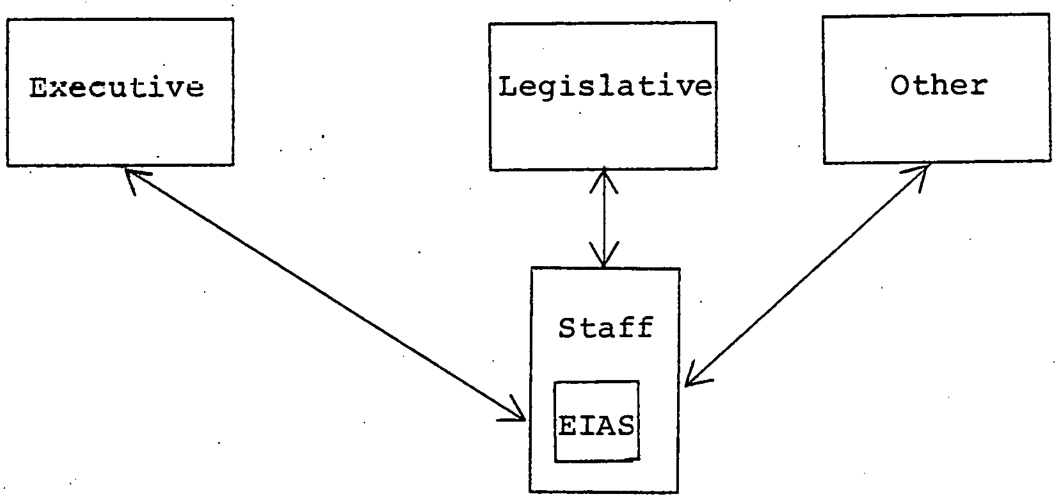
As was stressed in an earlier section of this report, the development of an energy information and analytic system makes little sense in isolation from a staff using the system. The staff has basically two functions: the care and feeding of the system (expanding and updating the data and models) and the use of the system to perform policy analyses. While the first function could be carried out in part by distributed staff residing in organizations such as the Economic Development Board or the Department of Environmental Conservation, the second function is of necessity one for a specialized and concentrated staff. We would recommend that both types of functions being performed within a data and analysis group of some kind. To be effective that group should contain at least five people, covering the areas of computer programming and data analysis, energy technologies, economics, environment and system analysis.

Two possible relationships between policy makers, staff and the information/analytic system are shown in Figure 7. In Scheme 1 the system is highly coupled to a specialized staff. In this situation it would be difficult for the system to be used by more than one unit of State Government. Scheme 2 envisages a very small staff directly connected to the system responsible for maintainance and updating and staffs attached to or contracted to the ultimate users having access to the system. The choice between Scheme 1 and Scheme 2 (or variants of them) is a political one and is not prejudged here. The distinction is made, however, to point out that, if Scheme 2 is aspired to, the system itself must have a simplicity of access and use not required in Scheme 1.

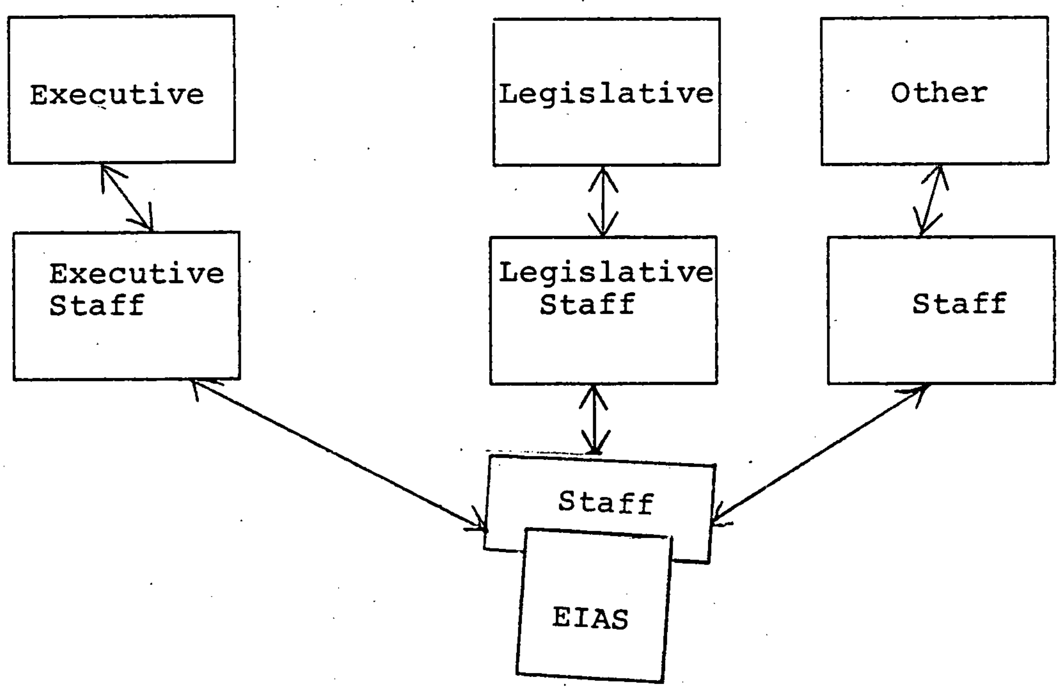
Figure 7

IMPLEMENTATION SCHEMES

SCHEME 1



SCHEME 2



V. THE ACTION PLAN

In this section of the report, we outline the sequence of steps required to construct and put into operation the Energy Information System for the State of New York. With a maximum of reliance upon existing energy models and data bases, the capability for providing information to decison-makers could be put into place within a one year time frame. However, the construction and implementation of a total energy information and analytic system must be viewed as an ongoing activity carried out in conjunction with performance of special studies which are responding to specific user requests. This approach not only results in a system which is tailored to user requirements, but it permits changes and refinements to be incorporated into the system before there has been too large an expenditure of effort. Also, we should note that the very process of collecting and assembling data offers a useful mechanism for bringing together technical staff in state agencies and legislative committees who are involved in the use of the system. This not only affords them an opportunity to become familiar with what the system offers, but to input their own needs and requirements.

There is a variety of energy planning and management activities within the State which will be able to assist in the development of the information system. These include agencies (PSC, DOT), legislative staff and committees, (Joint Legislative Commission on Energy Systems), university groups (SUNY, etc), and engineering firms (CALSPAN, DMB, etc.) active in energy systems analysis. One particularly important resource group will be the National Center for Analysis of Energy Systems (NCAES) at BNL which contains a Northeast Regional Studies Program. In addition, the electric sector modeling activities underway at Rensalaer Polytechnic Institute with support from NYS-ERDA, and complimentary work by the New York State Power Pool, are important components of a state energy information system and should be integrated into the overall framework. Discussions also should be initiated with the

California, Massachusetts, and Wisconsin energy office staffs since these groups are broadly representative of the type of structure required in the state and have a base of experience from which to suggest development strategy and likely problem areas to anticipate.

System development is outlined in two stages. The first provides a working system with which to test decision-maker response to energy information and stimulate broader consideration of energy policy in the State. Evaluation of this initial phase will form the basis for continuing improvement of the energy information system capability.

A. Initial Development

The initial phase of development of the New York State Energy Information System will establish a base of data and report generation capabilities to deliver to decision-makers a comprehensive overview of the State energy system, disaggregated fuel flows to specific end use sectors, flows to geographic regions within the State, trends in energy supply and consumption patterns, and other basic energy information. The system will operate primarily as an information system with only limited integration of energy-economic-environmental models. It is envisioned that the analysis of economic and environmental impact of energy policy options would be carried out through coordinated efforts utilizing model components and data files in conjunction with staffs in many organizations including the Economic Development Board, Department of Commerce, Department of Environmental Conservation, and others.

This initial phase of development is constructed in such a way that it may be implemented directly and on a permanent basis at a state central facility, or the system may be established at any location most convenient for implementation purposes with subsequent transfer to a central location.

An outline of the initial energy information system is shown in Figure 8. To establish an economical, low cost system, we note that the New York data base may be drawn largely from the Energy Model Data Base (Appendix A) modified and calibrated to

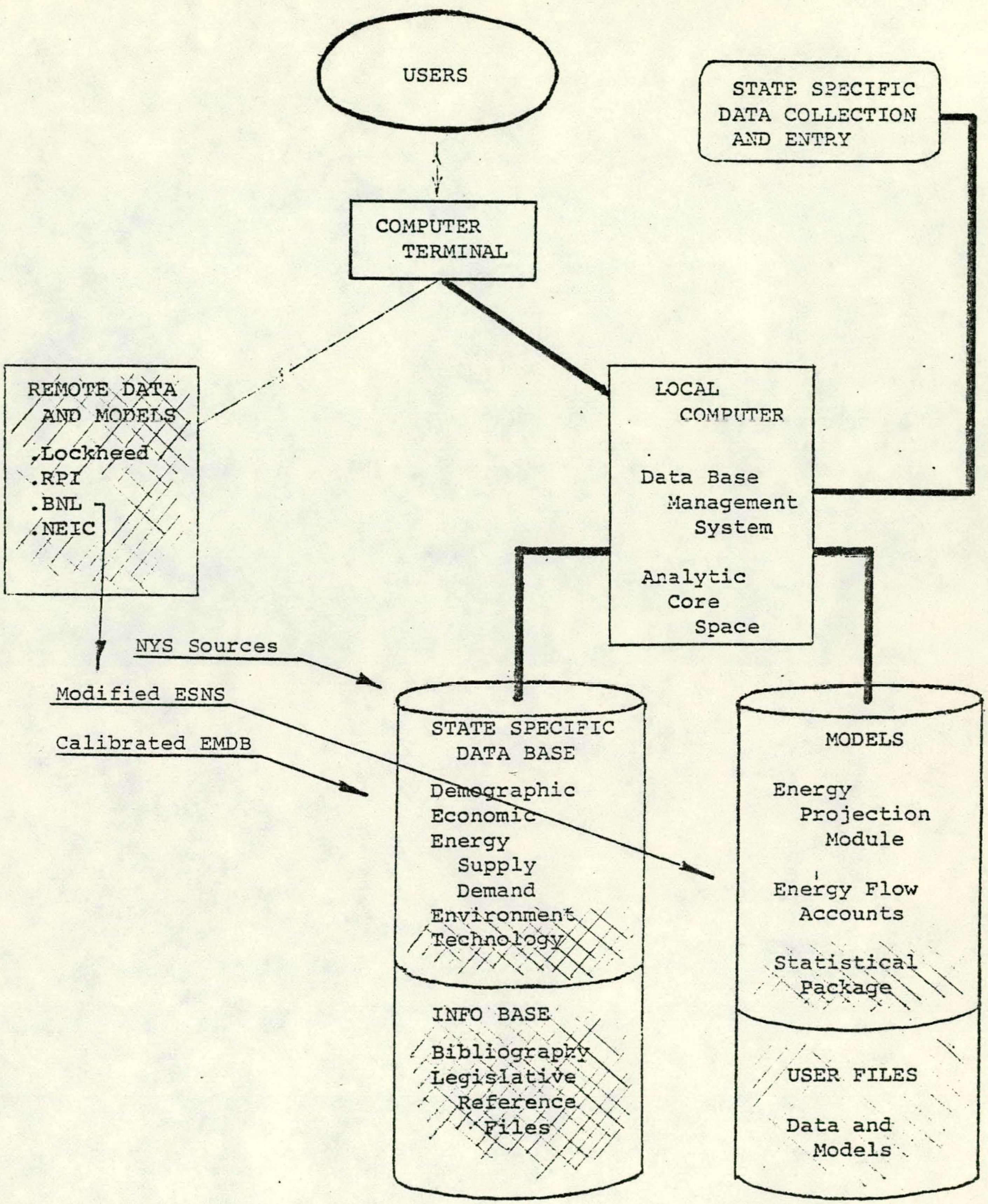

USERS
STATE SPECIFIC DATA COLLECTION AND ENTRY
COMPUTER TERMINAL
REMOTE DATA AND MODELS
.Lockheed
.RPI
.BNL
.NEIC
LOCAL COMPUTER
Data Base Management System
Analytic Core Space
NYS Sources
Modified ESNS
Calibrated EMDB
STATE SPECIFIC DATA BASE
Demographic
Economic
Energy
Supply
Demand
Environment
Technology
INFO BASE
Bibliography
Legislative
Reference
Files
MODELS
Energy Projection Module
Energy Flow Accounts
Statistical Package
USER FILES
Data and Models

Figure 8

state-specific use and that a modified Energy Systems Network Simulator (Appendix C) package may be the fastest approach to construction of energy flow accounts.* A specific list of tasks and their sequence is given below:

1. ESTABLISH LIAISON WITH NATIONAL AND STATE ENERGY INFORMATION SYSTEMS AND THE NEW YORK ENERGY COMMUNITY.

2. TRANSFER, CALIBRATE, AND COLLECT INFORMATION FOR BASIC DATA FILES (Demographic/Economic, Supply, Utilization, Technology/Cost).

3. DESIGN CURRENT ENERGY FLOW ACCOUNTS TO REPRESENT AND PORTRAY SUPPLY-DISTRIBUTION-DEMAND SYSTEM IN THE STATE.

4. CONSTRUCT SYSTEM OF INFORMATION REPORTS TO DECISION-MAKERS (Governors; Staff, Agencies, Legislative Staff, etc.,)AND DISTRIBUTE DRAFT ENERGY INFORMATION REPORTS.

5. COORDINATE ANALYTIC STRUCTURE FOR AND PREPARE THE STATE PROJECTION MODULE FOR DISPLAY OF MAJOR TRENDS IN SUPPLIES AND DEMAND. This should include consideration of integrating the WISE models, other state models, the RPI electric sector model, etc., into a coherent planning tool.

6. DOCUMENT INFORMATION, DATA HANDLING, AND ANALYTIC STRUCTURE PROCEDURES FOR OPERATING STAFF.

7. SPECIFY INFORMATION MANAGEMENT SYSTEM REQUIREMENTS AND PROCEDURES FOR ENERGY INFORMATION SYSTEM TRANSFER TO A STATE CENTRAL FACILITY.

8. EVALUATE USE OF INITIAL CAPABILITY BY DECISION-MAKERS. OUTLINE SYSTEM MODIFICATIONS AND EXTENSIONS FOR CONTINUING DEVELOPMENT.

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* The State of Maryland has taken this approach.

Activities through Task 4 represent development of the most basic informational capability of the system and, following the design specification earlier, could be accomplished with a two man-year effort of analysts and programmers over a nine month period. A heavy investment of development time is in data procedures. A part of the man-year effort might be offset by judicious organization of assigned time from selected staff or energy-related agencies. Since the data base management system (IMS, S2K, etc.,) is itself costly ($40,000 - $90,000), it is important to select a facility which already contains such software.* Tasks 4 through 8 complete initial development. Again, following the design specifications which call for maximum use of existing analytic structures, these tasks should require a one man-year effort by analysts and programmers over a four-to-six month period. Overall initial development of the New York State Energy Information System to the point where it responds easily to decision-makers' needs would require about three man-years and be operational within eight to twelve months of the formation of the development team.

At this stage of development, the energy information system will be useful in assessing a wide range of policies relating to the State's energy supply-distribution-demand system. It may also be used to formulate alternative actions in terms of their overall costs and benefits as they relate to the energy system, or alternatively to prepare scenarios under a variety of external conditions. As with any information system, there are certain limitations to its use. Data are not sufficiently detailed to deal with, say, monthly oil allocations. However, the framework will show how much oil could be saved through conservation efforts or other state policy initiatives. The basic framework also does not include some economic factors which affect, and are in turn affected by, the energy system. These must be inserted exogenously into the framework. Thus, a period of utilization by the energy community in the state is anticipated in which the

* The State central computing facility and the Brookhaven central computer facility are two such facilities.

energy information system is a useful framework with which to carry out energy policy analyses and though which its weak points can be identified. This will provide the basis for a continuing evaluation of agency and legislative staff requirements for energy information and for assessing additional development of the system.

CONTINUING DEVELOPMENT

Additional development of the system should include consideration of the following expansion of information and analytic capability:

- environmental models and data files
- integration of an electric sector model, transportation planning models, etc., into the analytic structure
- development of economic modeling components for the system
- initiation of bibliographic services.

These system elements provide decision-makers with the ability to engage in more broad-ranging economic-environmental studies.

Environmental data in the initial development of the State Energy Information System was limited to primary energy pollutant emissions. However, for detailed assessment of environmental and health aspects of energy use, it will be appropriate to add analytic capability to represent airborne and water dispersion of pollutants, population distributions near major sources, etc., and to begin to provide some environmental and health damage indices.

Detailed modeling of the state economy and its interactions with the energy system and environment should be undertaken in this latter development of the system. Linked energy system-input/output models have proven valuable in tracing the links between energy and economic activity and in estimating shadow price effects of alternative energy policies. Such models for the State of New York would clarify the relations between state gross product, employment,* energy and environment.

*Requires the labor matrix.

Adaptations of the PIES model concepts,* would clarify the elasticity of demand for energy in the state. As experience with the system grows, we can anticipate requests for augmenting the analytic tools with models oriented toward specific policy issues. Users would seek to utilize the data base directly in conjunction with their own models, and consequently the system should provide interactive access to storage and core space for entry of user-specific information and analytic models.

*Because of regional definitions, etc., current PIES structure would be difficult to apply at the state level.

BNL-21545
Informal Report

APPENDIX A

THE
ENERGY MODEL DATA BASE
PROGRAM

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June 1976

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Under Contract No. E(30-1)-16 with the
United States Energy Research and Development Administration

INTRODUCTION

The techniques of systems modeling and the methods of system analysis have proved to be very powerful aids in the attempts to understand how complex systems function and evolve. With these techniques and methods, sufficient simplification of the complexity can be obtained so that manipulation of the salient features will provide a reasonably realistic, but transparent, picture of system behavior under a wide range of conditions. In recent years, the network of technological processes and activities which provide the nation's energy requirements, starting with available resources and ending with consumer demands, has come in for detailed analysis. Many energy-related models have been constructed. Each of these has proceeded to simplify the complex energy system in such a way as to isolate selected system factors for subsequent manipulation.

The choice of which system features are of primary importance is usually dictated by the policy perspective of its potential user community. For example, the models developed by the National Center for Analysis of Energy Systems (NCAES) at Brookhaven were developed principally to provide a descriptive or normative overview of the technological aspects of the national energy system in order to permit analysis and intercomparison of the impact of future technological options. The quality of such models is usually determined by the success of the modeler in preserving a realistic picture of the system under the simplifying assumptions adopted and in maintaining relevance to policy objectives. Since the mathematical methods for model manipulation are generally rigorous, the quality of the results of such manipulations is largely determined by the quality of the numeric data used to parameterize the various characteristics of the system being modeled.

To meet the needs of the NCAES for high quality numeric data, a flexible, open-ended and model-independent computerized data system has been developed and named the Energy Model Data Base (EMDB). It has been designed to accept files of numeric quantities useful in energy systems modeling, together with the documentation which indicates the source and quality of the numbers. As noted, the EMDB is independent of any particular model, but choices made in both content and format reflect the requirements of the NCAES modeling programs. The purpose of this paper is to provide a non-technical description of the content of the EMDB and to indicate its linkage to Brookhaven optimization and network flow models.

EMDB CONTENT

The clarity of the following description will be enhanced if some terms are defined at the beginning. The terminology adopted can best be understood in relation to a hierarchy of levels of aggregation at which the flow of energy through the energy system are considered. Five levels are used, and these are defined, primarily by examples, as follows:

<u>Element</u> - a single quantity, such as sulphur oxide emissions, land use, or operating cost associated with a process.

<u>Process</u> - a single technological operation, such as coal transportation by unit train, electric power generation by a light-water reactor, or steel production by electric furnace.

<u>Activity</u> - a system component, such as coal transportation, electricity generation, or steel production.

<u>Trajectory</u> - a linked series of processes, such as offshore oil extraction to freight transportation by diesel truck.

<u>Sub-System</u> - a related collection of trajectories, such as coal extraction to all coal uses.

As an example, the set of trajectories which constitute the current coal sub-system are shown for illustrative purposes in Figure 1, with the activities identified across the top of the figure and the processes noted on the trajectory links. The end-use processes are not detailed but are indicated symbolically.

The EMDB presently contains approximately 635 supply processes for current technologies and approximately 180 supply processes for future technologies, associated with different fuels, activities, regions, and control technologies. On the utilization side, it presently contains approximately 220 processes for fuel-specific end-use demands. The set of end-use processes (without the fuels utilized for each) are shown by sector in Figure 2 (residential),

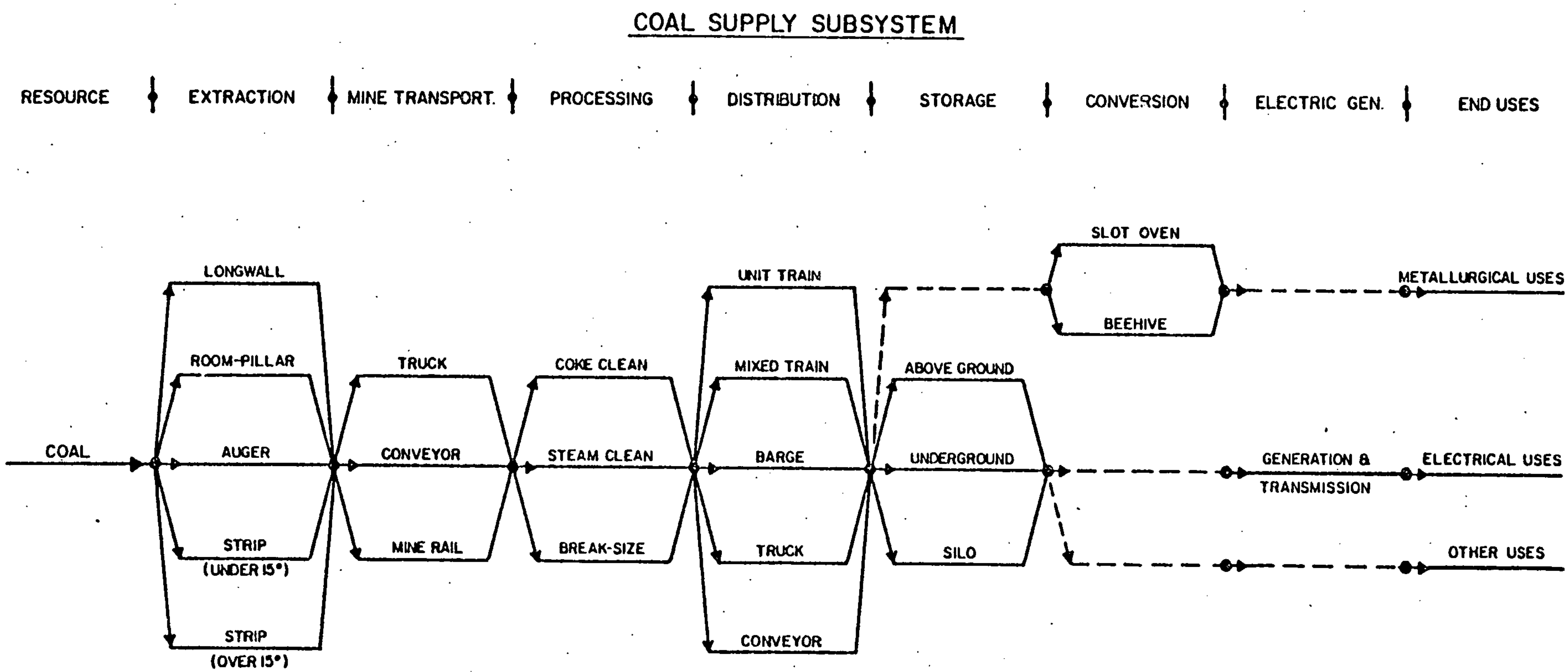
COAL SUPPLY SUBSYSTEM
RESOURCE
EXTRACTION
MINE TRANSPORT.
PROCESSING
DISTRIBUTION
STORAGE
CONVERSION
ELECTRIC GEN.
END USES
COAL
LONGWALL
ROOM-PILLAR
AUGER
STRIP (UNDER 15°)
STRIP (OVER 15°)
TRUCK
CONVEYOR
MINE RAIL
COKE CLEAN
STEAM CLEAN
BREAK-SIZE
UNIT TRAIN
MIXED TRAIN
BARGE
TRUCK
CONVEYOR
ABOVE GROUND
UNDERGROUND
SILO
SLOT OVEN
BEEHIVE
METALLURGICAL USES
GENERATION & TRANSMISSION
ELECTRICAL USES
OTHER USES

Figure 1

Figure 2

EMDB RESIDENTIAL ENERGY DEMANDS

ACTIVITY	PROCESS
• SPACE CONDITIONING	SPACE HEATER CENTRAL AIR CONDITIONER ROOM AIR CONDITIONER
• WATER HEATING	WATER HEATER AUTOMATIC CLOTHES WASHER MANUAL CLOTHES WASHER CLOTHES DRYER WATER PUMP
• KITCHEN	STANDARD OVEN-RANGE AUTOMATIC-CLEAN OVEN-RANGE REFRIGERATOR, STANDARD REFRIGERATOR, NO-FROST REFRIGERATOR-FREEZER, STANDARD REFRIGERATOR-FREEZER, NO-FROST FREEZER, STANDARD FREEZER, NO-FROST
• ENTERTAINMENT	BLACK & WHITE TV, STANDARD BLACK & WHITE TV, INSTANT-ON COLOR TV, STANDARD COLOR TV, INSTANT-ON RADIO RADIO-PHONOGRAPH
• LIGHTING	INCANDESCENT LIGHT FLUORESCENT LIGHT YARD LIGHT
• APPLIANCES	MANY

3 (commercial), 4 (industrial), and 5 (transportation).

A set of elements (and their documentation) is associated with each energy supply or utilization process. The set of elements defined for the current supply technologies and end-use demands are tabulated in Figures 6 and 7. Additional elements have been defined for some of the recently entered future supply technologies. All elements for supply processes (except the Efficiency Factors) are given in appropriate units per 10^{12} Btu flow into the process and for utilization processes in appropriate units per energy demand measure (dwelling, passenger-mile, ton of product, etc.).

For purposes of model sensitivity analysis, a "quality measure" has been included for each element in the data base. Since the nature of the data does not permit assignment of a conventional uncertainty measure (plus/minus numeric error, high-low uncertainty range, etc.) the data compilers have provided a judgmental "hardness" number for each value as a computer-recognizable quality measure. These hardness numbers range from 1 to 5 and have the following definitions:

Hardness	Definition
1	Very good. Highest confidence. Error probably $\leq$10 percent. Data well accepted and verified.
2	Good. Reportable and accepted. Error probably $\leq$25 percent.
3	Fair. Validity may be uncertain due to method of combining or applying data. Error probably $\leq$50 percent.
4	Poor. Low confidence. Validity questionable. Error probably $\leq$100 percent.
5	Very poor. Validity unknown. Error may be as high as an order of magnitude.

Documentation is provided in the EMDB for each element in the form of references and footnotes. A list of references documents

Figure 3

EMDB COMMERCIAL ENERGY DEMANDS

ACTIVITY	PROCESS
• SPACE CONDITIONING	SPACE HEATER ELECTRIC AIR CONDITIONER GAS AIR CONDITIONER
• WATER HEATING	WATER HEATER
• KITCHEN	COOKING UNIT STANDARD REFRIGERATOR-FREEZER
• LIGHTING	INDOOR LIGHTS STREET LIGHTS
• APPLIANCES	MISCELLANEOUS APPLIANCES
• FEEDSTOCK	ROAD MATERIAL

Figure 4

EMDB INDUSTRIAL ENERGY DEMANDS

• SIC 26	PAPER AND PULP MILLS PAPER PRODUCTS MANUFACTURE
• SIC 37	MOTOR VEHICLES MOTOR VEHICLE PARTS
• SIC 32	GLASS PRODUCTS CLAY PRODUCTS CEMENT AND RELATED PRODUCTS STONE AND RELATED PRODUCTS
• SIC 28	INORGANIC CHEMICALS ORGANIC CHEMICALS
• SIC 20	MEAT AND DAIRY PRODUCTS BAKERY, SUGAR, CONFECTIONERY BEVERAGE, CAN, CURED, FROZEN GRAIN MILL AND MISCELLANEOUS FOODS
• SIC 33	IRON AND STEEL MAKING IRON AND STEEL CASTINGS PRIMARY ALUMINUM PRIMARY COPPER PRIMARY ZINC

Figure 5

EMDB TRANSPORTATION ENERGY DEMANDS

ACTIVITY	PROCESS
• FREIGHT	BARGE SHIP TRUCK RAILROAD DOMESTIC AIRLINE INTERNATIONAL AIRLINE
• PASSENGER	DOMESTIC AIRLINE INTERNATIONAL AIRLINE INTERCITY AUTOMOBILE URBAN AUTOMOBILE INTERCITY BUS URBAN BUS MOTORCYCLE RECREATION BOAT GENERAL AVIATION RAILROAD URBAN RAIL RAPID TRANSIT
• MILITARY, GOVERNMENT	GROUND VEHICLES AIRCRAFT, PISTON AIRCRAFT, TURBINE JET SHIP

Figure 6

EMDB PROCESS ELEMENTS (CURRENT TECHNOLOGIES)

• EFFICIENCY FACTORS	MARKET ALLOCATION PRIMARY EFFICIENCY PRIMARY FUEL FRACTIONS ANCILLARY FUEL FRACTIONS ANCILLARY ENERGY ENERGY DEMAND ENERGY DEMAND MEASURE
• WATER EMISSIONS	ACIDS BASES PO_4 NO_4 OTHER DISSOLVED SOLIDS TOTAL DISSOLVED SOLIDS SUSPENDED SOLIDS NON-DEGRADABLE ORGANICS BOD COD THERMAL
• AIR EMISSIONS	PARTICULATES NO_x SO_x HYDROCARBONS CO CO_2 ALDEHYDES, ETC.
• SOLID WASTE & LAND USE	SOLID WASTE LAND
• HEALTH DATA	OCCUPATIONAL DEATHS OCCUPATIONAL INJURIES OCCUPATIONAL MAN-DAYS LOST

Figure 7

EMDB PROCESS ELEMENTS
(CONT'D)

• CONSTRUCTION MANPOWER	NON-MANUAL/TECHNICAL NON-MANUAL/NON-TECHNICAL MANUAL/TECHNICAL MANUAL/NON-TECHNICAL
• CONSTRUCTION MATERIALS	WOOD PRODUCTS CHEMICALS AND ALLIED PRODUCTS PETROLEUM PRODUCTS STONE AND CLAY PRODUCTS PRIMARY IRON AND STEEL PRODUCTS PRIMARY NON-FERROUS METALS FABRICATED STRUCTURAL PRODUCTS OTHER FABRICATED PRODUCTS MANY OTHER SELECTED MATERIALS AND EQUIPMENT
• CONSTRUCTION COSTS	TOTAL CAPITAL COST OWNER'S COST MULTIPLIER
• O&M MANPOWER, MATERIALS, COSTS	(SIMILAR LISTS TO THOSE ABOVE FOR CONSTRUCTION)

(ADDITIONAL COEFFICIENT DEFINING TIME-PHASING OF CONSTRUCTION MANPOWER, MATERIALS, AND CAPITAL) the sources from which the individual number was taken or from which information was derived by which the element value (or its quality measure) was calculated, derived, estimated, etc. The footnotes contain textual information detailing assumptions made, calculational techniques used, etc. in order to derive the element value or its quality measure. Each reference or footnote is assigned an identification number which is linked to each particular element to which it refers.

A sample output for a process, in a "people-readable" format, is shown in figure 8 and 9. The supply process is identified as to Resource (Coal), Activity (Distribution), Process (Unit Train), Region (National), and Control Level (Uncontrolled). A utilization process would be similarly identified as to Sector, Activity, Process, Fuel, and Control Level. There is a place reserved in which the history of variations made to process blocks through time can be recorded, dated for user convenience.

Figure 8

EMDB OUTPUT

COAL
DISTRIBUTION
UNIT TRAIN
NATIONAL
UNCONTROLLED

DATA ELEMENT		VALUE	UNITS	QUAL
***				
* MARKET ALLOCATION		5.280E-01		1
* PRIMARY EFFICIENCY		1.000E+00		2
* PRIMARY FUEL, PHYSICAL LOSS	N.A.			
* ANCILLARY FUEL, OIL		1.430E+10		2
* ANCILLARY FUEL, ELECTRICITY		1.030E+08		2
* ANCILLARY ENERGY,TOTAL		1.430E+10	BTU/10E12 BTU(IN)	4
* PARTICULATES		1.770E+01	TONS/10E12 BTU(IN)	4
* OXIDES OF NITROGEN		3.860E+00	TONS/10E12 BTU(IN)	3
* OXIDES OF SULFUR		3.350E+00	TONS/10E12 BTU(IN)	3
* HYDROCARBONS		2.560E+00	TONS/10E12 BTU(IN)	3
* CARBON MONOXIDE		3.610E+00	TONS/10E12 BTU(IN)	3
* ALDEHYDES,ETC.		5.670E-01	TONS/10E12 BTU(IN)	3
* TOTAL AIR POLLUTANTS		3.160E+01	TONS/10E12 BTU(IN)	3
* LAND USE		3.390E+01	ACRES/10E12 BTU(IN)	2
* OCCUPATIONAL DEATHS		6.100E-02	NUMBER/10E12 BTU(IN)	2
* OCCUPATIONAL INJURIES		5.850E-01	NUMBER/10E12 BTU(IN)	2
* OCCUPATIONAL MAN DAYS LOST		5.950E+01	NUMBER/10E12 BTU(IN)	2
* FIXED COST		5.100E+03	DOLLARS/10E12 BTU(IN)	3
* OPERATING COST		7.980E+04	DOLLARS/10E12 BTU(IN)	3
* TOTAL COST		8.490E+04	DOLLARS/10E12 BTU(IN)	2

DATA ELEMENT	REF#
***	
* MARKET ALLOCATION	4015
* PRIMARY EFFICIENCY	2
*	5
*	21
*	23
*	1004
*	1005
*	1006
*	1013
*	1056
* PRIMARY FUEL, PHYSICAL LOSS	
* ANCILLARY FUEL, OIL	4016
*	4017
* ANCILLARY FUEL, ELECTRICITY	4018
* ANCILLARY ENERGY,TOTAL	2
*	5
*	21
*	23
*	1004
*	1005
*	1006
*	1056
* PARTICULATES	2
*	5
*	21
*	23
*	1004
*	1005
*	1006

DATA ELEMENT	FTN#
***	
* MARKET ALLOCATION	1719
* PRIMARY EFFICIENCY	1005
*	1006
*	1007
*	1008
*	1801
* PRIMARY FUEL, PHYSICAL LOSS	
* ANCILLARY FUEL, OIL	1720
* ANCILLARY FUEL, ELECTRICITY	1721
* ANCILLARY ENERGY,TOTAL	1005
*	1005
*	1083
* PARTICULATES	
* OXIDES OF NITROGEN	1005
* OXIDES OF SULFUR	1005
* HYDROCARBONS	1005
* CARBON MONOXIDE	1005
* ALDEHYDES,ETC.	1005
* TOTAL AIR POLLUTANTS	
* LAND USE	1027
* OCCUPATIONAL DEATHS	1033
* OCCUPATIONAL INJURIES	1033
* OCCUPATIONAL MAN DAYS LOST	1033
* FIXED COST	1005
*	1044
*	1045
*	1052
* OPERATING COST	1005

Figure 9

EMDB OUTPUT (CONT'D)

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REF#?       33
   BUR OF ACCOUNTS, RAILROADS, TRANS. STAT. IN THE US, 1971, ICC,
      1972.
REF#?       1004
   MINERAL INDUSTRY SURVEYS, COAL-BITUMINOUS + LIGNITE IN 1971,
      U.S.D.I., BUR. OF MINES. SEPTEMBER, 1972.
REF#?       1005
   BITUMINOUS COAL FACTS, 1968, NATIONAL COAL ASSOCIATION,1968.
REF#?       1006
   GLOVER,T.O., M.E. HINKLE, + H.L. RILEY, UNIT TRAIN TRANSPORTATION
      OF COAL. U.S.D.I., BUR. OF MINES, IC 8444, 1970.
REF#?       1013
   COX, J. (U.S. BUR. OF MINES), PERSONAL COMMUNICATION. FEBRUARY,
      1973.
REF#?       1056
   DELSON, J.K. AND R.J. FRANKEL, RESIDUALS MANAGEMENT IN THE COAL-
      ENERGY INDUSTRY, UNPUBLISHED MANUSCRIPT, RESOURCES FOR THE
      FUTURE, INC., WASH., D.C. (UNPUBLISHED 1973).
REF#?       4015
   COAL TRAFFIC ANNUAL 45(1972).
REF#?       4016
   STATISTICAL ABSTRACT OF U.S., TABLE NO.878,P.547(1971).
REF#?       4017
   STATISTICAL ABSTRACT OF U.S., TABLE NO.875,P.546(1971).
REF#?       4018
   STATISTICAL ABSTRACT OF U.S., TABLE NO.878,P.547(1971).
FTN#?       1005
   IN GENERAL, A UNIT TRAIN HAULS 10,000 T OF COAL PER TRIP (1005,33)

      AND UTILIZES THE EQUIVALENT OF 4, 2400 HP DIESEL LOCOMOTIVES
      (FROM DATA ON MATTHEWS MINE IN (1006)).
      ENERGY CONSUMPTION BY FREIGHT TRAINS, ASSUMED TO APPLY AS
      WELL TO UNIT TRAINS, IS 690 BTU/TMI (FOOTNOTE 7013), OR
      0.005 GAL DIESEL FUEL/TMI (5.86E6 BTU/BBL, 0005,38).
      AN ALL STEEL HOPPER CAR WITH A CAPACITY OF 70 T HAS A GROSS TO
      TARE WEIGHT RATIO OF ABOUT 4/1 (0023,1136). IT IS ASSUMED THAT
      THIS FIGURE HOLDS FOR 100 T CARS AND THAT THE FUEL CONSUMPTION
      PER TRAIN IS AS CITED ABOVE. FROM DATA IN (0021,31) THE ENERGY
      CONSUMPTION ASSUMES AN AVERAGE USAGE OF 3 LOCOMOTIVES PER
      TRAIN.
      THE AVERAGE HAULAGE DISTANCE IS 300 MI (1005,96). HENCE, FUEL
      CONSUMPTION IS 25,000 GAL PER ROUND TRIP OR 1.03E5 GAL/1.0E12
      BTU. THE EMISSION FACTORS ARE COMPUTED FROM (0002,3-7).
      WINDAGE LOSSES, ASSUMED TO BE AIRBORNE AS PARTICULATES, ARE
      ABOUT 1P OF THE TONNAGE HAULED, SINCE THE LOSSES OCCUR MAINLY
      DURING HANDLING AT EITHER ENDPOINT. THEY ARE ESSENTIALLY
      INDEPENDENT OF THE HAULAGE DISTANCE (1056,IV-45). THUS, 410 T
      OF COAL FINES ARE RELEASED AS PARTICULATES FOR EACH 1.0E12 BTU
      HAULED.

      NOTE  HAULAGE BY UNIT TRAIN ACCOUNTS FOR 22P OF THE TOTAL COAL
      MOVEMENT (1004,54).
FTN#?       1006
   THE AVERAGE CAPACITY OF A BARGE IS 25,000 T (1005,34), AND THE
      AVERAGE HAULAGE DISTANCE IS ASSUMED TO BE 300 MI. THE EMISSION
      IS CALCULATED FROM DATA ON MOTORSHIPS UNDERWAY IN (0002,3-11).
      THE WINDAGE LOSSES, OCCURING MAINLY FROM HANDLING AT THE
      ORIGIN AND TERMINAL POINTS, ARE ASSUMED TO BE 1P OF THE TOTAL
      SHIPMENT AS IN THE CASE FOR UNIT TRAINS. THUS, 410 T OF COAL
      FINES ARE EMITTED AS PARTICULATES. (FOOTNOTE 1005)
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APPENDIX B

Energy System Network Modeling
(abstract from BNL-21545; See Appendix B)

To supplement the utility of the EMDB for use in modeling calculations, the network of processes in the energy system has been structured into a set of links and nodes which completely define the flow through the network. With this link-node structure, all trajectories connecting specific resources to specific end-uses can be defined for all or any part of the national energy system. The links have been identified with the basic process units in the EMDB, and any or all of the values in each unit can be associated with the proper link. Two programs, one called the Energy System Network Simulator (ESNS) and the other called the Energy System Generator (ESYG), have been developed (each serving a different purpose) to calculate energy flows and to sum up effects through any desired set of sub-systems or set of trajectories under different assumptions of growth rate, conservation policy, technological change, etc., allowing the impact of various policy options to be determined.

Figure 10 shows the supply process network for the ESNS flow model for the fossil fuel sub-systems, including an array of future fossil energy technologies, such as coal gasification, liquefaction, and methanol production, and shale oil development. The nuclear contribution to the national energy supply system, noted in two simple links in the upper right-hand corner, has been developed into a full set of process links defining the complete nuclear fuel cycle. The documented numeric data for this sub-system are already in the data base. Sub-systems for geothermal and solar energy have also been prepared, and the process data have been collected, documented and inserted into the EMDB. Examination of the figure will give some idea of the richness of technological detail available in the EMDB. It should be noted that most of the current technology supply processes

B-2

NATIONAL ENERGY SYSTEM SUPPLY PROCESS NETWORK

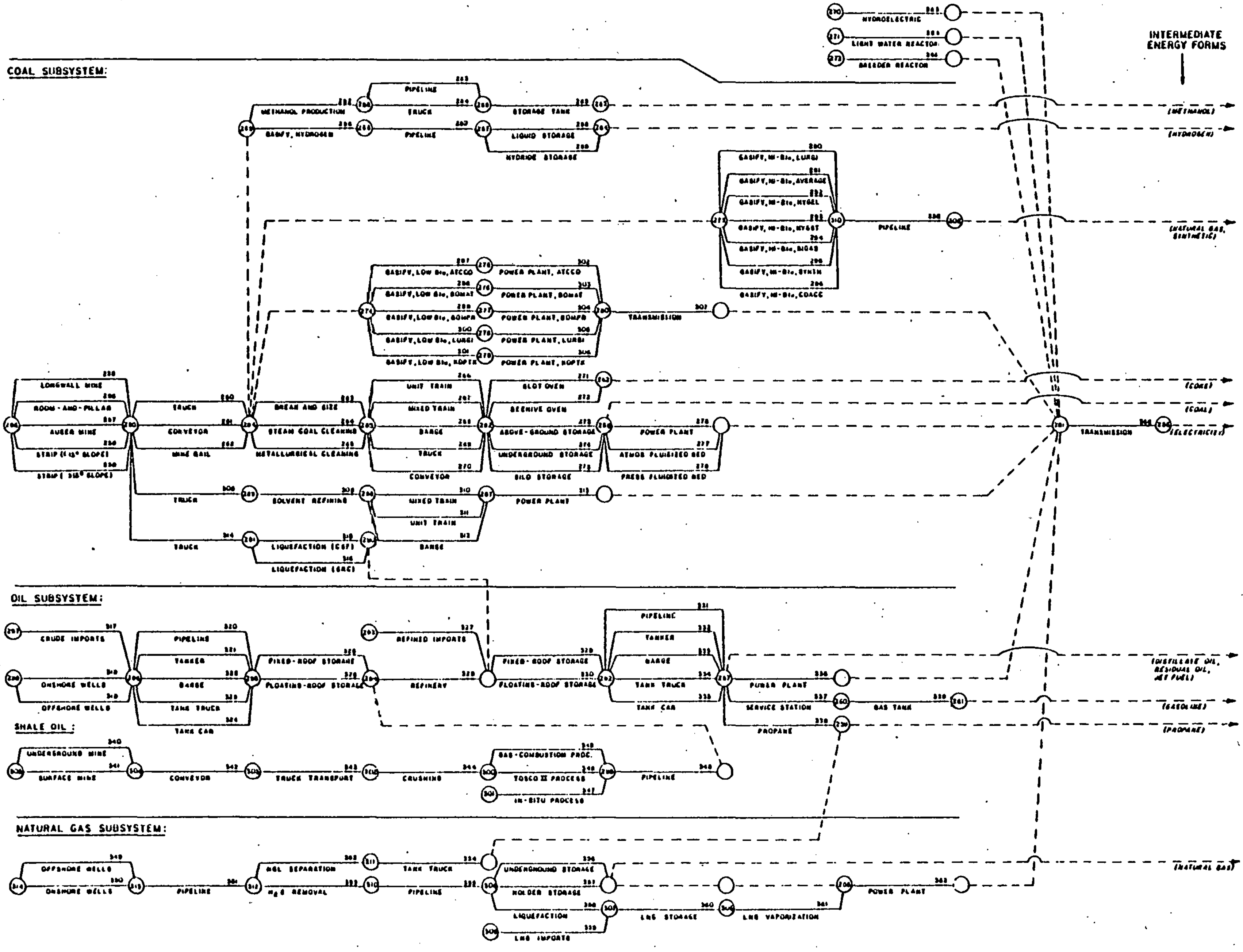

Figure 10

are represented by a number of blocks. These represent the differences resulting from regional characteristics of the resource or from the emission control strategy employed. For example, coals representing national average, northwest, southwest, central, northern Appalachian and central Appalachian coals are separately given. Likewise, environmental emission controls are given, when available, for both current standard practice (UNCONTROLLED) and for full application of best available controls (CONTROLLED).

For many policy applications, the level of detail involved in the full ESNS process network is not needed. Figure 11 displays a network in which the processes for a given supply activity have been aggregated to the level of that activity, i.e., there is only one link for the transport of crude oil rather than the five (pipeline, tanker, barge, etc.) of the process-level network. The utilization processes have been aggregated to the same set of end-use demands which drive the Brookhaven Reference Energy System. The input data for this network are not listed or documented in the EMDB since they are simply the weighted sum of the element values from the data base for all of the process included in the activity.

With either the full process-level network or the simplified activity-level network, the ESNS model provides the capability to explore a vast array of user-provided energy system modifications swiftly. Availability of an interactive program, called Interactive Remote Access To ESNS (IRATE), allows use of the model by those who have only a minimal acquaintance with computers.

NATIONAL ENERGY SYSTEM NETWORK FOR *ESS* MODEL

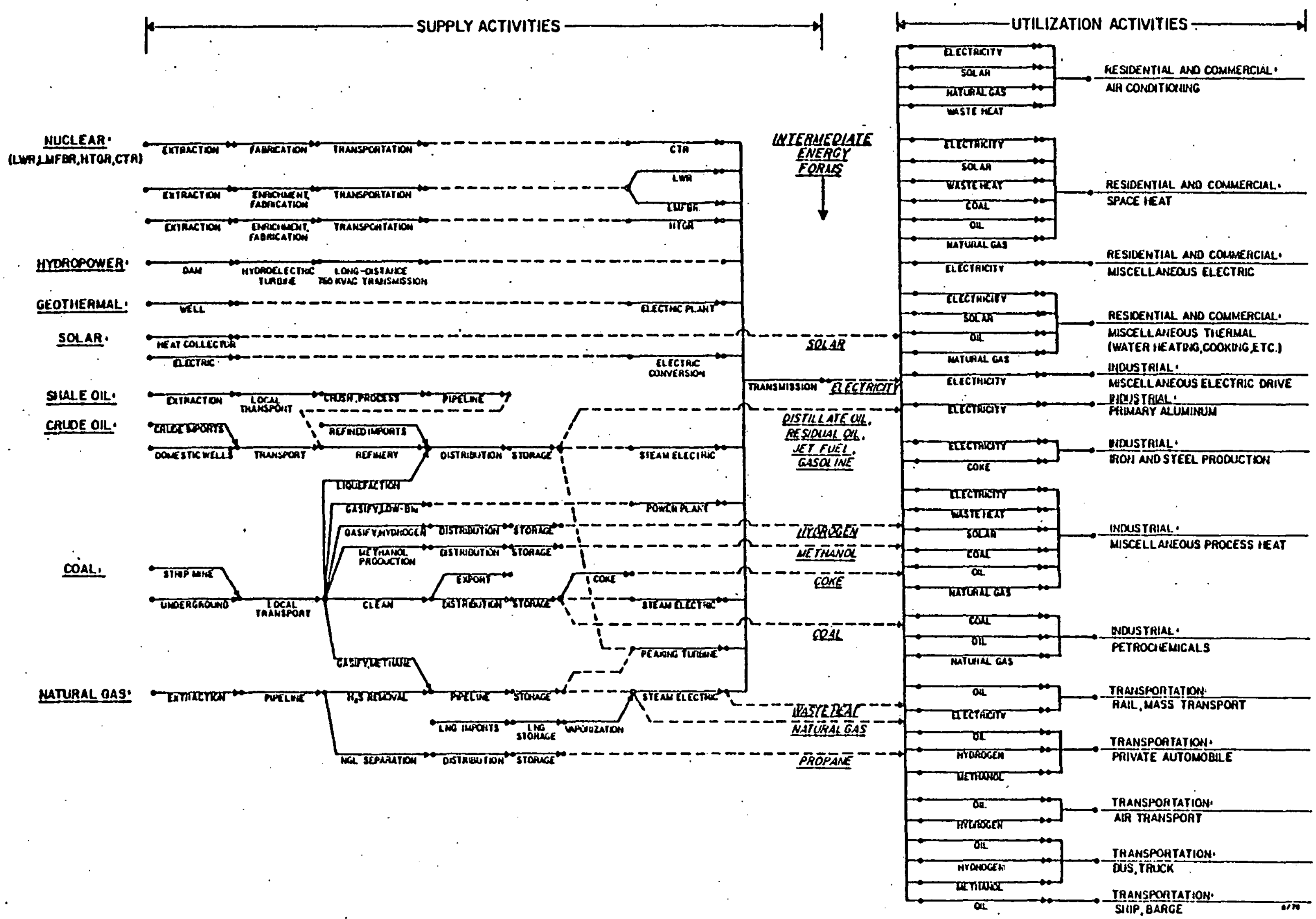

Figure 11