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Survey of Spatial Data Needs and Land Use Forecasting Methods in the Electric Utility Industry

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Survey of Spatial Data Needs and Land Use Forecasting Methods in the Electric Utility Industry

Environmental Systems Research Institute,
380 New York St, Redlands, CA 92373

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Ames Research Center
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NASA
National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

N82-30585#

SUMMARY

A representative sample of the electric utility industry in the United States was surveyed to determine industry need for spatial data and the methods used by the industry to forecast land use changes and future energy demand. Information was acquired through interviews, written questionnaires, and reports (both published and internal). Interviews were conducted with personnel at Houston Lighting and Power, Pacific Gas and Electric Company, Pennsylvania Power and Light, and Southern California Edison Company. Questionnaires were sent to 33 additional companies across the United States.

General conclusions of this study are:

- Spatial data are used primarily for siting and environmental analysis functions within the industry. Small utilities perform these functions at a site-specific level in response to needs. Large utilities are investigating the use of automated GIS techniques to perform at least parts of the siting analysis function.
- Interest exists in the concept of geographically oriented land use projections for purposes of distribution planning. Energy demand projections are now based on econometric models of regional growth. These could be coupled with land use projections to identify probable new service needs.
- Energy demand projections are currently made based on econometric models which have no spatial reference. These projections are used to satisfy regulatory requirements and to plan for capital investments and rate structures. Although relatively accurate in past years,

econometric models do not now accurately project long range energy demand or sales. Other projected methods would be acceptable if the utilities and regulatory agencies can be shown that new methods provide the needed information.

- Geocoded data are used for billing, facility location and tracking, property management, engineering, distribution planning, and environmental analyses. Several geographic identifier systems are employed by various users of these data.
- The industry is currently investigating potential roles of automated spatial analysis and modeling, and also new sources of spatial data. Automated cartography is now being adopted as a cost-effective methodology throughout the industry.

Electrical utilities can be subdivided according to that portion of the service they provide:

- Generating companies provide power;
- Transmission companies maintain major transmission lines;
- Distribution companies purchase power and distribute it to the comsumer;
- Complete utilities perform all of the previous functions; and
- Power pools consist of two or more companies which have linked their systems to distribute power regionally.

Functional or generic groups within the industry which use spatial data include:

- The customer service and billing group, which is the customer interface. This group maintains a large address-based data file which includes billings, consumption, descriptive and historic use data.

- The operations and management group maintains dependable power and manages the company's facilities. This group uses site-specific, schematic-specific and facility-specific spatial information. Some of this information is automated in larger companies.
- The real estate/legal group manages companies-controlled lands. This includes parcel tracking and valuation, development planning, capability/suitability analysis, first-cut siting of facilities, and management of timberlands, recreation facilities and other lands and activities resulting from electric utility management. Data needs vary from parcel-based resolution to small scale watershed and service district resolution.
- The engineering research and development group plans, develops and sites facilities. Spatial data needs are mostly parcel-specific engineering-scale, and are obtained by intensive field surveys. Smaller scale data in the form of side looking Airborne Radar and thermal scanner images are also used for site analysis and thermal plume monitoring.
- The system planning group forecasts system-wide needs for facilities, capabilities and fuels. These forecasts are based on econometric modeling of population/income/climate/appliance mix projections. While most companies use no spatial data in these analyses, those with large service districts allot forecast growth to specific subregions for planning purposes. This is generally done by field representatives, although Houston Lighting and Power is investigating the accuracy and costs of a land use projection model using Landsat input.

- The load forecasting group responds to specific load needs for new development in the field. This is a small-area forecasting process for distribution needs and is largely based on communication with local planning agencies to project near-term future needs. Land use projection models have been tested and found effective for small area forecasting. However, the industry as a whole depends on local planning data rather than change models. A rigorous analysis of areal land use with energy demand has not yet been demonstrated.
- The environmental affairs group projects, tracks and documents environmental conditions and impacts. Data needs vary from point sampling locations to regional environmental quality parameters. Several large companies are developing automated geographic information systems to aid in projecting environmental constraints and opportunities with respect to facility siting.

Current methods of data acquisition are conservative, and depend heavily on site-specific data generated in-house. Data such as small area load forecasts are aggregated by service district and compared to the system-wide forecasts made by the system planning group as a check on validity of assumptions. However, in many companies two or more functional groups are obtaining similar types of information independently-duplicating efforts and costs. This report suggests further investigation of these data types and users with an objective of combining their acquisition in some manner. Spatial data are acquired in the form of maps and low elevation aerial photos. Some functions in some companies also use high elevation photography. Limited use of Landsat data was encountered during this survey.

Primary analyses of spatial data are related to the end products of site capability/suitability for siting facilities, documentation of environmental conditions/impacts/mitigations, projection of regional energy load trends based on historic data, and forecasting system-wide energy demand to plan for capital improvements, fuel needs and rate changes.

The analyses are used in planning to make a variety of administrative decisions. For this reason, they must be communicated effectively to management, investors, public utility commissions, and the public. Communication of the results of analyses is enhanced by the production of maps, other graphic displays, and textual reports.

This survey suggests that considerable savings of time and effort could be obtained within the electric utility industry by linking the geographic data bases which now exist within most of the large companies. These companies are now obtaining automated mapping systems which could serve as the nucleus of a geographic data system which integrates address-based data with parcel-based data with facilities data with land use data, etc. A conceptual integrated system of this type is suggested in the report.

This report identifies several areas which should be investigated with respect to new applications and future research:

Data Sources - It may be possible to improve the timeliness and cost-effectiveness of data acquisition procedures by using remote imagery. Carefully designed classifications could provide land use/land cover data needed by the industry. The thematic mapper may provide the resolution required for most of the analyses which are not site-specific.

Data Analyses - Land use/energy demand correlations should be rigorously investigated in several climatic areas. Remote land use data may be applicable for this investigation. Land use projections by existing and newly designed models should be investigated.

A comprehensive geographic information system should be designed to take advantage of presently used data bases. New data bases could be added to such a system using new sources, such as remote imagery.

Our experience with the electric utility industry to date indicates that although research into new techniques is being conducted throughout the industry, individual companies are conservative in their adoption of technologies and methods. The major criteria for adoption of new methods are:

1. Accuracy - New methods should be at least as accurate as traditional methods.
2. Time Savings - A decrease in the time required to perform a function is desirable, as is timeliness of data for decision-makers.
3. Familiarity - In-house familiarity with the technology is important to its acceptance.
4. Cost - Cost is not necessarily the deciding factor if the other criteria are met.

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Survey of Spatial Data Needs and
Land Use Forecasting Methods
in the Electric Utility Industry

I. Introduction

This report presents the methodology, data and analysis of a survey of spatial data needs within the electric utility industry of the United States. The purpose of the study is to explore the types and sources of spatial data required by the electric utilities, the methods employed to analyze these data, and the specific tasks and decisions toward which these efforts are directed. Special attention was given to the current methods used by the utilities to forecast energy demand changes within their service areas, and the role which spatial data and analysis may have in projection activities.

This study was undertaken in the context of increasing costs for generation and distribution of electric power and a decreasing ability to accurately forecast both long-term and short-range energy demands. Increased costs of generation and transmission are a result of increased costs for fuel, capital investments, maintenance and records keeping/reporting mandated by regulatory agencies. Forecasting accuracy has decreased as a result of the difficulties involved in assessing the effects of energy conservation measures taken by the government, appliance manufacturers, and users. Thus, over the next few years the electric utilities will be faced with a need for more accurate forecasts on which to base capital improvement programs, while simultaneously the traditional trend analysis forecast methods are becoming less accurate, and energy demand is less predictable than it has been in the past.

This study was undertaken to determine both current methods used within the electric utility industry and the potential for using other technologies to provide these data needs and projection capabilities. Large utility companies spend hundreds of thousands of dollars annually to acquire spatial data and an equal amount to annually project energy demand and future energy sales. It is possible that new technologies (e.g., Landsat) could be shown to be more accurate or cost-effective than traditional methods. If this can be established, the electric utilities would be well served by new technologies. In addition, linking existing automated geocoded files with one another, and adding new geocodes to existing data, could enable utilities to use more efficiently the data which they now collect in several departments for several specific purposes.

General conclusions of this study are:

- Spatial data are used primarily for siting and environmental analysis functions within the industry. Small utilities perform these functions at a site-specific level in response to needs. Large utilities are investigating the use of automated GIS techniques to perform at least parts of the siting analysis function.
- Interest exists in the concept of geographically oriented land use projections for purposes of distribution planning. Energy demand projections are now based on econometric models of regional growth. These could be coupled with land use projections to identify probable new service needs.
- Energy demand projections are currently made based on econometric models which have no spatial reference. These projections are used to satisfy regulatory requirements and to plan for capital investments and rate structures. Although relatively accurate in past years, econometric models do not now accurately project long range

energy demand or sales. Other projected methods would be acceptable if the utilities and regulatory agencies can be shown that new methods provide the needed information.

- Geocoded data are used for billing, facility location and tracking, property management, engineering, distribution planning, and environmental analyses. Several geographic identifier systems are employed by various users of these data.
- The industry is currently investigating potential roles of automated spatial analysis and modeling, and also new sources of spatial data. Automated cartography is now being adopted as a cost-effective methodology throughout the industry.

This report has been prepared in two volumes. The Final Report summarizes the data obtained during the survey, presents various analyses, and identifies considerations of importance to the acquisition and use of spatial data within the electric utility industry. The second volume is a set of three appendices, and includes the written original data obtained from the interviews and mail surveys. Also included are a series of geographic data bases which are now employed by several companies.

II. Description of User Group Responsibilities

The electric utility industry in the United States has as its principal responsibility the provision of reliable electric power to their customers. It includes both publicly owned and privately owned utilities. The distribution of ownership by the public and private utilities as of the end of 1979 is as described in Table II-1.

As evidenced in Table II-1, the electric utilities can also be grouped according to their specific functional responsibilities. Some are generators of electric power, some transmit power from source to distributor, others purchase power from transmission companies and retail it to end users. Some utilities have joined their systems to form 15 regional power pools in order to distribute their generating capacities more efficiently among end users. These power pools are listed in Table II-2. Power pools include the basic elements of power generation, transmission and retail sales. Power can be diverted from one member utility with excess capacity to another member utility experiencing excess load demand. Such transfers represent power purchased by the consumer utilities which are coordinated through the physical and economic organization of the power pool.

In most cases, a single administrative entity is organized to provide all components of the electric utility from power generation to retailing, meter reading and billing. Such utilities range in size from small, community-oriented utilities serving hundred or a few thousands of customers, to the vast regional utilities serving several millions of customers.

The specific administrative organization of each company reflects its perceived planning needs and therefore differs from the organization

Table II-1
Ownership of Electric Utilities

Number	Type of Ownership
12	Non-Operating Holding Companies
20	Wholesale Generating Companies
12	Service Companies
18	Divisions
240	Investor-Owned Companies
1,753	Municipal Systems
936	Rural Electric Cooperatives
66	Public Power Districts
8	Irrigation Districts
41	U. S. Government
56	State
4	County Systems
7	Mutual Systems
3	Transmissions

Table II-2
Power Pools

Central Area Power Coordination Group
(CAPCO)
48 First St., NE
Massillon, Ohio 44701

Connecticut Valley Electric Exchange
(CONVEX)
PO Box 248
Southington, Connecticut 06489

Florida Electric Power Coordinating Group
(FCG)
402 Reo St., Suite 214
Tampa, Florida 33609

Michigan Electric Coordinated Systems
1901 Wagner Rd.
Ann Arbor, Michigan 48103

Mid-Continent Area Power Pool
(MAPP)
MAPP Coordination Center
1250 Soo Line Building
Minneapolis, Minnesota 55402

Missouri Basin Systems Group
(MBSG)
950 Big Thompson Avenue
Box 2327
Estes Park, Colorado 80517

Missouri-Kansas Pool
(MOKAN)
1330 Baltimore Avenue
Kansas City, Missouri 64116

New England Power Exchange
(NEPEX)
174 Brush Hill Avenue
West Springfield, Massachusetts 01089

New England Planning (NEPLAN)
174 Brush Hill Avenue
West Springfield, Massachusetts 01089

Table II-2 - (continued)

New England Planning
(NEPLAN)
174 Brush Hill Avenue
West Springfield, Massachusetts 01089

New Mexico Power Pool
PO Box 2267
Albuquerque, New Mexico 87103

New York Power Pool
(NYPP)
3890 Carmen Road
Schenectady, New York 12303

Northwest Power Pool
430 Public Service Building
Portland, Oregon 97204

Pennsylvania-New Jersey-Maryland Interconnection
(PJM)
955 Jefferson Avenue
Valley Forge Corporate Center
Norristown, Pennsylvania 19403

Rhode Island-Eastern Mass-Vermont Electric Council
(REMVEC)
Turnpike Road
Westborough, Massachusetts 01581

Wisconsin Power Pool
122 W. Washington Avenue
Madison, Wisconsin 53703

of others. Figures II-1 and II-2 illustrate two such administrative organizations. Despite this lack of organizational consistency from company to company, several major groups using spatially-oriented data have been identified which are common to the industry as a whole. These groups are functional in nature, and do not necessarily correspond directly with the administrative departments of any given utility company. These groups are listed in Table II-3, and a brief description of the responsibilities of each group is given in the following paragraphs.

Customer Service and Billing - This group is responsible for direct contacts with customers. New connections as well as repair requests are initiated through customer service. Calculation of power use and rates to be applied comprise the billing function. This group is also responsible for identifying and reacting to special customer needs, particularly those customers who depend on electric service to maintaining power health-related appliances. Top priority is assigned to maintain to hospitals and other such critical-use customers. Customer service and billing provides the required service by communicating work orders to the operations and maintenance group. This group also maintains power use summaries (sales, etc./transformer).

Operations and Maintenance - This group is responsible for operating and maintaining electric generation and distribution facilities throughout the service area. New connections and some distribution maintenance functions are identified by customer service and billing in the form of work orders. Other maintenance functions include repair of major equipment, scheduled testing and maintenance of generators, transformers, switching devices, etc., and scheduled maintenance of lines

Figure II-1
SOUTHERN CALIFORNIA EDISON EXECUTIVE ORGANIZATION

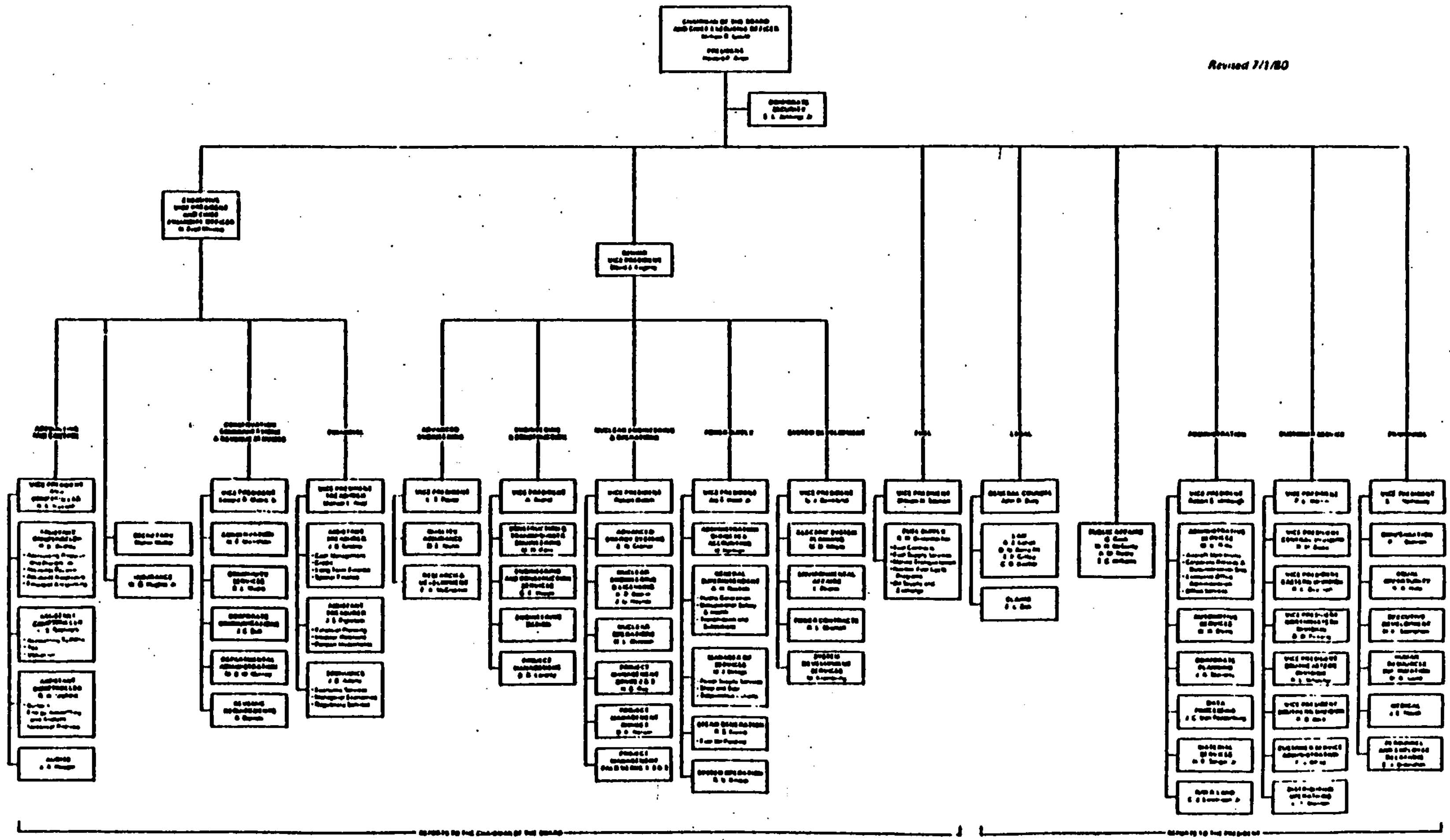


Figure II - 2 PACIFIC GAS AND ELECTRIC COMPAN

ORGANIZATION CHART

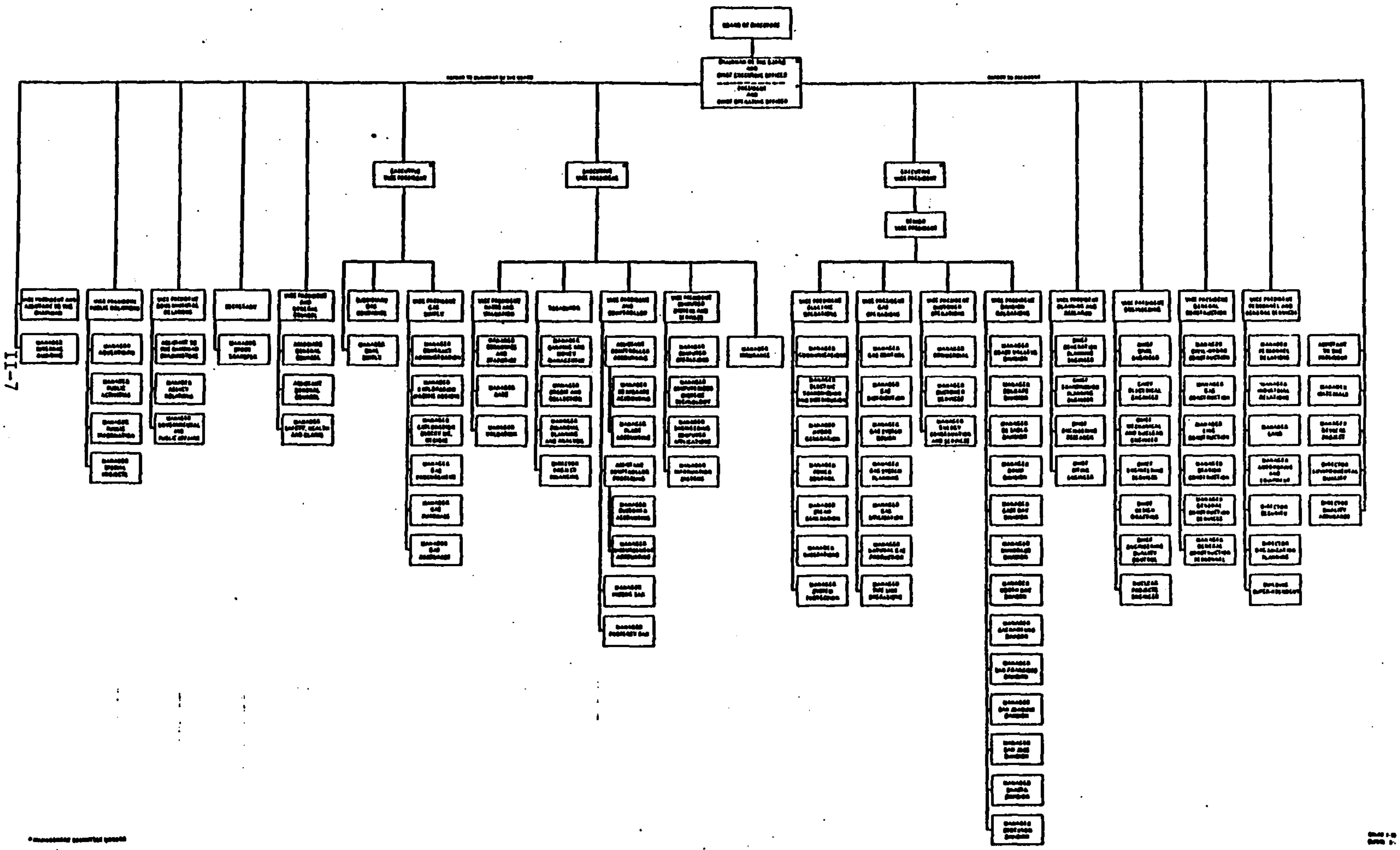


Table II-3
Major Groups Using Spatial Data

Customer Service/Billing

Operations and Maintenance

Property Management - Land

Engineering - R & D

System Planning
- Generation Facilities
- Fuel Supply
- Distribution

Load Forecasting

Environmental Affairs

and poles. Maintenance of lines includes tree trimming and brush removal along the right of way.

Real Estate/Legal - This group is responsible for identifying, acquiring and maintaining all company-controlled lands (both owned and under easement). This includes those lands controlled by the utility as right-of-way, those controlled as facility locations, and those lands controlled for non-energy functions. Large companies may control many acres of watershed, for example, and manage these for a variety of purposes, including hydroelectric power generation, recreation, forestry, etc. In larger companies, this group is often subdivided into an urban land management group and one or more other groups which control non-urban lands. In some companies the property management group is responsible for identifying potential sites and corridors for proposed new facilities.

Engineering/Research and Development - This group is responsible for site-specific engineering of new facilities from generator to substation. These facilities are designed in response to executive decisions based on data from the system planning group. Engineering is responsible for maintaining standards set or agreed to by the industry and the Department of Energy. In addition, this group tests and provides required maintenance at scheduled intervals for major facilities. In a few facilities (e.g., Pacific Gas and Electric and Duke Power) a research and development program is carried on within this group. This program is focused generally toward metallurgy, fuels, and materials. The electric utility industry as a whole supports continuing research and development through the Electric Power Research Institute

(EPRI) in Palo Alto, California.

Because they engineer both the site improvements and construction of proposed facilities, the engineering group often is also responsible for preparation of required environmental impact statements and documentation.

System Planning - This group is responsible for determining the need for changes in generation facilities, fuel acquisitions and distribution systems. This group provides executive decision-makers with data regarding availability and costs of purchased power, fuels and properties which can be developed to generate electric power. The actual decision to construct facilities or purchase additional power is made at the executive level. Distribution planning relies on field knowledge of projected areas of new development.

Load Forecasting - This group is responsible for projecting energy demand on the components of the distribution system. Short-term (annual) system-wide energy demand forecasts are used as the basis for these projections using data from prior years to determine demand rates. Small area forecasting is generally short-term in nature and is based on population projections for the sub-areas of the system. Small area forecasts serve to highlight potentially fast-developing regions and initiate preliminary planning for additional service facilities. The load forecasting group determines the need for additional services lines, transformers, and switching networks to mitigate potential circuit overloads.

Environmental Affairs - This group is responsible for general siting of potential facilities and corridors in such a manner that potential environmental concerns are minimized. Rather than preparing Environmental Impact Statements (EIS) based on detailed projects, the environmental affairs group works with existing conditions and projected land use to identify potential conflicts in siting facilities. In some utility companies this group oversees the preparation of the EIS by the engineering group and then directs the public review and analysis of the document. Environmental affairs is also responsible for providing data on potential conflicts to regulatory agencies.

III. Survey Procedure

This survey of data needs was conducted using three types of activities: personal interviews, telephone interviews, and mail-out questionnaires. During the course of the survey, the value of using a personal interview process was increased as it became apparent that mail-out questionnaires were generally answered by a single individual in a given company and, therefore, often lacked the depth of reply desired for this study. For this reason, this report emphasizes data gleaned by personal interviews, and uses the mailed questionnaire replies to support these interviews.

Each of the companies contacted during this survey had expressed an interest in the use of automated geographic information systems and/or Landsat technology. The major criterion for contacting these companies was the relative ease of communication between the company and the survey team. The companies contacted are a cross-section which is representative of the electrical utilities in the U. S. Figure III-1 illustrates the locations of all companies contacted during the course of this survey. The organizations selected for participation in the survey are listed on Table III-1. The organization addresses and persons contacted are listed in Appendix B.

Personal interviews were conducted at Pacific Gas and Electric Company (PG & E) in San Francisco, Southern California Edison Company (SCE) in Rosemead, Houston Lighting and Power (HLP) in Texas, and Pennsylvania Power and Light (PP & L) in Allentown. Initial contacts were made with each company by telephone, and an interview appointment was made. At PG & E and SCE an initial interview was conducted to determine those groups within these organizations, which use spatial data, and individuals within these groups who should be contacted. A

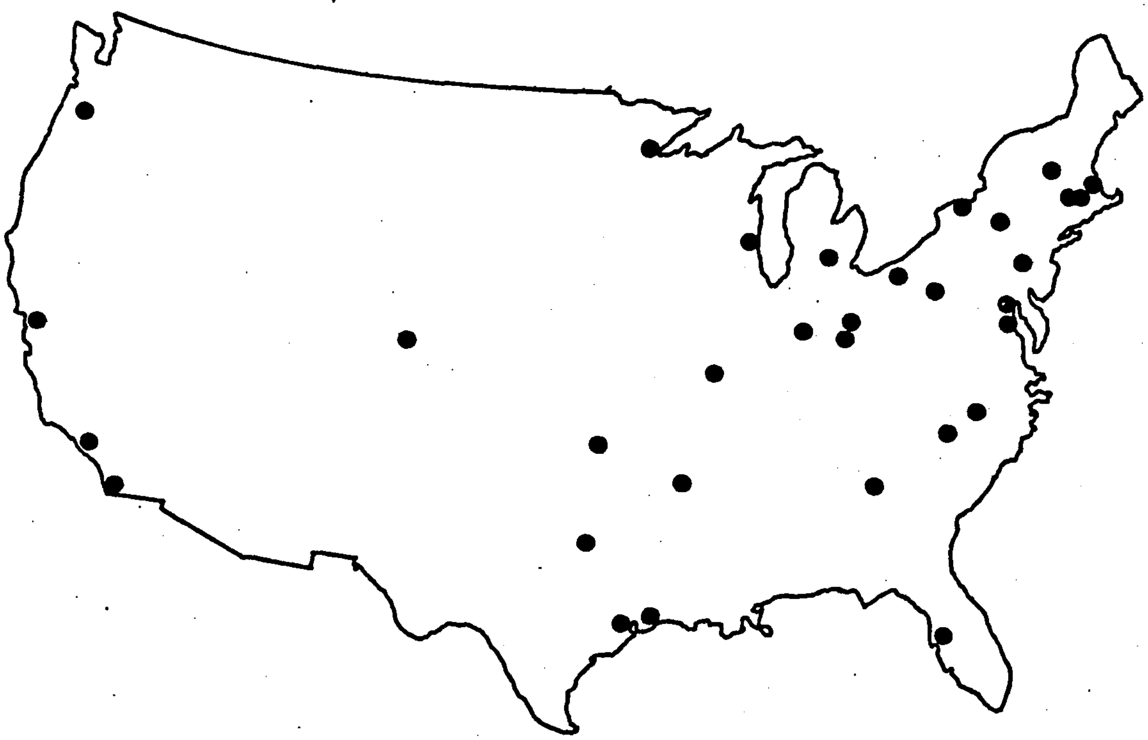


FIGURE III-1

Locations of Electric Utilities Surveyed

Table III-1

ORGANIZATIONS SELECTED FOR PARTICIPATION

Public Service of Oklahoma	Commonwealth Edison
Public Service of Colorado	Florida Power and Light
Portland General Electric	Niagara/Mohawk Power
San Diego Gas and Light	Atlantic City Electric
Florida Power	Virginia Electric and Power
Colorado and So. Ohio Electric	Long Island Lighting
Pennsylvania Power and Light	Rhode Island/Massachusetts/Vermont Energy
Georgia Power	Middle South Services, Inc.
Potomac Electric	Pacific Gas and Electric
Baltimore Gas and Electric	Public Service of New Mexico
Carolina Power and Light	Union Electric
Texas Utility Services, Inc.	Tampa Electric
Iowa/Illinois Gas and Light	Southern County Services
Detroit Edison	New England Power Exchange
Northern States Power	Toledo Edison
Northern Indiana Public Services	New York State Gas and Electric
Cleveland Electric	Boston Edison
Duquesne Light Co.	Arkansas Power and Light
New England Gas and Electric	Public Service of Indiana
Philadelphia Electric	Gulf States Utilities
United Illumination Co.	New York Power Pool
Texas Power and Light	Ohio Edison
Indianapolis Power and Light	Dayton Power and Light
Houston Light and Power	Duke Power Co.
General Public Utility Services	New England Electric System
Central Vermont Public Services	Minnesota Power and Light
Consolidated Edison Co.	Consumers Power Company
Cincinnati Gas and Light	Wisconsin Electric Power
Otter Tail Power Co.	Pacific Power and Light
Rochester Gas and Electric	Allegheny Power System
Virginia Electric and Power	Baltimore Gas and Electric

second series of interviews was then scheduled with representatives of the specific user departments to determine their data needs and analysis capabilities. At HLP and PP & L, a single series of interviews was scheduled with groups known to be using spatial data.

After the initial PG & E and SCE interviews, a questionnaire (Figure III-2) was designed and used to insure that all necessary data items were obtained by the follow-up interviews. Additional notes were taken where appropriate, and subsequently summarized.

As information was obtained from the interview process and analyzed, a mail-out questionnaire (Figure III-3) was designed. The design was intended to simplify responses while simultaneously obtaining information about the spatial data needs and capabilities of the utilities. A description of the Landsat-MSS system was included as an appendix to each questionnaire.

Selection of utilities to receive the questionnaire was based on a list of organizations represented at a conference sponsored by the Edison Electric Institute.* Each utility was contacted by telephone and several departments were identified as appropriate responders to the questionnaire. A single individual was identified to be responsible for the questionnaire. The questionnaire was then sent with a cover letter explaining the purpose of the survey and requesting a timely response.

*EEI in Washington, D. C. functions as the lobbying arm of the privately owned utilities in the U.S.

Figure III-2
Personnel Interview Questionnaire

Name of Interviewer:____________________
Date:____________________________________
Time: Start:________End:________________

A. ADMINISTRATIVE

1. Name the organization being interviewed.

2. Name(s) of individual(s) being interviewed.

3. What is the location and size of the service area of this organization?

   ______________________________(sq. miles, acres, other)

4. Approximately how many customers are served?

   _________________________Residential
   _________________________Commercial
   _________________________Government/Institutional
   _________________________Industrial
   _________________________Other

5. What specific responsibilities does this utility have to the communities served?

6. Describe the basic organizational structure of the utility. Obtain a management chart if available. If not, diagram relationships between departments.

7. What are the specific responsibilities of each department?

8. Within each department, what operational decisions require spatial data?

B. <u>DATA TYPES AND ACQUISITION</u>

1. Name or describe the current types of spatial data in use.

<u>Maps</u> <u>Tabular Data</u>

2. List the sources of this data.

What portion is generated in-house?

What portion is acquired outside the utility?

3. What classes/categories are used to subdivide spatial data?

4. Describe the scale and locational accuracy of the mapped data which is currently used (i.e., placement of features with respect to surrounding features).

5. Describe the temporal accuracy of the mapped data which is currently used (i.e., how up-to-date is it?).

6. Describe the extent of coverage currently available from mapped data (localized, regional, statewide?).

7. What is the approximate annual cost of spatial data acquisition?

8. What is the frequency of updating of mapped information? Is this frequency adequate for the needs of this department?

9. Does this utility (or department) use remotely sensed data? If so, describe how it was used and potential future uses. If not, is there a perceived need for such data?*

10. Does this utility use automated geographic data (digitized files) handling procedures? Which data categories are included in these files? Do the files cover the entire service area?

---

* See attached description of Landsat.

C. <u>DATA ANALYSIS AND UTILIZATION</u>

1. Which departments within the organization utilize land use/land cover data?

2. How are these data used to support the decision-making processes?

3. Describe the types of modelling (e.g., econometric, weighted overlay analysis) that are being done. Use flow diagrams and describe methods used.

4. What type of trend analysis or forecasting methods are currently used?

5. What are the factors limiting the use of land use/land cover data by your department and others? Which factors are the most important limitations?

6. Identify potential users of land use/land cover data if these data types were automated.

D. DATA PROCESSING SYSTEMS

1. Identify the automated types of spatial data currently used. How many systems and files are currently employed?

2. Is spatial data automation done in-house? Describe. How many personnel are engaged in this task?

3. Describe the hardware/software configuration currently used. Specify the model of computer used.

4. How are data files maintained and updated?

5. Are the data files tied to an x,y coordinate reference?

6. Can stored data planes be overlaid using an automated technique?

7. Are image processing and classification capabilities being used or investigated?

Figure III-3.
Mail Survey Questionnaire

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company______________________________

2. Respondent's Name______________________________

Title______________________________

Address______________________________

Contact Telephone______________________________

3. Describe the service area of the company:
   Size (sq. miles/acres, etc.)____________________

   Location (include sketch map if available)__________

   Number of customers:
   - Residential______________________________
   - Commercial______________________________
   - Gov't/Institutional________________________
   - Industrial______________________________
   - Other______________________________

4. Indicate (X) which of the following responsibilities are required of this company.

   ( ) Provide adequate power for existing users
   ( ) Provide adequate power for projected future users
   ( ) Promote efficient power use
   ( ) Minimize adverse impacts to environment
   ( ) Allow public agencies access to data for planning
   ( ) Other:______________________________

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area			
( ) Census			
( ) Economic			
( ) Land Use			
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   ( ) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   ( ) Accurate enough for small-area analysis and demand projections
   ( ) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial data acquisition?

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
( ) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons:
( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis:

System-wide Analysis:

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

( ) Availability of source data
( ) Data at appropriate scale
( ) Base map precision
( ) Data not kept current
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
( ) Time
( ) Budget

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ________
( ) Data files are referenced to x,y coordinate system
( ) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files_____________

16. Describe your current hardware/software configuration. Specify model of computer.

IV. Description of User Data Needs

To fulfill their responsibilities, the user groups identified in Section II must acquire and maintain a variety of data types for reference and use. The types of data range from address-specific information to system-wide summaries of aggregated information. In general, the types of data needed by the user groups are similar from one company to the next. This is because their operating procedures for fulfilling responsibilities are also similar. Specific data items and methods of acquisition, however, differ throughout the industry.

It should be noted that not all utility companies perform all tasks identified in this report. Some companies, for example, purchase power from transmission companies and are not directly responsible for generation. Other companies generate or transmit power and are not responsible for maintenance of local consumer networks. However, each company has at a minimum a service and billing function, and must also fulfill the other identified responsibilities throughout the system.

This section discusses each of the identified user groups and the types of data required to fulfill its functional responsibilities. For each group, general and specific function are identified, operating procedures used to fulfill these functions are listed, and appropriate geographic data types are summarized, along with typical geocoding systems. These data are presented in the form of a matrix for each user group, and summarized at the conclusion of this section. These data have been identified by analysis of both personal interviews (Appendix A) and responses to questionnaires (Appendix B). In addition, reference has been made to a survey* by Boeing Computer Services Company to assess requirements for a distribution data base design.

*Boeing Computer Services Company, 1979. Distribution Data Base Design, EPRI report EL-1150. Volumes 1-3

A. Customer Service/Billing

This user group is the direct interface with the consumer of electric power. General functions of this group include providing service to customers, billing customers for power consumed, and maintaining summaries of power use and sales.

In order to provide efficient service to customers, this user group must provide meter connections as needed, identify and plan for service to new developments, prioritize customers based on critical need and rate structure classifications, and maintain reliable electric service to customers. Specific operating procedures which are used to accomplish these functions are identified in Table IV-1. These can be broken into procedures which facilitate communication between the customer and utility work crews, and procedures which relate to classifying, storing, sorting and recalling characteristics of customers. The former group of functions is handled by a telephone and work-order staff in the utilities, with automated processing of work orders based on address or DIME files and a priority system at the larger customer service companies. The latter function requires maintenance of a comprehensive data base which includes identifiers for location or address, customer type, location within the power distribution network, and a variety of special flags. These data bases are generally sorted by address to respond to customer requests. They may be sorted by other fields, however, to list critical use customers, all customers within a specific portion of the distribution network, customers with certain appliance types, etc. Due to the address-specific nature of these data, such files are maintained for internal company use only, and are not accessible outside of the company.

To facilitate the billing function, specific customer power use must be determined - usually by reading meters - the power used must be determined, and a rate applied to that usage. Regularly scheduled routes are generally used to read meters. The meter number and present reading are recorded and compared with the data base of prior readings to determine consumption. The meter number is cross-referenced to a rate schedule which has been determined previously. This information is used to produce a periodic billing for the customer. Each periodic rate is also stored as an incremental unit of data, as well as summarized over a given reporting period (e.g., quarterly, annually). The only locational parameters needed for the billing function are customer billing address and meter location (usually address).

Because this group collects, maintains and uses data on power sales and usage rates throughout the system, it is also responsible for summarizing these data for defined reporting periods. Summaries of power sales - and trends in sales from one period to the next - are compiled and maintained as an adjunct to the billing function. These summaries are used to determine appropriate rate structures, total power consumption by area, and future power needs.

Table IV-2 lists the geographic data types used for the customer service/billing functions.

Table V-1

USER GROUP: Customer Service/Billing

GENERAL FUNCTION	SPECIFIC FUNCTION	OPERATING PROCEDURES	DATA ITEMS	GEOCODES
Provide service to utility costomers	Provide meter connections	Install meters, and connect to mains	Meter numbers/ addresses	Address
	Install service for new developments	Cooperate with developer on installation of cable, transformers, etc., and provide meters	Small area distribution system	Parcel & Tract
	Identify customers with critical need	Flag customers with critical need (e.g., hospitals)	Type of customer, Priority	Address
	Determine customer classification	Identify type of customer	Type of customer, appliances used	Address
	Maintain service	Identify needed maintenance & issue work order	Location of malfunction Nature of malfunction	Street address Transformer location Circuit grid location Sèrvice district
Billing	Bill users for power used	Read meters, bill according to amount, customer classification, contracts	Meter reading Billing address by meter	Meter location Mailing Address
Power use summaries	Summarize power use	Calculate power uses as a function of electrical sales per transformer unit	Total billings-address Small are power use	Service district

Table IV-2

Geographic Data Items
Required by
Customer Service/Billing

Date Type	Geocode
Meter locations	Address, descriptive location
Customer Service Location	Address
Billing Location	Address
Customer by Type or Class	Address, transformer ID
Transformer location	Address, X,Y coordinate service district
Location of New Developments	Address, Parcel and Tract, Legal Description

B. Operations and Management

This user group is responsible for operating and maintaining the equipment used to generate, transmit, and distribute electric power to customers of the company. General functions of this group can be subdivided into the physically different functions of generation of power and its distribution to customers. Generation operations are regulated by a number of agencies including Federal (Department of Energy, Environmental Protection Agency, Nuclear Regulatory Agency), State (Public Utility Commission, Regional Air/Water Quality Control Boards, Coastal Zone Commission, etc.), and local (Municipal/County General Plans, Zoning, easement requirements, etc.).

Table IV-3 identifies the specific functions used to satisfy these responsibilities. In order to maintain and operate the physical system, this group must monitor sources of fuel (and water for hydroelectric facilities), electrical load, and the physical condition of facilities. New equipment is installed as required and funded by management decisions. Line maintenance includes field crews which check for breaks in cables, insulation and dielectrics, clean and repair equipment, and clear vegetation from lines, poles and towers. Crews also maintain substation equipment, set manually-controlled switches, and reset automatic circuit breakers and switches. Operations and maintenance also responds to work orders originated by the customer service and engineering user groups.

Both tracking and locational data types are required to perform the specific functions of the operations and maintenance group. Tracking in real time of power load and residual capacity, switch settings and operating conditions requires a variety of automated sensors, displays and servomechanisms which monitor major generation and distribution dynamics. These automated systems generally may be overridden by the operator when such activity is required. Manufacturers, engineering departments and regulatory commissions have established testing and maintenance schedules for all critical components of the generation and distribution systems. Utilities such as PG & E maintain a data base which is sorted by test/ maintenance data. When the required date is reached, the system prints a work order which identifies the part, part number, location, and type of maintenance needed.

Locational data are used to identify specific sites of needed operations/ maintenance activities. These include the geographic locations of potential hazards to the operation (e.g., earthquake epicenters) and areas sensitive to operations (e.g., air quality control basins, downstream conditions). Many of these more obvious constraints on operations are addressed during engineering and siting of the facilities, however, the operations group often becomes responsible for monitoring these constraints. In the case of effluents, other groups (such as EPA and regional administrative units) are also monitoring ambient conditions. Utilities are also responsible for monitoring and controlling effluents which may adversely affect ambient conditions.

For operation of hydroelectric facilities, the location and quantity of precipitation are needed in order to project the amount of generating capacity available. In addition, parameters which influence the rates of runoff and siltation are required in order to calculate potential water availability. These parameters include vegetation, soil types, slope gradients and stream channel characteristics. Most utilities with hydroelectric capacity maintain a data base of topographic maps which have overlays of these paremeters. Precipitation is monitored by standard weather stations at key locations.

Distribution maintenance functions require a data base which contains the location and characteristics of each piece of equipment regarding maintenance. Companies are now using automated map systems to create and maintain such a data base for this user group as well as the real estate/legal group. These data bases are being digitized at a large scale (e.g., 1" = 100'), primarily on stand-alone map graphics systems such as CADCOM. An interesting problem, identified by Pennsylvania Power and Light is the lag time between construction of new transmission lines and updating small scale (e.g., 1" = 24,000") maps of their location. The small scale maps are used for identifying maintenance routes and other planning functions which often must begin before these updates become available. Updating of the locational component of the distribution network by interpreting aerial photographs or other remote imagery is being explored by PP & L.

Geographic data types utilized by the operations and maintenance functions are identified in Table IV-4.

Table IV-3

USER GROUP: Operations and Maintenance

General Function	Specific Function	Operating Procedures	Data Items	Geocodes
Generation operation	Operation of fossil/ nuclear plants	Monitoring of load fuel supply, and plant conditions; air pollutant levels, seismic activity	Transformer/substation load and capacity Fuel supply/availability Operating conditions Air Quality Seismic activity	Distribution network Plant-downwind area Regional
	Operation of hydroelectric plants	Monitoring of runoff and operating conditions, and compliance with downstream water delivery requirements. Maintain hydraulic head.	Stream gaging station reports Precipitation Land Cover Downstream flows Sediment loads	Watershed/stream segment Polygon Stream segment
Distribution network operation	Substation operation and feeder switching	Small area loads on "real time" basis, estimate power losses	Transformer loads "Use v.s. sales"	Distribution network
	Line maintenance	Maintain power lines and poles; tree trimming	Rights-of-way status	Distribution network
	Installation of new equipment/facilities	Provide necessary transformer substation and related facilities according to engineering plans Respond to work orders initiated elsewhere	Location of facilities	Distribution network

Table IV-4

Geographic
Data Items Required by
Operations and Maintenance

Date Type	Geocode
Location of Facilities, rights-of-way	Address X,Y Coordinates
Geologic, Vegetation, Environmental Data	X,Y Coordinates

C. Real Estate/Legal

This user group is responsible for acquiring, managing and administering lands and easements controlled by the company. As such, it has direct involvement in several geographic data types and analyses. Specific functions of this group include maintaining an inventory of all lands owned or controlled, developing management plans for these lands based on company priorities, implementing approved management plans, and investigating purchase and title options. This group is also responsible for inventorying and documenting property for tax purposes.

Table IV-5 illustrates the procedures used to accomplish specific functions of the Real Estate/Legal user group, and the data requirements for each procedure. Typical geographic codes associated with each data type are also identified.

In order to inventory all property controlled by the utility, a file of property records must be maintained and updated as changes occur. Property records are geocoded according to the parcel identifier system used within the area of ownership (e.g., assessor's record number, or other assessor's ID). In some files, parcels are also geocoded according to the company service district or map unit in which they occur. By referencing the legal description, X,Y locations based on survey monument data can be determined. Urban lands controlled and managed by PG & E are being included in the digitized map files now under development for each of its 13 geographic divisions.

To assess the value of land, the company must also assess the value of taxable resources which the parcels support. Assessed values for site improvements are based on studies of market values for comparable improvements and properties with similar surroundings. Thus, knowledge of adjacent land uses is also necessary to adequately assess the value of a parcel. Surrounding land uses are generally determined in the field and recorded descriptively in the data records for each parcel. Updating of land use records is generally done in response to legal or management requirements for reassessment of property values. In the case of watershed managed for timber production, recent changes in California tax law now allow deductions for the value of unharvested standing timber. PG & E has committed itself to a 9-year inventory cycle of its productive timber holdings, and an 18-year inventory of its marginal timber lands. These surveys are based on field sample quadrates extrapolated to polygonal areas determined by interpretation of aerial photography. The result of this data analysis is a series of management unit maps which indicate timber type, harvestable volume, growth potential, topography and access.

In order to develop management plans for utility controlled land, this group must investigate the variety of possible management options, evaluate their potential benefits and costs, and relate these evaluations to the objectives of the utility. Before alternative management plans can be developed, the physical and legal constraints and opportunities of the parcel(s) must be determined. Current use of the site and adjacent parcels, potential changes allowed by zoning or other development plans, and physical/biological characteristics of the site must all be addressed by the final management plan. These required data items are acquired and maintained in the form of maps and map overlays. Several large companies are pursuing map automation programs which will commit all or portions of these data types to computer storage and analysis. Southern California Edison Company is presently digitizing land uses at a scale of 1:24,000 for each of its service districts. These files are being used to evaluate potential conflicts and opportunities which would result from alternative utility management and facility siting programs. Houston Lighting and Power has recently determined that automation of their existing facilities and ownership maps plus planned maps would economically pay for itself during a 3-year period when compared to manual cartographic and storage methods. HLP is beginning a digitizing program based on these economies.

When new facilities have been proposed by a company, perhaps with some locational guidelines, the real estate/legal user group investigates the ownership and feasibility of acquisition of appropriate parcels of land. This function requires a search of ownership records, market analysis and initial contacts with the present owner(s). The data required exist as government records, and are acquired by field personnel with access to the appropriate agencies.

The administration of distribution corridors and rights-of-way requires that potential conflicts with adjacent land uses be resolved in an equitable manner to mitigate conflicts and to satisfy requirements of regulatory agencies. Potential conflicts can be resolved before they actually occur if future land use and development patterns can be projected accurately. This projection is often based on the greatest impact use that could occur given the zoning patterns of parcels near the proposed corridor. Regional representatives frequently respond to development and zoning changes proposed by local and regional planners. These evaluations of potential conflict require parcel, zoning and future plan maps, as well as proposed transmission corridors and facility locations.

Data items required to accomplish the functions of the real estate/ legal user group are identified in Table IV-6.

Table IV-5

USER GROUP: Real Estate/Legal

GENERAL FUNCTION	SPECIFIC FUNCTION	OPERATING PROCEDURES	DATA ITEMS	GEOCODES
Property Management	Inventory utility-owned lands	Inventory all property owned/leased by utility for tax purposes and fiscal analysis (incl. forest)	Property records Standing timber	Parcel Resource management units
	Develop Management Plans	Determine cost-yield benefits, alternatives, constraints	Land Use, Zoning, Plans, management objectives, constraints/opportunities	Parcel, X,Y coordinates, polygon
	Watershed Management a) runoff for hydroelectric b) forestry c) recreation	Maintenance/enhancements of watershed integrity for multiple use	Runoff rate topography/soil/land cover Forest resources - type, age, standing timber (field & remote) Land use, trail network	Watershed Polygon (e.g., 10 acres) Management unit
Acquisition	Recommends and implements acquisition of title/easement	Investigate feasibility of acquiring land for facilities recommended by planning & engineering title search	Land ownership Land use	Parcel
Rights-of-way Administration	Administer transmission corridor rights-of-way	Resolve land-use conflicts regarding corridor placement. Satisfy regulatory requirements	Zoning Future land use Legal property description	Parcel

Table IV-6

Geographic Data Items
Required by Real Estate/Legal

Data Type	Geocode
Property Records	Parcel Numbers, X,Y coordinates, Administrative Unit, Legal Description
Parcel Improvements	Parcel Number, Resource Management Unit, X,Y coordinates
Natural Resources/Conditions	Watershed, X,Y coordinates
Land Ownership	Parcel Number
Land Use	Parcel Number, X,Y coordinates
Zoning	Parcel, X,Y coordinates
Future Land Use	Parcel, X,Y coordinates

D. Engineering/Research and Development

This user group is responsible for the engineering and design of facilities and site improvements constructed by the company. The research and development function for most of the electric utility industry is carried out by the Electric Power Research Institute (EPRI) funded by voluntary contributions from the industry. However, several larger utilities also conduct in-house research and development of devices and techniques. This function requires technical data and significant amounts of computer time and storage. The PG & E Engineering Research division, for example, runs many of its engineering computations at night or during weekends when billing functions are not being processed. For some engineering development programs, computer time is leased from the Battelle Northwest computer center in Richland, Washington.

Table IV-7 identifies procedures and data items required to perform the engineering functions of this group. In order to engineer specific sites for construction, the engineering group must have detailed spatial information regarding the topography, geology and cover of the site. In addition, the exact legal boundaries must be known and surveyed. Regional characteristics such as seismic activity, ambient air quality maintenance zones, and water resource basins are essential to the choice of design criteria for a given facility. Aerial photos are often used for the first-cut design based on topography and major visible features. However, the resolution obtained is not adequate for specific engineering. Detailed site-specific data are obtained by on-site crews. Maps are prepared at a scale of 1:100 or larger to identify the location and extent of various site features which influence engineering design (e.g., topography, soil type, rock outcroppings, drainage channels, etc.).

PG & E has experimented with airborne thermal sensors to aid in geothermal energy exploration. While effective at general siting, specific engineering requires greater resolution than is currently available from this sensor.

For evaluation of regional characteristics, several geographic data items are used. Geologic faults are determined by reviewing geologic maps, aerial photographs, side-looking airborne radar (SLAR) images, and field investigation. Air quality maintenance district boundaries are defined by the regional air quality authority having jusisdiction. Determination that the site is within a specific district identifies the specific emission criteria which will be required of the facility design. Likewise, design of water cooling system for a fossil or nuclear fueled generating facility requires identification of the regional water resources agency having jurisdiction over water quality and quantity.

Based on regional and site-specific data, as well as design criteria, the engineering group designs the facility to conform to the property boundary and the jurisdictional requirements. Upon completion of one or more alternative designs, the engineering group produces an environmental impact statement. Data for the EIS is derived from existing maps and reports supplemented by detailed field studies by experts in specific areas. Acquisition of these data is a significant cost item as evidenced, for example, by the fact that 40 PhD biologists are employed by PG & E for the purpose of conducting and evaluating environmental impacts of existing and proposed facilities. Other disciplines such as geology, archaeology, etc., are also represented within the research and development group.

An example of environmental modeling work currently under operation was provided by the PG & E engineering research division. The cooling water outfall for the Diablo Canyon Nuclear Plan will produce a plume of hot water which will expand in 3 dimensions off-shore. In order to project the impacts of this thermal plume existing current patterns, water temperatures, water chemistry, and biological conditions must be measured. A hydraulic model is then developed for the area of the plume using a multivariate polynomial hydraulic engineering model. The model is then modified by parameters which reflect the proposed discharge location, rate and direction. The model is verified by a small scale physical model of the outfall and offshore area. Water quality changes projected by the hydraulic model and verified by the physical model are used to project impacts on biota. These, too, are simulated under controlled laboratory and field conditions. It was suggested that the Diablo Canyon facility would be an appropriate ground test area for NASA thermal imagery, as a large amount of ground data records taken over several years will be available.

Operating and maintenance standards and regulations which have been adopted by the utility industry and/or promulgates by regulatory agencies are enforced by the engineering/research and development group. Specific monitoring devices are constructed, installed, tested and maintained by the group. Records from devices and inspections are filed according to the facility being monitored. The record indicates the unit number, location, monitoring or test data, and operating conditions at the time if sampling. Ambient conditions are also noted for those tests requiring such information. Results of monitoring and testing are used to modify operating procedures, identify part failures, and report emission rates and ambient conditions to the environmental affairs group.

Table IV-8 summarizes the types of data items required to accomplish the functions of the Engineering/Research and Development user group.

Table IV-7

USER GROUP: Engineering/Research and Development

General Function	Specific Function	Operating Procedures	Data Items	Geocodes
New facilities engineering	Evaluate specific sites	Assists in alternative site review and models actual location	Land use/cover, topographic, geologic hazards, air quality, roads/infrastructure geothermal sites	Polygons-detailed
	Design facilities	Carries out specific design process based on local conditions	Detailed field studies Design criteria	Parcel boundary
	Impact Analysis	Prepare necessary Environmental Impact Studies for facility	Detailed field studies Historic data (climate, faulting, air quality) Monitoring	Parcel boundary, Polygons - resources, administrative units
Standards and regulations	Enforce utility standards and state/federal regulations	Monitors operations and construction to ensure quality control and to satisfy regulations, including special periodic testing and maintenance	Test data Monitoring	Specific sites (e.g., smokestack)

Table IV-8

Geographic Data Items
Required by Engineering/Research and
Development Functions

Data Type	Geocode
Topography Land Use, Land Cover Geologic Hazards, Geothermal condtions	Parcel, X,Y coordinates
Geologic Hazards Air Quality, Roads, Infrastructure	Parcel, Regional X,Y coordinates
Environmental Resources	Parcel, regional
Test, Monitor Results	Site location, facility

E. System Planning

This user group is responsible for advance planning of generation facilities, distribution facilities and fuel supplies. Costs identified during these planning activities are also used for the group to determine appropriate consumer rate structures to insure fiscal stability. Table IV-9 identifies the specific functions, procedures, and data needs required to fulfill these planning responsibilities.

Generation facilities planning requires reasonably accurate forecasts of future energy demand within the service territory. An 8 to 12 year lead time, or more, if required for new generation facilities. Historically, three methods have been used to project energy demand: trend extrapolation, average demand by residential customer adjusted to normal weather and conditions and for seasonal variation, and more recently the econometric model which disaggregates users and appliance types. A symposium paper* by Richard Comerford of Public Service Electric and Gas Company, Newark, New Jersey, lists the following characteristics of a good forecast:

-"Forecasts must account for all relevant factors, both quantitative and qualitative. The basic approach is to build the forecast from its smallest components.

-"Forecasts should be reproducible and adjustable. That is, if any one assumption changes, the forecaster has a structure by which he can logically and consistently adjust the forecast.

*EPRI, March, 1979. How Electric Utilities Forecast: EPRI Symposium Proceedings. EPRI publication EA-1035-SR.

-"Forecasts should be responsive to management decision-making needs.

-"Forecasts should be determined by using several models. Reliance on a single model is dangerous because of possible inherent errors in that method. This multifaceted approach allows the forecaster to evaluate the requirements of several different methods. For example, forecasting residential energy consumption by several methods will provide a range of forecasts. The forecaster can then select a forecast in the range predicted by all the methods that reasonably meets the assumptions made for each approach.

-"Forecasts must stand up to regulator and investor scrutiny. The forecast is the beginning of all planning for such items as capital requirements, operating costs, and revenues. Thus the forecast must be detailed and documented so that it meets the tests of rate cases, license applications, and other regulatory proceedings, as well as the needs of security analysts."

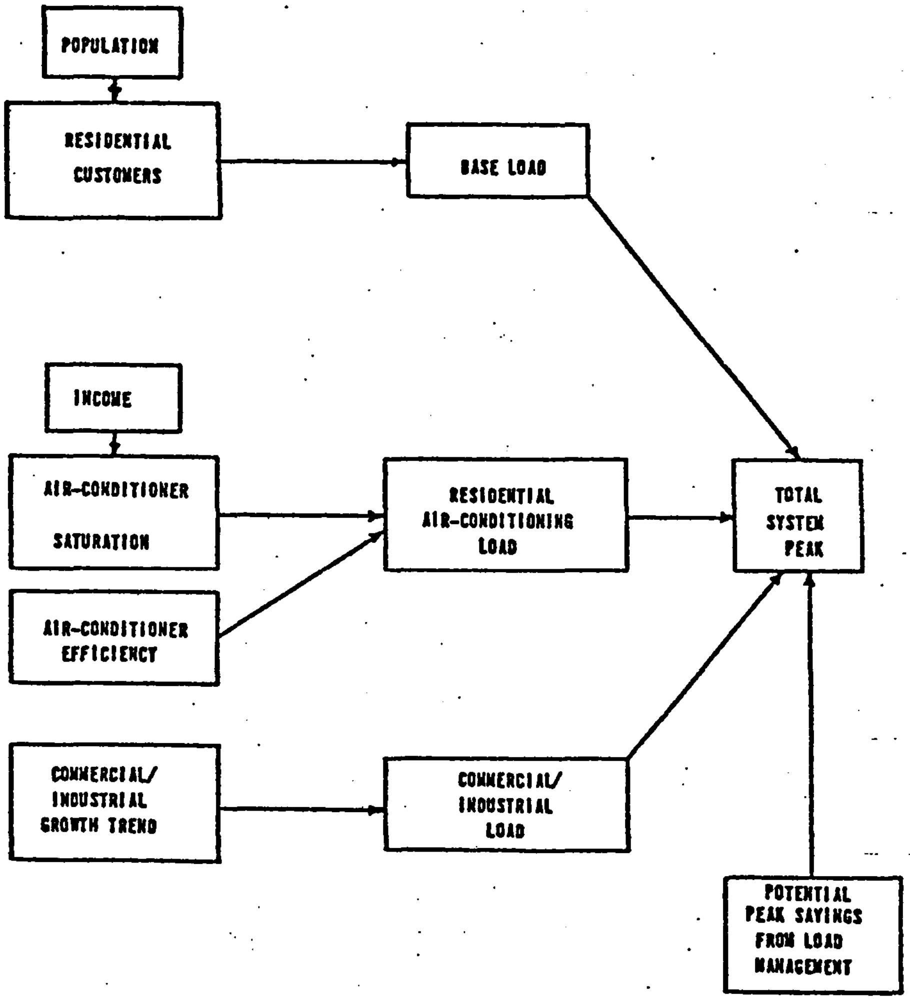
Because forecasts are used to make decisions which commit enormous amounts of company resources to future planning and design work, these forecasts must withstand intensive scrutiny. For this reason, the objective of forecasting has become the documentation of changes expected to occur within each subcomponent of power use. Not only are projections of changes in the number of customers required, changes in appliance types and conservation installations are also required in order to forecast system needs accurately.

During the early years of growth of the electric industry, a relatively simple extrapolation of a trend curve based on number of customers (residential, commercial, industrial) was sufficient to plan new facilities. As new appliances with higher demand were introduced (e.g., window air conditioners), the residential portion of the customers began to dominate peak energy demand periods. More accurate information concerning the number and types of appliances were required in order to plan for needed generating capacity.

More recently, dramatic changes in pricing and conservation measures which followed the 1974 oil embargo have had more impact on energy demand than the number of residential customers. In addition, the cost of providing new facilities has increased with inflation. One respondent at SCE indicated that their present policy of advertizing conservation measures results primarily from an effort to delay massive capital investments in new power plants, rather than efforts to save fuel. The relative importance of residential customers is illustrated by Figure VI-1,a load forecasting model used by Orange and Rockland Utilities, Inc. The model is designed to yield peak energy demand for the system based on major energy-consuming appliances as well as conservation measures in the form of load management. Peak demand has historically been a major factor used to plan system expansion, as designing for peak loads provides capacity to meet all other load periods. However, investment in capital resources to meet peak loads is often not justified, so compromises have been made between designing for peak loads and managing the size and duration of such loads by reducing power supplied to certain users.

Figure IV-1

LOAD FORECASTING MODEL

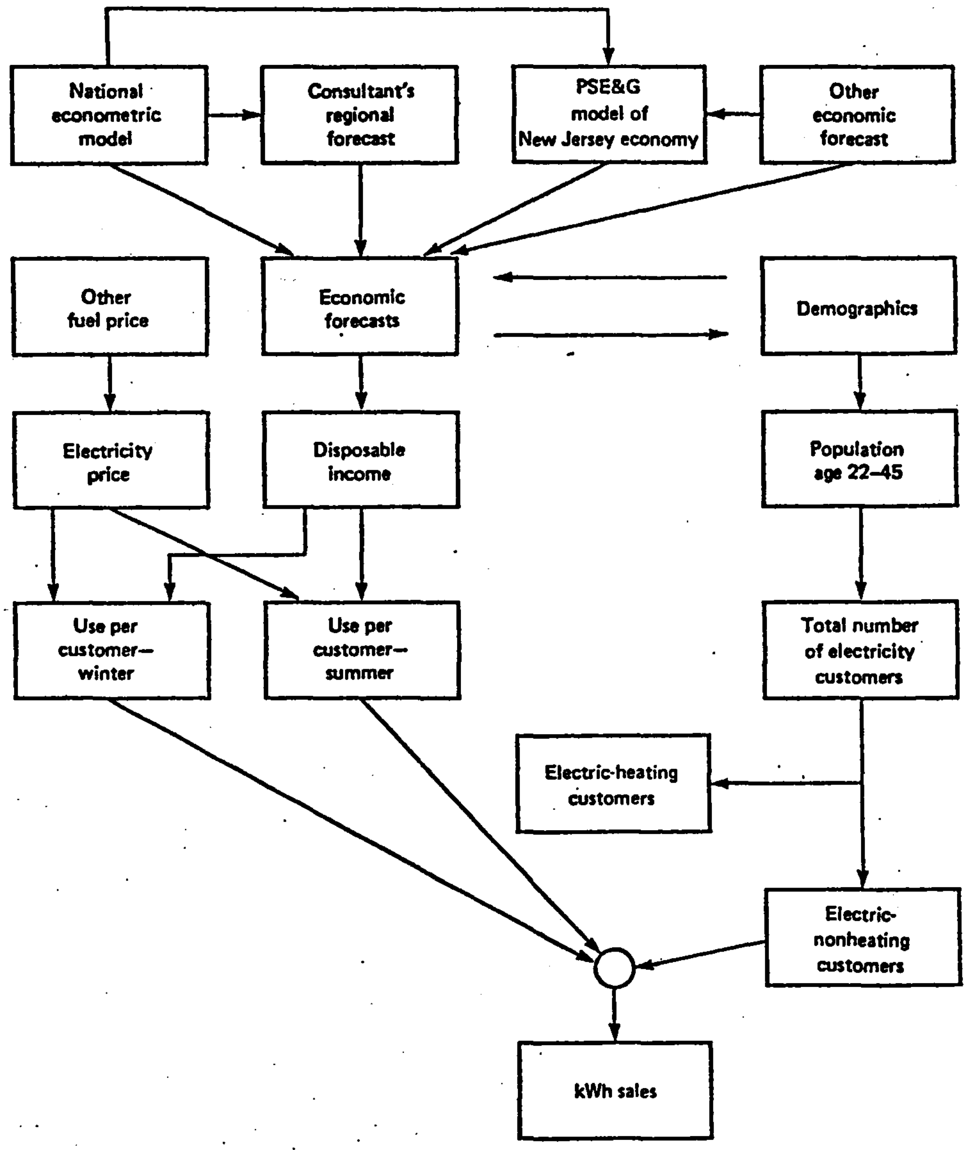


Source: Report of Member Electric Systems of the New York Power Pool and the Empire State Electric Energy Research Corporation, Volume 1, 1979.

Load management has become more significant as the costs of increasing power generation have also increased. Models of potential savings from load management programs also enter into the overall energy demand model used for planning.

The most widely accepted type of model used for residential energy demand projection is the econometric model. This model is structured around projections of population change, appliance types entering service and being retired, costs of power with respect to disposable income, and average income relative to national income. An example of a multifactorial econometric model is illustrated in Figure IV-2. This model is used by Public Service Electric and Gas Company, Newark, New Jersey, and illustrates the types of data needs for econometric models. These needs include economic forecasts, energy price forecasts, demographic projections, and a data base of historic power sales. Sources of these data vary somewhat throughout the industry: Some utilities drive their models using the output of national econometric projections (e.g., those by the Wharton School of Economics) modified by consultant projections and in-house projections of economic trends. Other utilities further disaggregate the inputs to econometric models so that changes in subcomponent trends can be entered into the model as soon as they become known. For example, the appliance sales submodel used by Northeast Utilities, Berlin, Connecticut is illustrated in Figure IV-3. As can be seen by these models, spatial identifiers are notably absent. This results from the major thrust of the models: systemwide sales and generation needs. By the time land use changes can be identified spatially within the service area, the

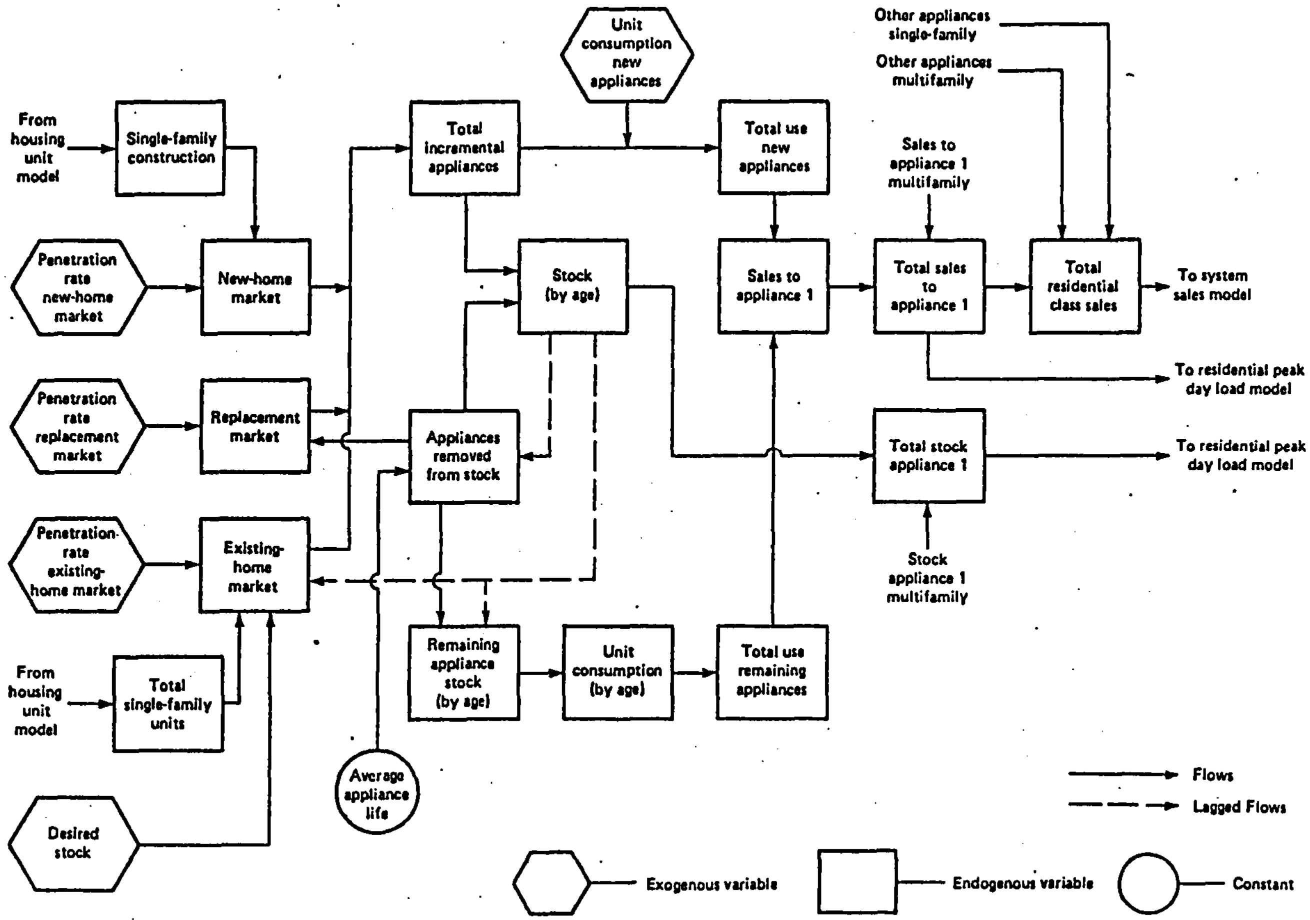
Figure IV-2



Residential-Nonheating Econometric Model

Source: Comerford, Richard B., 1979. "PSE & G Method for Forecasting Residential Kilowatthour Consumption" in How Utilities Forecast, EPRI EA-1035 SR.

Figure IV-3
Appliance Submodel



Source: Burbank, Donald H., 1979. "Forecasting Residential Demand for Electric Energy" in How Electric Utilities Forecast. EPRI EA-1035-SR.

time required to increase generating capacity has passed.

This is not to say that projections based on land use trends cannot be useful for systemwide projections. In fact, interviews with Houston Lighting and Power have revealed that this company is actively testing a method for systemwide planning based on land use change projections. They are using a data base derived from Landsat imagery and land use projections based on adopted growth plans, historic development patterns and trends, and regional growth projections. Energy demand per unit of specific land use type (based on HL & P's own data) is used to project the total energy demand expected to result from projected land use changes. This system is exploratory at present. Its usefulness to the company will depend on how accurately it projects the needs for new generating capacity (compared to HL & P's econometric projections) and how cost effective the result is.

The Electric Power Research Institute* has also indicated that the role of spatial land use data in energy demand projections should be investigated in a rigorous manner. The correlation of power demand by land use type and area has not been well-documented in the past, although data bases exist within utility records to begin work on this correlation. Thus, although spatial and land use analyses related to energy demand projections are not now used by much of the industry research is being done by certain companies, and the usefulness of such projections to the overall projection needs of the utility industry is being investigated. More interest throughout the industry is likely to result from one or more successful demonstration projects.

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*Sherman Feher, personal communication

Spatial data used for the econometric models include a variety of census items, which are generally aggregated to census tracts and subsequently aggregated to the system as a whole. Historic use records are obtained from the utility customer/meter records file. Daily and hourly records of sample meters are used to estimate the annual and diurnal variations in power demand.

Siting of potential plant sites is done in response to a management-perceived need for new generating plants. A general evalation of available sites is made by investigating major geographic and economic constraints and opportunities. This "first-cut" evaluation requires spatial data such as land use, ownership, zoning and future plan designations. Together, these items provide an evaluation of the political/economic suitability of alternative sites. In addition, a data base of geographic data to identify seismic activity, geologic condition, air quality control regions and water availability is used to determine the physical constraints and opportunities of alternative sites. These data are generally obtained in the form of map sheets from various agencies.

The system planning group is also responsible for planning major distribution routes to service new areas. This requires that areas of high growth potential be identified, transmission corridors to these areas be defined, and tower, and cable equipment be identified. This function is the spatial assignment of the energy demand projected by econometric or other methods.

Areas of high growth potential are identified principally on the basis of locally projected land use changes, communication with community and area planners, and by field investigation. The Advanced Systems Technology Division of Westinghouse Electric Corporation reported* on the use of land use data to forecast small area energy demand and to plan distribution systems which would service these areas. Data sources studied included aerial photography, Landsat imagery and field surveys. Aerial photography was found to be of higher resolution, less timely, and more labor-intensive than Landsat imagery for the purpose of determining land use patterns and historic trends in these patterns. Imagery was judged to be a good source of data, primarily because it is timely and efficient. Field surveys were judged to be the most expensive source of data, and resulted in more detailed data than are required for this level of distribution planning. The Westinghouse report also identifies a group of automated models which serve to locate the most probably areas of growth, based on a number of assumptions related to distance from employment centers, past trends, etc. Models such as the Projective Land Use Model (PLUM) and the Urban Systems Model are used in this manner. The EMPIRIC**Activity Allocation Model is one of a group of models designed to allocate projected regional population, employment and land use growth to a set of smaller subareas within the region. The model performs three specific functions:

- Generate small area forecasts of population, employment and land use, based on specified regional totals and planning policies;

*Advances Systems Technology Division, Westinghouse Electric Corp. and Salt River Project, Phase I Final Report, April, 1979. Research Into Land Forecasting and Distribution Planning EPRI Electircla Systems Division, Draft.

**EMPIRIC tapes and documentation are available from the Urban Planning Division, HHP-25, Federal Highway Administration, U.S. Department of Transportation, 400 Seventh Street, S. W., Washington, D. C., 20590.

- Evaluates impacts of alternative planning policies on projected distribution of activities; and
- Serves as a mechanism to evaluate, integrate and coordinate future policy decisions.

Inputs to the model include existing land use, future plans, policies of various types, and reporting needs. Geocodes for the examples given in the Salt River Project by Westinghouse are Transportation Area Zone (TAZ) and Census Tract. Transportation is a significant component of the model and is used to project residential and commercial development patterns. A test of the EMPIRIC model over the area covered by the Maricopa Association of Governments in Arizona showed an overall error rate of 6.5% in assigning projected households, a 5.1% error in assigning housing locations and a 3.4% error in assigning employment locations. This compares favorably with the ability to track and project development in the field by the historical methods of maintaining a liaison with local and regional planning agencies.

Having identified areas which are most likely to experience development, the system planning group then defines alternative distribution routes which can be used to supply projected power needs. Routes are evaluated based on linear distance, the cost of acquisition and construction, and potential conflicts with existing land uses, proposed land uses, and environmental considerations (such as visual impacts, habitats, etc.). Data required for this analysis include land values supplied by the real estate/legal group, and land use/cover/environmental conditions by location and level of conflict as determined by the environmental group.

To generally define transmission corridors, these data are adequate at a relatively low resolution (e.g., several acres). SCE uses a 3 acre minimum polygon size to determine land use conflicts with potential transmission routes. Aerial imagery at a scale of 1:24,000 has been adequate for this purpose.

The amount and types of equipment needed to provide for power distribution are roughly estimated by the linear distrance of routes. After a route has been selected and approved, more exact costs are determined by the engineering department. Specific connection needs such as meter connections are identified and planned for by field representatives who work with individual developers. Spatial data required for this function are addresses of customers and point/line locations of service access locations.

The system planning group also identifies the types and amounts of fuels required to provide the projected energy demands. Historic fuel use is used as a basis for projecting future needs. The historic use rate is modified to reflect:

- increased energy demand
- effects of increased fuel costs
- effects of increased conservation measures
- effects of projected climatic patterns (heating - days/ cooling - days)

These data are obtained from the historic address-based data file, correlated with climatic data for the service areas and marked studies of generation rates of conservation measures.

Because fuel types differ in thermal content and effluent residue, the fuel supply planning function must be sensitive to regulatory requirements and controls regarding air contaminants. These controls are imposed at the level of the area influenced by the power plant, which is often the entire system. In some cases, siting power plants in a remote area enables the operator to apply less stringent emission control standards than would be required of a power plant located within the service area.

Because the system planning group identifies the need for new facilities and projects the costs of their construction and acquisition, this group also determines the rates which will be required to amortize these costs. Rates are based on amortization of capital expenditures plus operating costs plus offsets for fuel costs. Rate structures are proposed to a State regulatory board or commission for approval, and thus must be clearly substantiated in order to be approved. A major jusitification for energy demand projection is to document a realistic need for investment in new resources, which in turn justifies proposed rate structures.

The rate structuring function requires energy demand projections, the availability of purchased power, and its cost, the need for and cost of new facilities and distribution systems, and projected fuel costs based on proposed power sources. These data are aggregated to the entire utility system to document rate structures.

Table IV-10 summarizes the types of data items required to accomplish the functions of the System Planning user group.

Table [illegible]-9

USER GROUP: System Planning

General Function	Specific Function	Operating Procedures	Data Items	Geocodes
Generation facilities planning	Estimate future generation loads	Model electrical demand growth rates based on population/ economic trends & electric use levels	Population forecasts, economic forecasts, census, market surveys Electric use records, conservation, appliance/heat/cool trend	Census tracts, service area Parcels, meters-aggregate
	Evaluate potential plant sites (general)	Determine generation sites based on constraints, economics	Land use, ownership Zone/plan designations Environmental data base	Parcel Polygon
	Project equipment and/or purchased power needs	Identify potential shortfalls in capacity and equipment & availability of purchased power	Electric demand forecasts	Service Area
Distribution planning	Identify growth areas	Identify service areas with high growth potential	Land use/projected land use Zone/plan designations Windshield surveys	Parcel Service area Street/neighborhood
	Site transmission corridors	Define most economical route for areas requiring service, with minimum conflicts	Land Use/Cover Environment/topography	Polygon (coarse resolution ± ¼ sec)

USER GROUP: System Planning (continued)

General Function	Specific Function	Operating Procedures	Data Items	Geocodes
	Identify equipment needs	Project potential distribution inadequacy/ needs	Distribution system Meter locations, critical need customers Small-area load levels (from load forecasting)	Points, lines Address file Service district
Fuel Supply Planning	Project seasonal variations in power/fuel needs	Estimate short-term demands for power and availability of fuel	Climate (^{o} - days) Users Small-area load levels	System-wide Address file Service district
	Satisfy regulatory requirements regarding rates & environmental	Project annual/ seasonal fuel costs and requirements regarding use	Use levels Air Quality (fossil fuels)	Service district System-wide
Rate Structuring	Determine and substantiate need for changes	Document actual costs of projected power needs to establish rates and justify requests for rate changes	Projected energy needs Power availability & cost Facility needs & costs Distribution requirements Fuel costs	System-wide

Table IV-10

Geographic Data Items
Required by System Planning
Functions

Data Type	Geocode
Population Forecasts, Economic Forecasts, Census, Market Surveys, Electric Use Records, Conservation Penetration, Appliance Types Heat/Cool Trends and Projections	Census tract, Service area
Land Use, Ownership Zoning/Plan Designation Topography, Land Cover, Geology, Regulatory Zone, Windshield Surveys	Parcel
Electric Demand Forecasts	Service Area
Location of Forecasts Critical-need customers	Address, X,Y coordinates
Climate, Air Quality, Power Availability, Costs, Fuel Costs	Service Area

F. Load Forecasting

This user group is responsible for the daily management of power loads in small areas. This function requires the group to project specific locations and amounts of short-term demand for power and to meet these demands by scheduling construction of distribution improvements including transformers and substation switching systems. Table IV-11 identifies the specific operating procedures and the data items required to perform them.

Short-term localized power demands are projected by examining existing loads on specific transformers and substations, identifying new customers being brought into the system, identifying trends (increase or decrease) in power use per customer, and identifying fast-growing areas within the distribution system. These are compared to the capacities of the existing transformer/line/substation system to identify those components which may not be able to handle projected increases in demand.

The equipment necessary to upgrade the system to meet the projected demand is identified by engineering staff and work orders are issued by the load forecasting group. This requires locational information which identifies specific components of the distribution network.

PP & L has expressed interest in developing an automated gridded map which reflects the load capacities of each substation service area. When overlaid on a second map showing existing loads at the same locations, problem areas can be quickly identified. This would aid the load forecasting function and at the same time allow PP & L to easily advise potential large consumers of power (e.g., aluminum plants) of those geographic locations within the system which would be least impacted by a new installation.

Table IV-12 summarizes the types of data items required to accomplish the functions of the Load Forecasting user group.

Table IV-11

USER GROUP: Load Forecasting

General Function	Specific Function	Operating Procedures	Data Items	Geocodes
Short-term, small-area load management	Project short-term power demand	Examine present loads and evaluate potential changes due to new customers, use patterns, seasonal variation; Identify fast growing areas	Electric use levels Transformer/network loads Conservation trends, Appliance/heating/cooling trends New construction; approved/proposed probable development Climate	Address files Service districts System-wide Service district Service district System-wide
	Schedule construction and system switching	Provide operations with estimates of power demands for transformer, sub-station switching and for distribution system improvements	Distribution system to transformer level	Distribution network

Table IV-12

Geographic Data Items
Required by Load Forecasting Functions

Data Type	Geocode
Existing Loads Potential Changes in Loads New Construction by type	Address, Service District
Climate	System-wide
Distribution System	X,Y coordinates, links between elements

G. Environmental Affairs

This user group is responsible for maintaining land use and environmental data, projecting changes to these data, monitoring company activities which affect the environment, providing in-house environmental analysis expertise to other departments and preparing environmental impact statements for regulatory agencies. Table IV-13 illustrates the data items used to accomplish these functions.

Regional and specific land use patterns are determined by acquiring zoning and future plan designations, census data, population forecasts, real estate trends, large-parcel ownership status, and jurisdictional permitting requirements. These data types are geocoded in the form of polygonal maps; generally these are available at a variety of scales and must be reformatted so that they can be adequately compared. A prediction of future land use patterns may be made by applying the knowledge of individuals familiar with each area. Many companies use a Delphi approach, working with a group of land use experts, economists and development analysts to reach a consensus on general development patterns.

These projections are used to determine potential sites and corridors for facilities which will intrude least on conflicting land uses. When sites have already been determined, the area is examined to determine whether the suggested site should be re-evaluated or not with respect to land use conflicts. Thus, the environmental affairs group often works closely with the system planning and the real estate/legal user groups.

The environmental affairs group also maintains a data base of environmental base-line data which can be (or has been) evaluated in terms of constraints and opportunities for specific types of development. Maps, reports and regulations which pertain to the service area and the types of construction and maintenance activities of the utility are included in this data base and made available to other departments. SCE has automated environmental inventories for portions of its service district in the California desert and along the Pacific Coast. These are being used to evaluate potential transmission corridors and sites for facilities. PG & E and PP & L have also automated significant portions of their service areas using a combined land use and environmental data base. Proposed corridors are initially evaluated using these systems.

Using the data base, jurisdictional requirements, and specific site surveys and proposed improvements (from the engineering and R & D group), the environmental affairs group prepares the mandated Environmental Impact Statement. The group is responsible for presenting the EIS to regulatory agencies and communicating with these groups and the public during the review period. This function requires expertise, familiarity with legislation and review procedures, locations to be evaluated and environmental conditions, impacts and proposed mitigation measures. The latter data are obtained by working with the engineering staff.

The Environmental Affairs group also monitors stack emission and water effluent levels from operating facilities. Records are maintained and evaluated with respect to ambient air and water quality and legally mandated emission standards. When breakdown of a control device is evidenced by the monitoring program, operations and management is notified and a work order is issued to repair or replace the unit.

Locational data for this task includes locations of outfalls, emission stacks and control equipment, as well as monitoring devices.

Table IV-14 summarizes the types of data items required to accomplish the functions of the Environmental Affairs user group.

Table IV-13

USER GROUP: Environmental Affairs

General Function	Specific Function	Operating Procedures	Data Items	Geocodes
Land Use Projections	Project regional land use patterns	Evaluate existing patterns of land use and couple with regional trends, land ownership, regulatory requirements	Land use; zone/plan designations; census data (density); population forecasts; real estate surveys; land ownership; jurisdictional requirements (permits, etc.)	Census tract Parcel
	Identify potential land use conflicts with utility proposals	Determine possible facility/corridor locations and identify land use constraints; re-evaluate siting suggestions	Projected land use	Parcel/polygon
Environmental Data Base Maintenance	Provide environmental information to other departments	Prepare environmental data bases and impact analyses for planning, siting, or other utility functions	Engineering data Environmental constraints and opportunity	Varies
Environmental Consulting	Prepare EIS documents	Determine conditions, proposed changes, impacts, mitigations, document	Location of proposed change. Environmental conditions. Environmental standards, mitigation measures	Parcel, regulatory zones, X,Y locations
Pollution Monitoring	Document pollutant levels and mitigation measures	Maintain monitoring systems and programs for air, water, soil pollution for reporting to regulatory bodies; direct use of pollution control technology	Ambient air/water/soil quality Effluent levels	Air/watersheds Site-specific

Table IV-14
Geographic Data Items
Required by Environmental Affairs
Functions

Data Type	Geocode
Land Use Zoning, Plans Census Data Population forecasts Ownership Jurisdictional Boundaries Projected Land Use Topography, Geology, Land Cover	Census Tract, Parcel
Air and Water Quality	Regional
Effluent levels	Site

V. Summary of Current Methods

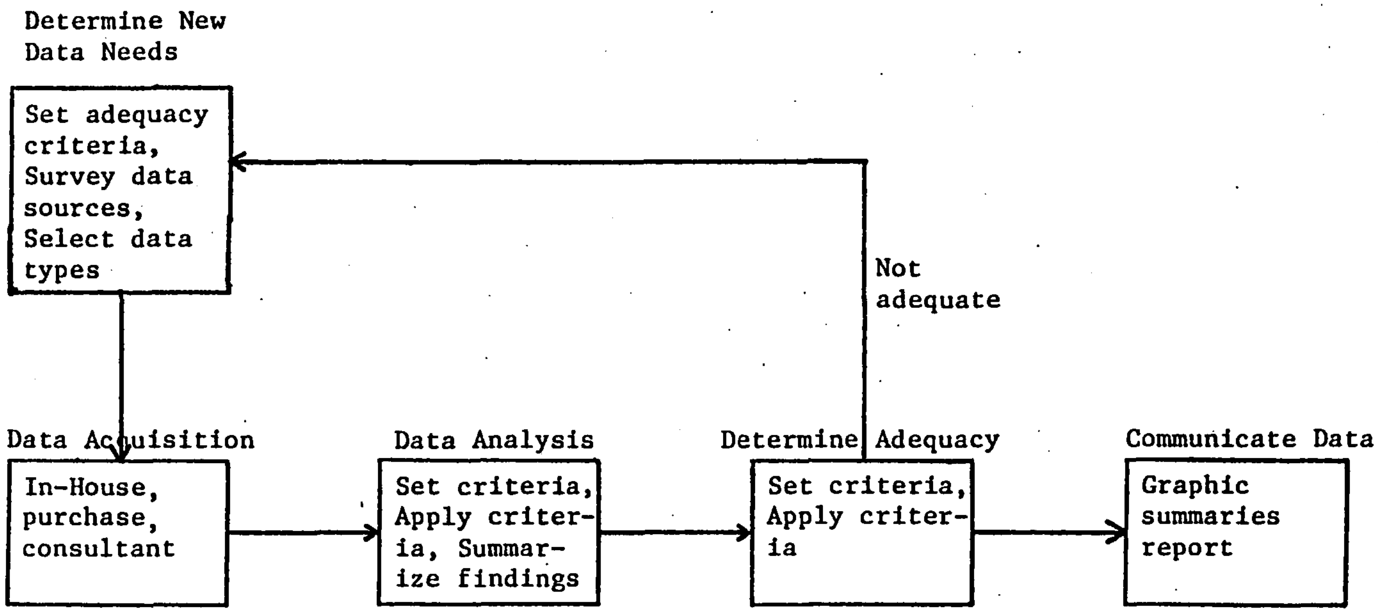
This section summarizes the current methods used by the U. S. electric utility industry to acquire and analyze spatial data and to communicate the results to other departments, management, regulating agencies, and the public. Figure V-1 illustrates the generalized sequence of activities used to process spatial data for presentation.

Data may be acquired in-house, purchased from suppliers, or contracted from consultants. The source varies with the availability of the data type, required accuracy, and in-house personnel. Data are acquired according to prioritized needs determined by responses to legal requirements and regulatory agencies, planning and scheduling constraints, and the need to communicate with customers, investors, and the general public.

Data are analyzed for specific end purposes. The purpose of the analysis determines the type of analysis and the criteria to be applied. Adequacy of the data is determined by applying criteria related to the original reason for acquiring the data.

Ultimately, the analyzed data are summarized in a form which allows communication with the decision-maker, regulatory body, or public. Summaries are often in a graphic format and include data summaries as well as a written report.

Figure V-1


Determine New Data Needs
Set adequacy criteria, Survey data sources, Select data types
Data Acquisition
In-House, purchase, consultant
Data Analysis
Set criteria, Apply criteria, Summarize findings
Determine Adequacy
Set criteria, Apply criteria
Not adequate
Communicate Data
Graphic summaries report

A. Data Acquisition

Methods used to acquire spatial data consist largely of acquiring and drafting maps at a variety of scales. Generalized topographic data are obtained largely from USGS topographic sheets and road access data are obtained from several map distributors. New data are added to these maps at variable intervals, based largely on field reports or printing of updates by map suppliers. For those areas being considered as facility sites, large scale engineering maps are drafted from field survey data. The engineering group usually produces this scale of map and includes land cover, geology and soils data important to siting the facility.

Several companies utilize low elevation aerial photography of their service areas to aid in siting transmission corridors, substations, identifying customer characteristics, and determining potential conflicts based on development patterns. A few instances of Landsat use have been identified in the industry. A feasibility study was conducted in the Phoenix area*, and Houston Lighting and Power is using Landsat imagery to identify existing land use patterns.

Customer data, such as family size, dwelling unit characteristics, and appliance mix has been obtained from census data, from surveys of existing customers, and surveys of new residential developments. Most companies appear to use in-house surveys rather than census information. The 1980 census did not include several questions formerly used by the utility industry, resulting in a definite need for alternative sources of similar data. While many companies conduct their own

*Westinghouse Electric Corp., ASD, 1979. Research into Load Forecasting and Distribution Planning. Draft.

surveys, several hire consulting firms to perform the survey and analyze the results.

Data are maintained in manual or automated data bases. Nearly all address/billing data files are automated, for example, while most of the real estate and environmental data are maintained in a manual graphic form. The costs of automated mapping systems have reached an economic break-even point now, and several companies are automating their existing maps, as well as new mapped data.

B. Data Analysis

The types of analyses to which the data are subjected vary according to the purpose of the analysis. Certain generalizations can be made with respect to facility siting. Mathematical summaries of the areal extent of mapped data types are common, particularly when siting facilities. Identification of specific types of constraints (e.g., earthquake faults) is a type of analysis by location and constraint factor: a multiplier indicating the effort or cost of mitigating the constraint. These analyses may be done manually by professional staff members or, if automated data are used, area summaries and constraint analyses may be provided by software routines.

Energy demand forecasting analysis draws on geographic data in the sense that development of new customers is constrained by the geographic parameters of the service area. Current analysis methods use energy use trends and economic projections to project changes in numbers of customers and the average energy demand per customer. This analysis may be further disaggregated by identifying market saturation rates (% customers) of new appliances and retirement rates (% customers) of older appliances. A recent change to these econometric models has been the addition of a coefficient to represent conservation measures undertaken by customers. While this econometric analysis relies primarily on district-wide summaries, it can be disaggregated into geographic areas. For example, the population data and economic projections are often based on census tract summaries of urban areas. The projections for separate areas may differ, even though these are included in the same electric utility service district. To project localized energy demands, utility companies often disaggregate the system-wide projection according to subareas. This disaggregation is usually accomplished by field representatives from the several areas meeting and discussing the relative portions of the system-wide projection which will be assigned to each subarea. Distribution plans are then initiated to provide for the additional energy demands projected for the subareas.

C. Communication of Results

After the specialized staff has analyzed data and determined that the analysis adequately responds to the need, the results of analysis must be presented to management for decision-making and/or to public groups or representatives. The presentation generally summarizes the data and the analyses applied to obtain the results. The results themselves may be presented as a preferred course of action supplemented by alternative actions. Graphic displays including maps are frequently used in the communication of results. These displays may consist of topographic basemaps supplemented by aerial photos and drafted map overlays. Those companies with automated GIS capability use computer-generated overlays of analyzed data for purposes of presentation.

In summary, the current methods for dealing with spatial data are primarily manual, with the exception of address-based data and transformer-based aggregate data. The analysis and display of data and results utilize expertise and manual methods throughout most of the utility industry. A few larger utilities are experimenting with new technologies such as Landsat land use/land cover data. Many other companies are now investigating and implementing automated cartography systems to replace or supplement their manual cartographic techniques.

VI. Data Sources

This chapter presents information regarding the potential sources for the data items identified in the previous section as needed by various utility user groups. These data are of many types, and are needed at varying scales, degrees of resolution and accuracy, and currency. In general, however, the identified data items can be classified into four general types: operations, related to specific operating parameters and procedures; environmental, pertaining to terrain features of the landscape and associated environmental characteristics; demographic, related to population and economic factors; and land use/planning, expressing the nature of existing and projected human activity on the land and the attempts to direct that activity.

To efficiently fulfill their obligations, utility user groups must be able to retrieve the data they need and apply it. Although much of this data is already available, it exists in a variety of formats at several different scales and resolutions. These data sources may be divided into four broad somewhat overlapping categories: cartographic sources which exist in a mapped form; imagery, photographic or other remote sensing sources; non-graphic sources containing spatial data in a statistical or textual form, and field investigations at a site by trained specialists. Within each of these categories are numerous specific data sources, such as USGS maps and low altitude photography.

The matrix of data sources at the end of this chapter relates specific data sources to the identified data item/geocode needs. This list is intended to represent the options available to users for acquiring the data they need, and not to suggest that there are no alternative sources or that all the sources must be used to accomplish the designated task.

A. Data Items

Each task performed by the various user groups within a utility requires a unique set of data for its efficient execution. These data have been delineated in the previous sections by user group, general function, and specific function. They vary widely in scope, availability, currency and accuracy, and applicability, among other characteristics. Moreover, as can be seen on the matrices in Chapter IV, some functions require many data items of a variety of types, and some data items are essential to a large number of tasks.

To clarify the variety and number of data items represented on the user group data needs matrix, these data items have been reorganized into four general categories:

- operations data
- environmental data
- demographic data
- land use/planning data

All of the relevant data items are assigned to one of these categories. In certain instances, closely similar data items have been combined into one item for purposes of discussion.

Operations data - This class of data consists of information related to specific operating parameters of the utility itself, such as distribution networks, transformer loads, rights-of-way, etc. It includes details of the structure of the system, location and type of equipment, meter numbers and addresses, and so forth, as well as records of the operations of each of the components of the system on a real-time, daily, or long-term basis. Typically, this information is collected and maintained entirely within the utility. Portions of the data may be made public as part of rate adjustment requests, applications for facilities siting, and other processes involving governmental approvals. A large amount of the data, however, is utilized internally and not released due to its proprietary nature.

Environmental Data - This class of data refers to the broad range of information related to physical terrain features and associated variables. Generally, much of this type of data has been collected and mapped for a given area, although utility companies or other users may supplement this information with additional investigations. Most of the specific environmental characteristics included in this class are researched, analyzed, and mapped by specialists in the subject, such as geologists, biologists, etc. Some information may be obtained by non-specialized personnel using available measurement equipment. As opposed to operations data, environmental data are useful to a wide range of land assessment and planning activities. Local and regional planners, development interests, and resource (agricultural, mineral, water) companies and agencies all use environmental data. Certain types of data would of course have more limited utility or more specialized applications. Timber standing crop or stream flow data are critical to specific functions but are not used in most planning efforts.

Demographic Data - Information related to population and economic conditions makes up this class. While some of this data may be generated by utility personnel or within the day-to-day functioning of the utility, much of the data are produced by governmental agencies as part of on-going population and economic studies. The primary effort in this regard is that of the U. S. Census Bureau, but all states and many municipalities are involved in demographic estimates and forecasts. This information, when summarized and aggregated to appropriate levels of detail, is useful to utility system planners and siting specialists, in addition to its value to governmental planners responsible for directing and accommodating development and for providing social service delivery systems.

Land Use/Planning Data - This class of data is in many respects closely related to Demographic Data, since it represents the extent and scope of human activity on the landscape. Specifically, it refers to primarily spatial data regarding the distribution of land use patterns currently existing and those projected in a region, such as housing, commercial, and industrial development, agriculture, open space, and roads and infrastructure. It also encompasses plans and policies whose purpose it is to direct growth in a city or region, including General Plan designations, zoning ordinances, building and siting codes, etc., and land ownership and parcel descriptions. Larger utility companies may have a department or division responsible for determining land use patterns and for projecting future land use for purposes of system planning. More common is the use of specific land use surveys as part of corridor or facility siting studies. As with demographic data, land use/ planning data are also useful to governmental agencies as well as other industries for a variety of assessment and planning efforts.

Data items used by utility user groups can be differentiated on the basis of their geocode, that is on the basis of the format and size or scale of the spatial unit to which the data attribute is referenced. For example, some data items will be referenced to a component of an electrical distribution system, others to watersheds or stream segments, and still others to census tracts. Closely related to the concept of geocode is the question of scale, since this bears directly on the resolution and accuracy of the data.

The geocode for a given data attribute set may be presented in one of two formats - spatial, as on a map or photograph, or statistical, in which areal unit is described in terms of prescribed limits instead of being delineated graphically. Examples of spatial geocodes would be map delineations of environmental or land use characteristics; statistical references would include addresses, DIME files, or legal parcel descriptions.

Data coded in either format can be presented at varying degrees of detail. Small scale graphic sources display fairly generalized information, useful for evaluating regional patterns and trends. Large scale sources can show much more detail and are thus useful for more specific site-oriented planning. Thus, different resolutions are most suitable for specific purposes. In other words, the largest scale, most detailed map or image is not necessarily the best one for a user group function. The scale at which data are presented is determined not only by technical requirements or limitations of the mapping/imaging system, but also by the geocode format and the data item itself. Certain geocodes, such as census tracts, cannot be enhanced to a higher level of resolution, so there is no need to map these at a larger scale than that necessary to accurately delimit the boundaries of the geocode area (unless the map is to match the scale of another, more detailed map). Certain data items such as ambient air quality within an air basin are themselves rather generalized, so any map representing them cannot be more detailed or have a higher resolution.

B. Data Sources

Data can be obtained from a tremendous variety of sources, both pre-existing and prepared for a specific study. In general, sources used by utilities can be grouped into the following categories:

- Cartographic
- Imagery
- Non-graphic
- Field

Each type has specific advantages and disadvantages for portraying data, based on limitations of scale, resolution, and the type of data itself.

Cartographic - Cartographic data sources include any which show information in a mapped form. These can be published maps, such as those prepared by the United States Geological Survey (USGS) and other public or quasi-public agencies, or topical maps specifically prepared for a study, such as geology and vegetation maps. The range of scales is almost unlimited, although popular USGS maps are at scales of 1:25,000, 1:62,500, and 1:250,000. Resolution is directly proportional to scale, and accuracy is dependent on the individual map.

Imagery - This data source class consists of photography and other remote sensing tools. It includes conventional aerial photography from low and high altitudes using black and white, color, and color infrared film; side-looking airborne radar (SLAR); and satellite-based multi-spectral scanners (Landsat). The range of scales is generally less than that for cartographic sources, from about 1:12,000 for low altitude photography to an order of 1:250,000 for Landsat imagery. Although Landsat imagery exists for the entire United States, current low and high altitude photographic coverage is sporadic. Photographic coverage for any area can be contracted for when needed. Other specialized sensing equipment can be utilized for specific purposes, such as thermal scanners, television monitors, and so forth.

Non-graphic - This class refers to data sources which, though spatial in nature, present data in a textual or statistical form. They include, for example, lists of addresses or point locations of equipment; schedules; and records; census files; hydrology calculations; agriculture, timber, and mineral resource records; engineering tests and special investigation results; proposed development types and location; etc. These sources are usually used in conjunction with maps and imagery, since they provide descriptions or explanations for the data presented on a map or evident on imagery. Although such sources have no scale per se, their accuracy and resolution does reflect the detail with which an investigator has researched the topic or collected the data.

Field - Field investigations provide a critical source for information, since they supplement the other sources of data. In fact, field investigations, along with imagery, often provide the basis for cartographic and non-graphic data displays. Unlike the other three data classes, field data is rarely acquired externally (except as it is represented in published maps, statistical summaries, etc.), but is performed by a utility user group in response to a specific need. Typical studies undertaken are land use "windshield" surveys, inspections of equipment, meter readings, and environmental assessments. Field studies can provide a detailed inventory for a limited area, or a broad overview (i.e., with lower resolution) of a region as a whole.

C. Matrix of Data Sources

The previous chapter to this report described individual data items and their geocodes necessary for the performance of specific functions by utility user groups. The matrix on the following pages presents these data items organized according to the general classification of data types described above, that is, operations, environmental, demographic, and land use/planning data. Each data item/geocode identified on the data needs matrix is listed on the data sources matrix following. For each, potential sources for these data are listed, in the general categories of cartographic, imagery, non-graphic, and field. Some data can be reasonably acquired from only one type of source, or even one specific source within that type, such as zoning. Other data are available from many different sources of all four types, such as land use.

DATA TYPE: Operations

DATA ITEM	SCALE/ GEOCODE	DATA SOURCES: CARTOGRAPHIC	DATA SOURCES: IMAGERY	DATA SOURCES: NON-GRAPHIC	DATA SOURCES: FIELD
Meter readings	Numbers/ addresses	Service area maps - detailed Plat maps		Address files	Meter reading
Power sales	Service sub-district	Service area maps		Billing files	
Power use	Address/meter Service sub-district System	Service area maps		Transformer, sub-station loads Generation loads	
Distribution network	Service sub-district System	Parcel maps w/ network facilities System maps	Low altitude	Inspection schedules, results	Line inspection
Customer priority	Numbers/ addresses	"Flags" on system map (by address)		Customer records	Installation notes
Operating conditions	Address Sub-district System	Address map Network map Corridor map	Low altitude for major transmission corridors	Customer reports & complaints Automated switching records Equipment records by location	Distribution/generation equipment checks Equipment inspections

DATA TYPE: Operations (cont.)

Data Item	Scale/ Geocode	Data Sources: Cartographic	Imagery	Non-Graphic	Field
Conservation patterns/ efficiency requirements	Service district (aggregate of parcels)	Map showing new development Land use	Low altitude, high high altitude (land use)	Legal requirements Purchasing patterns Meter records	Meter readings
Property records	Parcel	Parcel map		Legal description	Surveys
Fuel Supply	System			Stockpiles Contracted delivery	
Effluent levels	Point source	Outfall locations Stack locations Monitoring locations	Thermal scanner	Effluent records Stack records Ambient quality records	Monitoring equipment

DATA TYPE: Land Use/Planning

Data Item	Scale/ Geocode	Data Sources: Cartographic	Imagery	Non-Graphic	Field
Land use (including change detection)	1:24,000/parcel 1:62,500/census tract 1:250,000	Land use elements Plat maps Planning area maps	Low altitude B & W High altitude CIR Satellite MSS	Census data Land use summaries	"Windshield surveys" Parcel surveys
Projected land use	1:24,000 1:62,500 1:250,000	Land use elements Future plans Zoning maps		Approved/proposed/ probable projects lists Market surveys Future plan summaries	
Zoning	1:1,200/parcel 1:7,200	Zoning maps		Zoning ordinances Allowable uses, deed restrictions, building codes	
Future plan designations	1:24,000 1:62,500 1:250,000	Plan maps		General plan requirements	
Jurisdictional requirements				Ordinances, building codes Permit procedures	
Land ownership	1:12,000 or larger/ parcel	Parcel maps		Parcel/tax records Deed records	

DATA TYPE: Land Use/Planning (cont.)

		DATA SOURCES			
DATA ITEM	SCALE/ GEOCODE	CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
Legal property description	Parcel	Survey maps		Parcel records	
Roads/Infra-structure	1:24,000	USGS maps Transportation/ Highway plans Road maps Pipeline maps Utility corridor maps	High altitude Low altitude	Public works records	Windshield survey
Trail network	1:24,000, other	USFS/DPR maps	Low altitude	Trail resources	Field survey

DATA TYPE: Environmental

Data Item	Scale/ Geocode	Data Sources: Cartographic	Imagery	Non-Graphic	Field
Topography/ Landform	1:24,000 1:250,000	USGS maps	Low level High level Satellite MSS		Field notes
Geology/Soils	1:10,000 1:24,000 1:250,000	Soil surveys Geological maps	Low altitude High altitude MSS	Engineering tests, profiles, published records, seismic records	Soil scientist/ geologist interpretations
Land cover	Any scale/ polygon resolution	Previous studies (siting, corridors)	Low altitude High altitude	Lists of species, habitats	Field checking, notes
Timber	Parcel Resource management unit	Parcel maps Resource management maps	Low altitude B & W, CIR	Timber type, age, volume Harvest records	Sample (0.2 acre) Records
Climate/Air quality	Regional Air sub-basin	Air basin maps Climatic condition maps		Monitoring station summary reports	Field recorders
Hydrology	Watershed, groundwater aquifer area Stream segment	USGS maps Water resources maps Hydrology maps	Low altitude High altitude	Gauging station reports Runoff calculations Well logs	Channel measurements Test wells Percolation tests

DATA TYPE: Environmental (cont.)

DATA ITEM	SCALE/ GEOCODE	DATA SOURCES: CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
Water quality	Point locations Coolant discharge area	Water resources maps	CIR Aerial, Scanning thermal sensor	Water quality records	Water monitoring stations
Precipitation	1:250,000 watershed	Isohyet maps Snowfall maps	MSS (snow cover) High altitude CIR	Historical records Snowmelt records	Rain gauges Snow depth
Natural hazards	1:10,000 1:24,000/ natural lines 1:62,500 1:250,000	Geology maps Floodplain/insurance maps Soil maps Fire hazard zones Slope maps	Low altitude side-looking airborne radar (SLAR)	Seismic activity records Fire records Landslide records Slope calculations	Trending/seismic surveys Vegetation cover

DATA TYPE: Demographic

Data Item	Scale/ Geocode	Data Sources: Cartographic	Imagery	Non-Graphic	Field
Census	Address Block group Census tract	Census tract maps		Census files/ DIME data tapes Reports, summaries	
Population forecasts	Service district	Service district maps Community Maps		Population projections/models Land use projections Approved/proposed/ probable projects lists	Interviews with planners, developers
Economic forecasts	Service district System	Regional aggregation or reporting maps (e.g., census maps)		Regional/national projections	
Market/real estate surveys	System	Regional aggregation or reporting maps (e.g., census maps)	Low altitude	Real estate records	"Windshield" surveys

VII. Potential Linkage of Existing Data

Within the electric utility industry several non-automated geocoded data bases have been identified. These data bases have not been automated due to the cost versus return on investment, planning priorities or lack of experience with such systems. Table VII-I lists the types of data bases used within the industry which would be adaptable to an automated mode.

Of the data files identified, the address file is most universally automated. This results from its use in the billing function, which is the major automated function of most utility companies. Mainframe computers maintained by utility companies are occupied by this function for most of their operating hours, other functions being secondary in priority. Within the address file, most utilities maintain historic power use records, special flags which indicate users of special or critical equipment, notations for meter readers, billing instructions, and the location or number of the transformer which supplies the meter. Summaries of these data are used to track historic trends, to identify overloaded or idle transformers, and to project small-area needs.

The transformer data file may be automated or exist as card files within some smaller utilities. The physical and schematic location of the transformer is recorded with its capacity and present loading. Loading may be determined from a summary of the data in the address file or from transformer records. Land uses effecting the transformer loading are also noted (number of residential/commercial customers, type of appliances used, type of industrial user, etc.). Service and maintenance

TABLE VII-1

GEOCODED DATA BASES

1. Address File .

   -Customer Type
   -Usage
   -Historic Usage, sales
   -Special Flags, notations
   -Meter number, address
   -Billing address
   -Transformer I.D.

2. Transformer File

   -x,y location
   -Grid location
   -Transformer capacity
   -Service Data
   -Nameplate number
   -Power demand

3. Distribution System

   -Substation location, capacity
   -Switch connections, conditions (open/close)
   -Pole number, location

4. Small Area Load Forecasting

   -Transformer capacities, locations
   -Transformer loads
   -Existing land use
   -Proposed land uses
   -Substation loading analysis

5. Equipment Data File

-Equipment by ID
-Equipment by location
-Description
-Maintenance Schedule

6. Real Estate Data File

-Location
-Description
  Size
  Land use
  Valuation

7. Environmental Data File

-Land use / land cover by location
-Constraint / opportunity factors
- Monitoring records

data are also noted.

Every utility maintains a data base concerning its distribution system. Data such as location and capacities of substations, lines, switches, transformers and poles are generally maintained on maps. The maps may be geographic, schematic, or combinations of one another. Several utilities have begun to automate this data base. PP & L and SCE are automating their distribution networks to maintain an efficient data retriveal system in order to respond to both in-house needs and requests for data from the California Public Utilities Commission. H L & P has recently determined that automated mapping would be more cost-efficient than manually drafting the same data. They anticipate a three year amortization of the investment in such a system. This type of map automation is now becoming an acceptable method of data storage within the industry.

A data base of load capacities defined by small areas is generally maintained in tabular form by the distribution district offices or by the operations and maintenance group. New development proposals are evaluated with respect to this data base to determine the possible need for new or additional equipment. Automation of the capacities of equipment for the distribution system would allow rapid identification of these data. New projects could be identified geographically and overlaid on a map of existing capacities to determine potential need for new services or additional power. PP & L has expressed interest in developing such a system based on their experience with an automated GIS (The Environmental Land Use Data System). Land use data within the distribution system may exist as maps or as expert knowledge applied to specific improvements.

Each item of equipment which makes up the generation and distribution system is identified and tracked by means of a data base. This data base is a file or catalogue which is used to determine system valuations, load capacities, maintenance history and maintenance schedules. PG & E uses an automated system which sorts through the file periodically and identifies each item scheduled for inspection, service or maintenance during a specified time frame. This avoids the possibility of missing a required servicing because of misinterpreted records. It also allows maintenance schedules to be centralized and tracked efficiently.

Properties owned or controlled by the utility are identified in a data file which includes geographic identifiers, parcel identification, property description (including improvements, cover, etc), and a history of valuations for tax purposes. Mapped data are generally included in this data base, usually in manual form. However, as described above, the automation of distribution system maps has been found cost-effective. PG & E and SCE are including real estate property identifiers in their automated distribution facilities maps. These property identifiers could be linked to other descriptive data files (e.g., valuations, land cover, etc.) to provide additional capabilities.

Each utility involved in the development or construction of facilities maintains data concerning land uses, land cover, geology, and other geographic parameters. These data are evaluated by applying a constraint/opportunity analysis to the environmental data in order to determine the type and magnitude of impacts which would be expected to result from certain types of development. These analyses are then interpreted in terms of the suitability and capability of a given location to support a specific facility or activity.

More specifically, several utilities utilize environmental data maps to determine constraints which may lie within a predetermined general transmission line corridor. SCE has developed two environmental data bases which focus on desert and coastal areas in California. PG & E has used a large land use/land cover data base to identify expected constraints in several alternative transmission corridors. These analyses are "first-cut", and are followed by more specific analyses of the impacts and potential for their mitigation.

In addition to environmental data related to physical planning, generation facilities must maintain a data base which accounts for changes in ambient air and/or water quality. This data base includes the raw data and analyses from air and water monitoring devices and procedures throughout the area affected by the facility. The zone of influence is determined by hydraulic models (atmospheric and water) as well as administrative requirements (e.g., air quality management districts). Both baseline data acquired before operation began and data acquired during operations are included in the data base to detect changes which may have occurred. Meteorologic conditions are also recorded, as their effect on air emission concentrations may be substantial. Water quality data are recorded upstream and downstream from the facility. Water availability is determined by hydraulic models applied to precipitation and snow-depth data sampled throughout the watershed.

The information contained in the seven data bases identified here could be used interchangeably by some of the functional user groups identified in Section IV. Not all types of data in all data bases are required for a given function, but interchange of certain data types would facilitate analyses at various levels of decision-making, while reducing the number of times that the same data are acquired by a single company. Figure VII-1 illustrates an initial concept of data base linkage which would integrate the geographic data needs of a company. This system assumes an existing automated mapping function which could serve as the focus for integration of the other data bases. This assumption is a result of the present trend toward adopting automated mapping facilities in the industry.

An even more comprehensive database has been suggested elsewhere* which would focus on the operations and maintenance of the entire electrical distribution system and billing functions. Geographic data requirements are identified in that system as a framework on which to add electrical schematic reporting and operation functions in an automated system.

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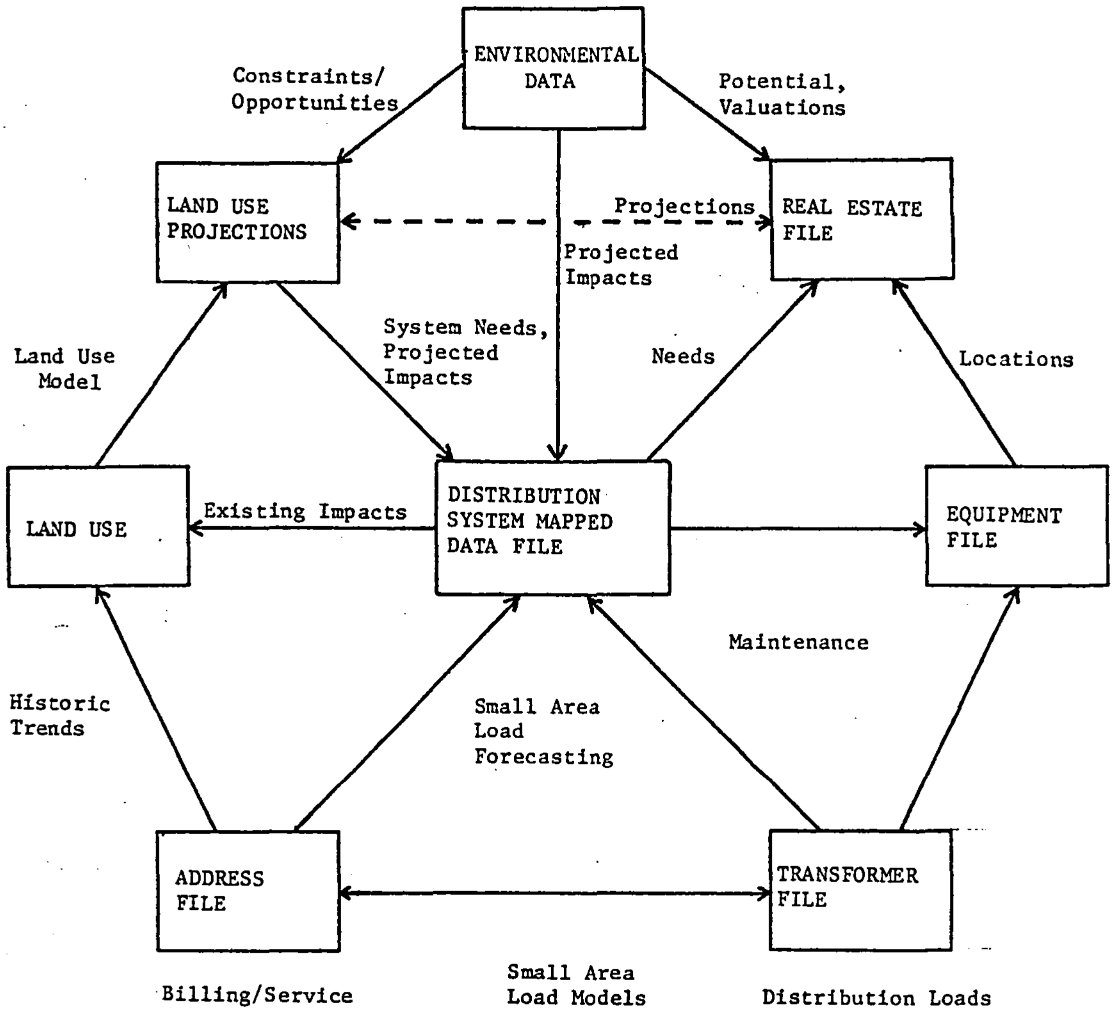
*Boeing Computer Services Company, 1979. Distribution Data Base Design. EPRI EL-1150.

Figure VII-1

Conceptual Geographic Data Base System



VIII. Potential New Applications

In order to identify the potential for new applications related to data needs in the electric utility industry, this section first presents a matrix which links the functional user groups described in Section II with specific sources of needed data (described in Section IV). This is followed by a discussion of the opportunities which NASA may desire to pursue.

A. The following matrix identifies the potential sources of geographic data needed to fulfill each specific function identified in the previous discussions. Not all data sources are utilized by all utility companies. However, each user obtains these data to perform the functions noted.

USER GROUP: Customer Service/Billing

GENERAL FUNCTION	SPECIFIC FUNCTION	DATA SOURCES: CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
Provide service to utility customers	Provide meter connections	Service area maps-detailed Plat maps		Address files	Meter readings
	Install service for new developments	Parcel maps with network facilities		Inspection schedules, results	Line inspection
	Identify customers with critical needs	"Flags" on system map		Customer records	Installation notes
	Maintain service	Address map Network map Corridor map	Low altitude for major trans-mission corr-idors	Customer reports complaints Automated switching records Equipment records by location	Distribution/generation equipment checks and installation
Billing	Bill users for power used			Address files	Meter readings
Power use summaries	Summarize power use	Service area maps		Transformer, sub-station, generation loads	Meter readings

USER GROUP: Real Estate/Legal

General Function	Specific Function	DATA SOURCES Cartographic	Imagery	Non-Graphic	Field
Property Management	Inventory utility-owned lands	Parcel map		Legal description	Surveys
		Resource management maps	Low altitude B & W, CIR	Timber type, age, volume, harvest records	Sample (0.2 acre)
	Watershed Management a) runoff for hydroelectric b) forestry c) recreation	USGS maps Water resources maps Hydrology maps Resource management maps Land use plans Planning area maps Plat maps USFS/DPR maps	Low altitude B & W high altitude CIR satellite HSS	Gaging station reports Runoff calcs Well logs Timber type, age, volume Census data Land use summaries Trail resources	Field notes/survey Channel measurements Test wells Perc tests
Acquisition	Recommends and implements acquisition of title/easement	Parcel maps Land use plans Plat maps	Low altitude B & W	Parcel/tax records Deed records Census data Land use summaries	Windshield survey Parcel surveys
Rights-of-way Administration	Administer transmission corridor rights-of-way	Zoning maps Future land use maps		Property descriptions, valuations	Property surveys

USER GROUP: Operations and Maintenance

General Function	Specific Function	DATA SOURCES Cartographic	Imagery	Non-Graphic	Field
Generation operation	Operation of fossil/nuclear plants	Facility location maps, schematics Environmental management District zones		System load/capacity Fuel supply/availability Operating conditions Air quality Seismic activity	Air/Water monitoring
	Operation of hydroelectric plants	Facility location maps, schematics Watershed maps Land cover maps Soils maps Forestry maps	Snow cover aerial or Landsat High altitude aerial, Landsat Low altitude aerial	Stream gaging reports Precipitation Downstream flows	Water monitoring
Distribution network operation	Substation operation and feeder switching			Transformer loads use vs. sales data	
	Line maintenance	Transmission corridor maps	High/low elevation aerial survey	Rights-of-way status	Field inpsections, maintenance
	Installation of new equipment/facilities	Location of new facilities			Property survey, engineering data

USER GROUP: Engineering/Research and Development

		DATA SOURCES			
GENERAL FUNCTION	SPECIFIC FUNCTION	CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
New facilities engineering	Evaluate specific sites	Land use/cover topography, geology, soils, roads, infrastructure	Low altitude aerial SLAR, thermal	Constraint ratings, air/water quality	Land use/cover topography, soils geology, etc.
	Design facilities	Parcel map facility schematic		Facility needs, building codes design criteria	Detailed field studies
	Impact analysis	Large scale topographic map	Low altitude aerial	Constraint ratings	Detailed field studies
Standards and regulations	Enforce utility standards and state/federal regulations	Monitor locations	Thermal, low altitude aerial	Regulations, test/monitoring data	Specific sites

USER GROUP: System Planning

GENERAL FUNCTION	SPECIFIC FUNCTION	DATA SOURCES: CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
Generation facilities planning	Estimate future generation loads	Reporting areas (e.g., census tracts)		Population forecasts, Economic forecasts, Census, Market surveys, Electric use records, Conservation trend, Climatic trent	Census, Surveys
	Evaluate potential plant sites (general)	Zoning, future plans, land use Environmental data	High altitude aerial, Landsat	Constraint factors	Windshield surveys
	Project equipment and/or purchased power needs			Electric demand forecasts, Equipment capacities	
Distribution planning	Identify growth areas	Land Use, Projected land use, Zoning	Low altitude/ High altitude/ Landsat	Development trends	Windshield surveys
	Site transmission corridors	Land use/cover Topography, Environmental data	High altitude, Landsat	Constraint factors	Field verification/sampling

USER GROUP: System Planning (continued)

		DATA SOURCES			
GENERAL FUNCTION	SPECIFIC FUNCTION	CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
	Identify equipment needs	Distribution system meter locations		Meter addresses critical need customers small-area local forecasts	
Fuel supply planning	Project seasonal variations in power/fuel needs			Climate (^{o}-days) use histories system-wide load levels	
	Satisfy regulatory requirements regarding rates and environmental			Regulatory requirements use levels air/water monitor records	Field samples
Rate structuring	Determine and substantiate need for changes	Proposed distribution system		Projected energy needs, power availability/cost facility needs/cost distribution requirements, fuel costs	

USER GROUP: Load Forecasting

GENERAL FUNCTION	SPECIFIC FUNCTION	DATA SOURCES: CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
Short-term, small-area load management	Project short-term power demand	Substation/transformer service areas, Distribution system, Proposed construction sites		Use levels transformer loads, Conservation trends, Appliance trends Proposed construction types, Climate	Construction proposals
	Schedule construction and system switching	Distribution system		Construction time-frame	

USER GROUP: Environmental Affairs

		DATA SOURCES			
GENERAL FUNCTION	SPECIFIC FUNCTION	CARTOGRAPHIC	IMAGERY	NON-GRAPHIC	FIELD
Land Use Projections	Project regional land use patterns	Existing land use, Future plans, Census tracts, Ownership maps, Jurisdictional maps, Development Capability maps	High altitude, Landsat	Census data, population fore-casts, Real estate surveys, ownership records, Jurisdic-tional requirements	
	Identify potential land use conflicts with utility proposals	Projected land use, proposed facilities	Low/High altitude aerial, Landsat	Constraint factors	
Environmental Data Base Maintenance	Provide environmental information to other departments	Parcel maps, Environmental data, Constraint/opportunity maps	Low/High altitude aerial, SLAR, Landsat	Constraint/ opportunity factors	
Pollution Monitoring	Document pollutant levels and mitigation measures	Monitoring network	Low/high altitude aerial	Air/Water/Soil quality, Effluent/Emission rates	

B. NASA Applications

The most immediate spatial data acquisition need perceived by most users is for accurate and timely land use/land cover data for purposes of first-cut siting of facilities and observing changes within the service districts. Such data may be useful at a variety of scales for a variety of purposes. For example, the following remotely-sensed applications may be of value:

1. High Altitude CIR Imagery
   - Land Use
   - Land Cover - forestry
   - Transmission corridor conditions
   - New construction/facilities
   - First-cut siting
2. Low Altitude Photos
   - Land Use/Land Cover
   - Forestry
   - Environmental Affairs
   - Siting Constraint Analysis
3. Thermal Imagery
   - Geothermal Siting (generalized)
   - Thermal Plume Monitoring
4. SLAR Imagery
   - Earthquake fault detection
   - Geologic constraints

5. Landsat Imagery

- First-cut facility siting
- Monitoring land use changes
- Forestry - generalized modeling
- Watershed analysis
- Cloud cover - solar equipment siting

In addition to providing spatial data, several companies felt that a Landsat image overlaid with service district boundaries would be an excellent graphic device to use in communications with the public and company personnel. The graphic presentation would add a concept of physical reality to otherwise abstract data summaries.

In addition to the purely graphic presentation of spatial data, personnel working with analysis of surficial data indicated a need for more information about the capabilities of Landsat imagery and/or other analysis systems. In particular, the forestry personnel at PG & E expressed interest in thematic modeling of forest resources and also the development of an automated mapping system which would allow more efficient forestry management. A predictive model was also suggested which would "grow" the forest into the future and identify changes in wood volume and valuation, as well as determining appropriate harvest dates. The major barrier to implementation of such a system was stated to be lack of familiarity with these techniques. Thus, an educational program would be in order to familiarize industry personnel with the new technologies available. A demonstration project designed in consultation with a specific function or group of functions would serve as an illustration of the techniques, costs and benefits of new technologies, as well as serving as an educational tool for disseminating these throughout the industry.

In addition to provision of data, NASA could provide support for more efficient utilization of the data bases which now exist in the electric utility industry. Data management and data flow studies could be conducted to identify all parameters which influence data acquisition and analysis. Because the industry is not standardized administratively, this task would best be performed within each company. NASA support could take the form of identifying techniques to improve data acquisition and analysis.

C. Future Research

A major future need identified during this survey is the correlation of land use types with energy demand and the development of predictive land use change models. Although land use types are used in projecting energy demand, the relationship is defined by number of customers of a given type rather than areal coverage or location of customer types. Lead time for new industrial customers is generally adequate for planning purposes, but residential development patterns change abruptly and are difficult to predict. Commercial development is correlated with residential development. The importance of residential customers has increased over the past few decades because of the introduction of high-demand appliances for space heating and cooling. The seasonal use of these appliances results in a vast difference between summer peak loads and average system loads.

In order to project the potential peak demands for additional energy, a relatively accurate correlation between user types and energy use could be made by using the existing billing data history. Correlations could be made according to lot size, zoning designation, age of unit, and similar parameters. These correlations, tempered by factors which account for conservation developments, could be combined in a model with projected development patterns within the total area suited for specific types of development. This areal component could be modeled, for example, from existing zoning patterns, types of development on specific slopes and soil types, future plans, road patterns, and other geographic parameters. This would enable planners to use the spatial geographic characteristics of the service district to both project future energy demand and to locate such demand and initiate plans for additional service. The rate of development (and hence, energy demand) could be projected as at present, using econometric modeling. An automated GIS system would facilitate this type of geographic modeling, and insure that the same identifiable factors are applied to each area under consideration, perhaps standardizing a function now performed largely by expertise and familiarity with each area. The expertise would be applied to developing the models and validating them. A demonstration project of this type could be used effectively to relate this concept to the industry as a whole.

IX. Cost - Benefit Considerations

Our experience with the electric utility industry to date indicates that although research into new techniques is being conducted throughout the industry, individual companies are conservative in their adoption of technologies and methods. The major criteria for adoption of new methods are:

1. Accuracy - New methods should be at least as accurate as traditional methods.
2. Time Savings - A decrease in the time required to perform a function is desirable, as is timeliness of data for decision-makers.
3. Familiarity - In-house familiarity with the technology is important to its acceptance.
4. Cost - Cost is not necessarily the deciding factor if the other criteria are met.

In order to place spatial data acquisition in this perspective, our survey indicates that large companies such as SCE and PG & E (over 2,500,000 residential customers each) spend $500,000/year and more on staff and contracts to acquire spatial data (land use, land cover, environmental). This does not include site-specific studies done by the engineering departments. Other companies (about 600,000 residential customers) indicate significantly lower data acquisition costs of $5,000 - $100,000, although it is not clear whether this figure includes staff time. Companies with fewer than 250,000 residential customers may use no significant amounts of spatial data (maps). Thus, the cost of using new acquisition methods will be compared with the ranges of costs identified by these companies.

While actual economic costs can be readily calculated, the impact of increasing temporal accuracy of data is much more difficult to measure. However, an argument can be made that a reduction of error in long range projections will save companies the costs of increased lead time resulting from continually changing projections.

For those functions which require the production of a discrete product, such as maps or reports, cost-benefit ratios can be calculated in a straightforward manner, amortizing equipment costs over a suitable period of time. This approach has resulted in the recent acceptance of automated cartographic systems among large and medium-size companies.

The cost of creating an integrated GIS system which is designed to improve data interchange between existing functions, such as the conceptual system presented in Section VII, are also relatively easy to calculate. This is because the costs are principally in the form of hardware and operations requirements. However, benefits accruing from such a system are in the form of such intangibles as accuracy, speed of information flow, speed of decision-making, and other expertise-oriented tasks which are difficult to quantify. In this case, if companies can be shown that benefits include significant increases in accuracy and savings of time, the criteria of cost may be of lesser importance.

The interest of regulatory agencies in new technologies may also have an impact on the industry, as these agencies require appropriate responses to their requests. For example, the Pennsylvania regulatory agency was provided data from an automated GIS by an intervenor responding to a proposed facility. The agency then asked Pennsylvania Power & Light (PP&L) whether they used such a system for facility siting. PP&L was able to evaluate the same location using its automated Environmental Land Use Data System, and thus satisfy the request of the regulatory agency. As more data analyses are requested by the regulatory agencies, the value for GIS data bases becomes increased in terms of accuracy, timeliness and documentation . A map-based GIS also provides rapid graphic alternatives for presentation purposes.

Two routes are apparent for determining the usefulness and benefits to the industry of remotely-sensed data, GIS systems and land use-based energy demand projections. In first route would be a demonstration project or projects conducted by NASA and one or more large utility companies (the larger companies have a greater perceived need for such data and technologies). The demonstrations would be followed by technical reports and trade journal articles.

A second route is to channel some effort through the Electrical Power Research Institute, which funds research projects conducted on behalf of the industry as a whole. Significant portions of EPRI's research and development budget are earmarked for environmental and geographic-oriented research into resources, siting and impact relationships. EPRI also indicated interest in correlations between land use patterns and types and their energy demand.

In either case, the objective of the research would be to demonstrate the applicability of the new technologies to the industry, document their accuracy and costs, and to communicate these findings throughout the industry.

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Appendices to

FINAL REPORT

Survey of Spatial Data Needs and Land Use Forecasting Methods in the Electric Utility Industry

Prepared for

National Aeronautics and Space Administration
Ames Research Laboratory, California

Contents:

APPENDIX A

Interview Notes (Summaries)

1. Copy of questionnaire format
2. Summaries of interviews with:
   a. PG & E
   b. SCE
   c. HL & P
   d. PP & L

INTERVIEW QUESTIONNAIRE

Name of Interviewer:____________________
Date:____________________
Time: Start:________ End:________

A. ADMINISTRATIVE

1. Name the organization being interviewed.

2. Name(s) of individual(s) being interviewed.

3. What is the location and size of the service area of this organization?

   ____________________(sq. miles, acres, other)

4. Approximately how many customers are served?

   ____________________Residential
   ____________________Commercial
   ____________________Government/Institutional
   ____________________Industrial
   ____________________Other

5. What specific responsibilities does this utility have to the communities served?

6. Describe the basic organizational structure of the utility. Obtain a management chart if available. If not, diagram relationships between departments.

7. What are the specific responsibilities of each department?

8. Within each department, what operational decisions require spatial data?

B. DATA TYPES AND ACQUISITION

1. Name or describe the current types of spatial data in use.

   Maps | Tabular Data

2. List the sources of this data.

   What portion is generated in-house?

   What portion is acquired outside the utility?

3. What classes/categories are used to subdivide spatial data?

4. Describe the scale and locational accuracy of the mapped data which is currently used (i.e., placement of features with respect to surrounding features).

5. Describe the temporal accuracy of the mapped data which is currently used (i.e., how up-to-date is it?).

6. Describe the extent of coverage currently available from mapped data (localized, regional, statewide?).

7. What is the approximate annual cost of spatial data acquisition?

8. What is the frequency of updating of mapped information? Is this frequency adequate for the needs of this department?

9. Does this utility (or department) use remotely sensed data? If so, describe how it was used and potential future uses. If not, is there a perceived need for such data?*

10. Does this utility use automated geographic data (digitized files) handling procedures? Which data categories are included in these files? Do the files cover the entire service area?

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* See attached description of Landsat.

C. DATA ANALYSIS AND UTILIZATION

1. Which departments within the organization utilize land use/land cover data?

2. How are these data used to support the decision-making processes?

3. Describe the types of modelling (e.g., econometric, weighted overlay analysis) that are being done. Use flow diagrams and describe methods used.

4. What type of trend analysis or forecasting methods are currently used?

5. What are the factors limiting the use of land use/land cover data by your department and others? Which factors are the most important limitations?

6. Identify potential users of land use/land cover data if these data types were automated.

D. <u>DATA PROCESSING SYSTEMS</u>

1. Identify the automated types of spatial data currently used. How many systems and files are currently employed?

2. Is spatial data automation done in-house? Describe. How many personnel are engaged in this task?

3. Describe the hardware/software configuration currently used. Specify the model of computer used?.

4. How are data files maintained and updated?

5. Are the data files tied to an x,y coordinate reference?

6. Can stored data planes be overlaid using an automated technique?

7. Are image processing and classification capabilities being used or investigated?

These are notes from the meeting with P.G. & E concerning the energy EPT contract with NASA/AMES:

1. We identified during the meeting those users and potential users of land use forecasts, land use information and general geographic information that LANDSAT and a GIS system would support. They were as follows:
    - The land use group within urban and regional planning within the Land Department, specifically, Frank Burney and Joanne Effron.
    - Mr. Greg Lugger who is the manager of Computer Applications. It was suggested that he would be able to give us ideas about other people who are interested in the GIS as well as land use/LANDSAT information. He handles user requests for various types of data and would have an idea of who wanted what.
    - Mr. John Mock to discuss the electrical distribution systems analysis (EDSA system). This is a system which aggregates the customer file data.
    - Mr. Jack Simpson, Information Systems Division to talk about the customer master data file.
    - Mr. Jim Ochefee, Economics and Statistics Department.
    - Mr. Jack Cammeron and Forrest Sullivan in the Forest Division.
    - Department of Engineering Research, Marilyn Eaton and Jim Adams. Jim is director of the department and Marilyn is a specialist in remote sensing.
    - Mr. Orville Hill in Distribution Planning. He is the person who did the study with Westinghouse on LANDSAT in Fresno County.

The following is a description of three data systems that exist for P.G. & E for handling three levels of information:

The first of these is the customer master file. This system is an operationally based and maintained system which contains the information on each customer within P.G. & E. This system is maintained by the Information Systems Division and contains exhaustive files on each customer, including the name and address of each customer, historic and present consumption of energy, billing information, SIC codes for each user, special equipment coding (i.e., identification of customers with special P.G. & E such as larger substations or special types of meters), flags for users of life support systems such as medical - households with kidney or heart machine equipment in use.

On this file are hundreds of items and they are maintained in a secured file, that is, they are not extractable or usable outside of the company.

Electrical Distributions Systems Analysis (EDSA) system. This is an information system containing a series of data items by electrical transformer, each of these transformers has an X,Y coordinate grid associated with it, expressed in State Plane coordinates. Typical data items include usage data, peak loads by transformer, etc. There are typically four to five customers served by one transformer. This varies, of course. Some agricultural users have one transformer for their own use, whereas in more dense areas numerous housing units are tied to a single transformer. This system is under the charge of the distribution engineering department and is used for simulating peak loads and usage within the network.

This system is tied to a geographic aggregation program, which aggregates the X,Y coordinate point data to either grid cells or census tracts. When grid cells are applied, user can specify the grid cell size which he desires to have the information aggregated to. This information in turn is printed out numerically by the pre-specifiec grid or by census tract in the case where polygon information is desired.

This system is used to look at load changes within the subsets of census tracts.

This group is not interested in working on energy forecast techniques.

It seems that this file could be most useful as a file to integrate with the other GIS information.

This data file has one master file for the entire service territory and is updated on a yearly basis.

Within P.G. & E there are two types of forecasting efforts that go on. They include systemwide forecasts and distribution forecasting.

A. Systemwide Forecasts

For the large part, systemwide forecasting consists of econometric modeling for the entire service territory and includes various types of social and economic/graphic characteristics which are put into a model (we presume) and looked at over long periods of time. Within P.G. & E these are done by several different organizations.

1. Generation planning department. This organization reports to planning and research and does systemwide forecasting which is electrical related.

2. Economic and statistics department. This organization also does systemwide forecasting. Its forecasts are economically related. It does this in two ways: 1) small area forecasting similar to the urban and regional planning forecasting work and

in fact is used as a cross-check for it. 2) Systemwide modeling which uses an econometric model to look at the entire system and demographically model the future.

3. Transmission planning. Transmission planning also does systemwide and does it by breaking down each division with local data using an electrical method. This group takes various divisions and summarizes the forecast information by division. Because of this, the forecasts are usually higher than they would be if looked at in an aggregate total.

4. Division forecasting. Many of the divisions also do local area forecasts which are based on building trade information, local area indicators, and so forth. This forecasting technique is not done rigorously nor with a detailed analysis method. It is more a pragmatic approach- a pragmatic and subjective approach to what growth will occur in the future.

The company then uses a committee which judges and verifies the information coming from these various sources to make its long range forecasts. This committee attempts to make judgments on the data as to its validity but we have no clear understanding of how this evaluation and judgment occurs.

In the long range forecasting efforts - land use data is generally not used. Usually this is because, at a total systemwide level, the parameters are difficult to capture and the information that they do use is very general. The only way the geographic data (i.e., land use) could be used in the systemwide application would be to take small areas at a time and forecast them independently and then aggregate these small areas into a systemwide total. This approach, popularly called the'bottoms up'approach is typically less accurate because it tends to compound the error. Specifically aggregating small areas increases margin of error; therefore there are real problems analytically with this methodology.

One might say that the larger the area the better, basically because you compound your errors with taking smaller units. Smaller area forecasts tend to usually be higher.

B. Distribution forecasting.

The second type of forecasting work is done by the land department, urban and regional planning. It involves forecasting small areas within the overall service territory. They are usually short-range forecasts for small pockets of total service territory. They range in size from an entire county such as Santa Clara to parts of a county such as Fresno, to parts of cities such as Bakersfield and Stockton, down to small areas of urbanization such as Livermore Valley, Diablo Valley, Valencia, Selma, Red Bluff and the city of Santa Cruz. Over the past five years people in P.G. & E have covered approximately 25% of their service territory by performing these small area land use forecasts. These forecasts service three different groups within the company. Specifically there are three "clients" for the data. They include:

1. Distribution
2. Transmission
3. Divisions

Distribution

Distribution planning is typically interested in small local areas - especially interested in forecasting the population and land use changes occurring within small local areas.

Typical problems are to obtain a clear picture of what is happening to a small local area where they are experiencing eratic load growth or change. Typically they don't have the overall picture and cannot rationally explain the total growth activity and therefore request the land department to investigate these local areas and forecast growth. The indicators which tell distribution planning that something should be investigated are typically an up and down fluctuation in the peak loads and also a steep growth. Their problem is that in order to handle these fluctuations and growth surges they would like to obtain a longer term picture of the growth patterns so that they can better plan, budget and allocate resources (capitol resources) to support systematic supply of services. Specifically, these steep growth patterns require capital investment. Before they make these kinds of investments in substations, additional transmission, etc., they need to know what is going on both in the short term and the long term picture. Therefore they need to produce the growth assessments. These study projects are typically done over a three to four month period. The output is typically a report and an oral presentation containing the projections and a general description of the situation. The report is typically presented within two months, giving an additional month for formalizing the study's information and presenting it to the distribution planning group.

The forecasts typically are for five, ten and twenty year increments of growth.

Transmission (Engineering Planning)

This group is similar to distribution planning in that they need relatively short term forecasts (5-7years) for relatively small areas, more typically groups of small areas, such as the city with a series of small isolated communities around it. They are again interested in knowing the kinds of growth that would occur for which they will be required to support with engineering and capitol improvements. For example, will this area require a 230 KB line within the next five years. This request may assess whether energy is being adequately supplied to a given region. It may also be used to validate or evaluate a given proposal for a capitol investment, such as verification that at 230 KB line is justified or should be larger. Questions such as "will the growth be there" are often the source of such an investigation. Transmission assessments like to look at a broader perspective and are more focused on the regional fixture. The information is critical because small changes can have a big difference in the amount of capitol investment that is required. These investments are very sensitive to small variations in growth change.

The key information for distribution planning, transmission planning and the divisions, that is the key information that is supplied to these groups is population, residential units and employment.

3. Divisions

Within P.G.& E the service territory is divided up into geographic divisions, wherein the basic responsibility to provide gas and electrical services is managed. These divisions have allocation problems which require some type of allocation information. For example: Within any given division they need to know whether they need new district offices vs. dispatching from an existing office. If new dispatching office is required, how many people will be required to go there. Therefore manpower planning is a real consideration. Finally if a new district office is needed, consideration about location is necessary.

The basic problem is one of determining the most efficient manner to allocate district resources.

4. Gas Department

A fourth potential client is the gas department. Technically this group is also one of the clients and users of land use data, however, they have not been under as close a pressure to forecast as closely. One, gas is not expanding as rapidly. Also they have not been required to rationalize their planning procedures as closely.

5. Another group that could potentially use this information is the energy conservation people who are looking at the land use data as a source.

P.G. & E is also doing a private investigation into the use of a computer designed hardware/software turnkey package retrieval system. This is a special project mandated by the PEC so that information can be more readily retrievable on all the P.G.& E rights-of-way and land information and engineering data.

Applications

A. Environmental Data contained in the AEGIS system. This system is used by a series of clients in the land department. There are three users of the AEGIS system.They include the Land Department, the Siting Department and the Legal Department. The Land Department basically serves these three groups in the following manner.

1. Land Department - The Land Department prepares EIRS and environmental data statements for transmission lines, substations and activities which are performed by the company. These reports are done for the electrical and gas department who have sited something and need environmental review or want environmental information to assist in their siting efforts. These environmental studies generally fall into

three categories. 1) Regional study - These are generally information type reports and maps and are used to decide on the feasibility of a project or help define the geographic location of the project more finely - 2) Detailed Analysis of Project - These types of reports focus specifically on the impacts and mitigations that are associated with a planned project and the environmental data is used to support both understanding these impacts and also determining the kinds of mitigation that can be used - 3) Special Studies - These are various types of studies which look specifically at the detailed impacts associated with one particular impact. Examples of this are as follows:

- At one facility what are the impacts on the agricultural lands?
- What is the population density around a specific nuclear plant?
- A specific request by the Energy Commission desiring more detailed information on some aspect of a proposal.

B. Siting Department

The Siting Department asks the land department to do special kinds of studies associated with land use, cultural resources and general information on areas. These requests are generally to support some type of feasibility study. A typical question might be, given a particular power plant site, are there ways to fit a transmission line to it? Concerning land use a request may be made to look at and give an area and provide the basic land use data in a map or in a descriptive manner presenting not only the base line data but also the kinds of constraints that it represents, (ie, economic, political aspects, etc.). An example might be if we propose a wind generation or a LNG plant in a given site what can we expect the conflicts might be?

These types of requests are usually a short turnaround.

Include in the discussion concerning EDSA Gordon Johnston.

The person to meet in Econ and Stat would be Jim Okeefe.

The AEGIS system is primarily used for the following:

1. Environmental reports of various projects.
2. Primarily used for transmission line work.
3. Most of the work involves working with groups who need environmental review information.
4. Some of the studies involve working with consultants who need in-house data.
5. Some of the work is to serve other consultants.

P.G. & E is interested in doing a demonstration project with NASA which would involve doing mapping of agricultural lands in Fresno County. The background of this project is that a farmer was able to stop a project because he claimed certain kinds of economic or other types of damages to his farming activity. The key concern is vineyards for grape growing. Alternative corridors have been designed to avoid the vineyards and they would like to be able to develop a map for about a thousand square miles which show where the vineyards were.

This is a continuation of the assessment of the Siting Department's information needs. Mostly the Siting Department asks for three types of information:

1. Land Use data maps and descriptions.
2. Laws and regulations reflecting what they can do by various jurisdictions.
3. Parcel ownership information, specifically they want to know the boundary of the parcel, whether it is publicly or privately owned, and within the public and private categories, who more specifically owns it (i.e., Park Department, BLM, etc.)

3. Law Department

The Law Department's request for geographic data is primarily associated with "special studies". Typical requests are for details on the costs of certain kinds of crops, seasonal patterns of crop data,small assessment studies like visibility studies, investigations into compatibility between certain kinds of environmental conditions and certain kinds of siting facilities.

<u>Siting Department</u>

Siting activity is actually a very straight forward activity as perceived by the engineers. The overwhelming constraints for nuclear are geologic safety whereas the overwhelming constraints for coal are the air quality. All the other constraints are minor in their eyes and they can"buy out of them". Therefore the environmental data is used either for micro siting within a particular parcel for documenting existing mitigation efforts or also to assist in routing a transmission line to the plant.

Engineering research does biological studies and also investigations into remote sensing work.

Shiraz's group are effective in-house consultants of P.G. & E and have various clients. They provide study information too.

In summary I think we ought to look at the three different data systems; customer files, the EDSA and AEGIS (describe their data contents, how they work, their users and so forth) and describe the applications that can use this kind of information. Expand and evaluate the applications in terms of whether they can use LANDSAT data. This might best be constructed in a large matrix .

M.J. Doyle, Jr., Senior Environmental Specialist
Department of Engineering Research

Responsibilities:

The Department of Engineering research is responsible for siting and designing facilities. Once the facilities are constructed, the department is responsible for maintaining regulatory standards, including metallurgical engineering standards and testing. To facilitate this, they use extensive computer facilities, both in-house and at Battelle Northwest in Washington. PG & E does most of the basic research in the industry related to new products, machines, and methods.

This department researches and produces the site-specific Environmental Impact Statements and maintains a staff of oceanographers, biologists, geologists, engineers, and other professionals, many with earned doctoral degrees (e.g., 40 biologists on staff now). A general site selection process (capability, suitability) has already been accomplished by the Lands Department before Engineering is brought in. Of major concern at this time is the modeling and analysis of a thermal plume of cooling water which will be produced by the Diablo Canyon Nuclear Facility. This has required the continuous monitoring of oceanographic and meteorological data from 80 - 100 points over a 12 year period. Because a great deal of accurate ground data is available, this area was suggested as a test area for remote thermal sensing.

Geographic Data:

This department uses the following geographic data:

Aerial Photographs (low elevation, kelp bed mapping)

Topographic Maps (USGS and engineering scale)

Infrared Scanner (thermal plumes, geothermal siting)

SLAR imagery (Earthquake faults)

Dispersion rates (dye in water)

Analysis:

Geographic data are used first to determine the feasibility of an area as a site for a facility, and secondly to engineer the specific locations of the various parts of the facilities. Known and imaged earthquake faults are of paramount importance in siting nuclear facilities. Air quality is the primary constraint for siting conventional power generators. Hydroelectric siting requires long-term climatological and runoff analyses, as well as analysis of topographic and geologic constraints and opportunities.

Computer Facilities:

6 Wang systems - primarily for word processing Modem links to UC Berkeley, Lawrence Livermore Laboratories, Stanford, Battelle, and Information Research bibliography. Access PG & E Main Computer in San Francisco. Also access National Oceanic Data Center.

Gregg Thornbury

Land Department, Urban and Regional Planning Division

Responsibilities:

The Land Division is responsible for management of all PG & E owned lands. This includes lands on which facilities are sited, gas and transmission corridors, and other lands owned and/or managed by PG & E (forests managed for watershed, etc.)

For tax purposes and fiscal analysis, all owning must be inventoried with a relatively high degree of accuracy. In terms of watershed and recreation management, the primary criterion is runoff for hydroelectirc power. A secondary, but important, criterion is economic value of standing timber not harvested, as opposed to harvested timber. Recent changes in tax law have increased the value of standing timber as a write-off.

Analysis:

This group uses two types of geographic information systems. The first is AEGIS (Automated Environmental and Geographic Information System). It is used in corridor siting analyses and regional-scale inventories and modeling. The Urban and Regional Planning Division is the only group which actively uses AEGIS. However, the group serves as a consultant to the remainder of PG & E departments. This system is automated at a scale of 1:24,000.

Each of PG & E's 13 geographic subdivisions is acquiring a stand-alone automated map system for retrieval, alteration, and re-storage of facility and land data at a scale of 1 inch = 50 ft. This will allow the facilities inventory to be updated as necessary at the regional level. Most of the mapping is done in-house, and PG & E has estimated a $30 million, 10 year budget to digitize existing and projected maps. These data will be used for routing studies and planning as well.

A MIDAS (Map Information Display and Analysis System) data file is used to store information associated with energy usage. The file contains 128 layers of data with respect to types of electrical applicances, history of use, assessment data, flags for hospitals, critical machinery, etc.

John Cameron, Jr.
Supervising Forester

Land Department
- Forestry
- Recreation

Responsibility:

The Forestry Division manages 63,000 acres of commercial timberland, 54,000 acres of marginal timberland, and 43,000 acres of water which average over $2 million income per year from 22+ million board feet of timber. In addition, much of the area is subject to management of outdoor recreation facilities and activities. Management decisions rank hydro water production as top priority. Nine foresters are employed and approximately $100,000 annual budget.

Geographic Data Used:

Aerial photos (1:20,000, color at 1:11,000)

each 9 years for commercial land, 18 years for marginal.

Land management maps (1" = 1,000 ft.)

- Timber type
- Volume of wood
- Condition (growability)

Have looked at landsat imagery, but feel they lack expertise to use it.

Would like to automate certain map data and growability data so that a model could keep track of timber inventory with only spot checks required on ground.

Analysis:

Land management maps are drafted at a scale of 1 inch = 1,000 ft. Based on aerial photos and field samples (0.2 acre plots), the management units (1 Unit $\stackrel{=}{<}$ 640 acres) are subdivided into smaller polygons homogeneous for logging code, land class, age-density class, species, and sight class (growing power).

Timber management data are converted to annual site-specific yield and market values for tax data and harvest decisions.

Runoff estimates and measurements are used to indicate how much of a given watershed can be harvested.

Aerials are used to crown inventory holdings. Also extremely useful to determine landmarks which help identify corners of management area and possible sites of encroachment on property and transmission corridors. Other data input includes CDF & G soil/vegetation maps, recreation area maps, SCS soil surveys, and an in-house erosion potential map (for harvest planning).

Computer Facilities:

A tabular data file has been developed to store and analyze the field samples obtained by the department. Input includes township, range, management unit, county, logging code, land class, age class, density, species mix and sight class. No automated graphics is used at present. However, the department feels the technique would be useful. The respondent also suggested use of landsat data to assign classifications to unsampled areas based on similarity of signatures.

INTERVIEW NOTES

Electric Power Research Institute
Palo Alto, CA
Sherman Feher

EPRI is a non-profit research institute founded in the 1960's. It is funded by and represents both publicly and privately owned utilities throughout the U.S. EPRI develops a research program and manages the peformance of such research by consulting engineers, etc. EPRI employs 600 employees and 600 utility advisors.

EPRI sees a definite need within the industry for correlating land use and a spatial format with power consumption and projections of future demand. Energy demand projections are now based on population/economic growth indicators and models (e.g., market saturation of appliances per end-user class). Spatial data are now used primarily for siting: a function largely performed by consultants.

The Edison Electric Institute was identified as the lobbying arm of the investor-owned (private) electric utilities.

A day was spent obtaining publications and references from the EPRI library.

Notes from meeting with SCE concerning general data needs and processes

1. We identified during the meeting those SCE departments which use geographic data and automated data files, and also those groups engaged in forecasting land use changes and energy demand. These groups are:

- Customer Service Department automates power use as a function of electrical sales per transformer unit throughout its service area. This department is planning to automate these data by geocoded service area.

- The Treasurer's Office maintains an automated data base of economic data related to production costs and corporate financial structure. These data are used to produce financial reports and to support rate changes.

- Environmental Affairs has purchase automated land use - data files produced from interpreted aerial photos. Land use conflicts are the predominant constraint on facility siting in the service district, and SCE budgets approximately $50,000 per year to acquire land use data. THe geocoded data are mapped at a scale of 1:24,000, referenced to USGS 7.5 minute quadrangles. Contact: Bill West

- Research and Development has purchased an automated land use/land cover data file for two areas of concern: a transmission line siting study in the desert, and the coastal zone of the service area. These data bases are intended for use in screening potential sites for transmission corridors and other facilities, and for generating data required by reviewing agencies. Data files include topography, land resources, and other environmental resource data. Contact: Mona Myatt

- Right-of-way maintains parcel-based data on zoning, future land use, and legal property descriptions. These data are coded by parcel number, and consist of parcel-specific listings.

  This department is presently automating all of the land holdings and facilities owned by SCE. This project includes a digitized geocoded data file. This department has purchased a 13-station computer image system to support the mapping project. Contact: Steve Barrett, Kurt Stroebel

- The engineering and construction department (Emil Schultz) is responsible for actual siting of facilities. They currently employ engineering data bases which evaluate field-collected data from specific sites.

- The System Development Department produces quarterly and annual power projections, and a biennial forecast for electric system planning. Contact: Vikram Budhraja

2. The following data systems have been identified at SCE for handling information of varying levels of detail.

The customer information file (CIS) is a sortable cross-reference file which contains meter information, address, structure and appliance data and billing information. It is a secured file, and only summary information may be released outside SCE.

The mapping information file ("The Mapping Project") contains parcel numbers, geographic coordinates of digitized data, and identification codes of all SCE facilities. Land uses on adjacent parcels are also indicated. This data file may be updated as, for example, new subdivisions are approved or new facilities engineered.

The environmental and land use/land cover data files are x,y encoded and convertible to a grid format. These data files are used to evaluate general facility siting possibilities and constraints prior to actual site engineering. The environmental analysis group is interested in using regional scale land use data to support the current load forecasts. Forecasting is system-wide and does not presently use land use types as an input.

Land use is updated at 5 - 10 year intervals using aerial photos to identify areas which have changed.

3. Forecasting

   A. System-wide forecasting is done by the System Development Services Department using an econometric model which uses regional economic factors and appliance counts to project future peak and average energy demand. Land use data are not currently used in this projection.

B. Electric System Planning is responsible for allocating lines based on development in various areas. This assignment is done by consulting the district office, which keeps in touch with development patterns in its district. Projections are made based on estimated construction activity in the districts and the system-wide energy demand projection determined. Actual allocation of facilities is based on an as-needed basis, with major land acquisitions and substation/transmission line siting based on 2 - 5 year projections.

C. The Accounting and Control Division does economic and energy budget projections based on statistical analysis of past performance. Trends are identified based on billing and new connections, and reported to the SCE organization.

The Urban and Regional Planning Department of the System Development Division then uses a committee to evaluate projections and tentatively allocate resources to specific areas determined to be growing. A modified Delphi approach is used, with several iterations required before each member of the committee is satisfied with the results. The result is a report on the land use trends and energy demand projections within each division. These projections are reported in three geographic breakdowns:

- Entire County Projections
- SCE Service District Projections
- Census Tract Projections

An automated mapping system is used to provide land use data by category and acreage within each of these statistical reporting areas. It is called a land use mapping and overlay system (LUMOS).

THIS IS TAPE NO. 1 ON THE INTERVIEW WITH HOUSTON LIGHTING AND POWER CO.

On Monday I conducted an interview with five people from Houston Lighting and Power . They included Ed Klawitter, who is the head of that dept.; Wayne Hanson, who is the supervisor of engineering system planning; Jim Zubro, who is a geographer and heads up their land image processing efforts; Manuel Munoz, who heads up their load forecasting effort as load flow engineer; Mark Garrett, who is also an analyst in the load flow engineering section.

The interview began by a lot of talk from them and specifically by Ed Klawitter . HL & P, like other utilities, have a series of standard functions, which they are responsible for conducting analytic efforts within. The engineering department is focused on allocating by approximately 900 substation polygons, the overall growth forecast projected by an econometric model generated elsewhere in their company.

H.L. & P. covers approximately 5200 square miles, with between 30 and 40% of this land urbanized or in suburban land uses.

The problem for the engineering department is to forecast ___________ by land use by the some 900 geographic units. To do this, they have developed a model conceptually which is presented on figure 1. As input to this model, they require land use/land cover. Their plan is to use classified landsat data which they would process using the VICAR system or some other image classifier which they could make operable on their own hardware. They want to determine what the land use is now. They need this for two purposes: As input into their load forecast model; and for input to their land use forecasting methodology.

The land use methodology involves the manual integration of land use environmental data, social economic data, and transportation accessibility; as well as trend and real estate information in a small area sense, in order to forecast what land use growth will occur by each of the twelve to fifteen land uses. Therefore, they need the land cover data for two elements; the first is statistics by each of their 900 substation units for the region. These statistics go directly into the load forecasting model. The second is graphic data which display the geographic extent of various land use categories; that is, the geographic distribution of various land use categories over the entire service territory or by subportions of the service territory. This land use graphic/geographic data would be in the form of maps such as greytone electrostatic maps suitable for graphic overlay with other data variables such as those listed in Table 1.

H.L. & P. presently plans to conduct a scenario development looking at alternative growth futures for each of a number of subregional areas using the information on Table 1 as input.

LOAD FORECASTING MODEL

H.L. & P. have acquired a basic load forecasting model which runs on their PRIME minicomputer. It is a proprietary package called ________________. The basic inputs for this model are:

a. Land Use
b. Forecast of Land Use by Percent of Growth within Each Land Use Category
c. Historical load for the past six years, associated with land uses
d. Several minor data items in use and instruction

This group is termed in the company as the landsat experts, so the people from all over the company who need a little bit of landsat expertise or consulting work or just need to be educated about what somebody is trying to tell them or sell them, go to basically this division to get the answers. These include both outside vendors who are trying to sell something to the company as well as inside advocates of image processing. The past experience has resulted in the engineering department being able to settle down over-ambitious efforts to make landsat technology apply to things which were not realistic or beyond the capabilities of the software.

TABLE 1

INPUTS TO THE LAND USE FORECASTING METHODOLOGY:

1. Land Use (12 - 15 Land Use Categories)
2. Environmental Constraints
   a. Flooding
   b. Air Quality
   c. Hurricane Threats
   d. Related Problems, physical in nature
3. Socio-Economic Data (Various statistics displaying where geographically problem areas exist which may limit future growth and expansion of the urban land uses.
4. Transportation Accessibility
   a. Shipping Accessibility
   b. Rail Accessibility
   c. Road Accessibility (particularly accessibility to limited access highway interchanges.
   d. Access to Downtown (Including subcenters scattered throughout the metropolitan area)
5. Restricted Land (Various governmental ownership such as parks, reserves, wetland, etc.)

The output of this model results in three types of forecast: Short Range (i.e., five years); Medium Range (i.e., 5 - 10 years); Long Range (i.e., 10 - 30 years).

CONTINUATION OF LAND USE GROWTH FORECASTING

The results of developing the scenarios of growth will most likely be initially graphic maps manually reproduced and subsequently used to generate acreage statistics of land use growth by preset classification. Ultimately, these land use forecasts will be associated with the existing land use areas and percent of growth statistics will be generated for input to the land use forecasting model.

DIFFICULTIES AND NOTES

At this time, they have been working for approximately one year on several efforts associated with getting VICAR onto their IBM machine. The problem they have and seemingly endless series of problems in making this possible. They are principally associated with the difficulties of maintaining VICAR with a changing operating system. Specifically, the VICAR system is strongly tied to the operating system of the IBM 370. At HL & P this operating system changes frequently leaving the users of the VICAR system plagued with having to update VICAR's program on a weekly and monthly basis. The time is accomplish these updates has almost completely strangled their efforts to achieve operation of VICAR within the company.

Because of this problem, they have made a decision to convert the VICAR (?) system over to PRIME minicomputer as a way to make it operational without being subject to the frequent problems of operating the system modifications. Their effort on the landsat program has been one full time person, one half time person and several others who participate on a cumulative quarter time basis resulting in approximately a commitment of two persons on a full time basis.

HL & P is operating this effort on the basis of a pilot, They continue to use a fully manual system for forecasting the land uses based on straight line projections of historic land use within each of the regions. Therefore, their management feels that they have the ability to scrub the entire project at any time that they feel that it is not working out.

Previous to this effort, they had the development of some grandiose schemes and designs for involving massive amounts of digitizing of land use data by hand. This scheme was experimented with and ultimately dropped by the company because of the extensive management time and costing efforts that are required. In observing landsat, they felt that it would be a way to obtain cheaply land cover data for their forecast efforts. The objective is very clear; that is, the use of landsat for desegration of overall land use forecast for the 5,000 sq. mi. region.

They are very supportive within the engineering department of continuing on this experiment for as long as it takes to demonstrate that it is or is not going to work and they have made the commitment of maintaining one full time person and the other staff resources as mentioned plus up to $5,000 a year in incidental expenses. They feel that the benefit from this could be the following:

1. Acknowledge that such a system will or will not work.

2. In-house knowledge and capability to understand when outside organizations come and attempt to come and sell them a bill of goods. Specifically, they would like to have in-house knowledge of what is real and what is not real in the landsat technology area and land use forecasting areas.

They have two basic complaints: One is that the landsat data as has been shown to them is not necessarily demonstrated as a useful product to them. Two, they simply can't get the VICAR system to function smoothly for them. In this regard, they did do a demonstration project with the university simply resulted in a series of technical problems and no accomplishment in a real sense.

In particular, they would like to get a program running so that they could get a listing of the characteristics in an individual pixel. It is called out by some geographic location and find out exactly what has been classified in the way of land use data for that pixel. Table 2 is a breakdown of the land use classes that they are interested in.

GEOGRAPHIC RESOLUTION NEEDED

The geographic resolution required for total acreage summaries is 160 acres. That is for the load forecasting models the minimum resolution is 160 acres with a breakout of percentages of land use type for each of those grids. The resolution required for land use forecasting, however, since it is a graphic product and used with other data types, such

TABLE 2

LAND USE CLASSES OF INTEREST

1. Residential
2. Multiple
3. Single Family
4. Commercial
5. Industrial
6. Light Industry
7. Heavy Industrial
8. High-rise Office Bldg.
9. Transportation
10. Highways
11. Rail Lines
12. Water
13. Parks & Open Space
14. Undeveloped Area
15. Environmental Factors Constraining Land use (i.e., floodplains, tidal areas, hurricane prone areas, and bad air quality areas)
16. Institutional

air photos and maps would be better if more tightly associated with the polygon outline of the actual use.

Table 2 should have at the bottom a footnote that says, at present they are sti-l working on an adequate land use classification, but they feel that they can't do anything at this time until they have a better understanding of what landsat can give them in the way of a classification. They feel that they can adapt their requirements to the sensor outputs for a workable solution.

Philosophically, HL & P are very oriented to developing in-house capabilities as opposed to hiring short term consultants for "consulting" on what they need and how the system should work. They feel that by building the basic know-how in-house, they could make better judgements.

This philosophy will obviously have much higher pay-off because it represents an organization willing to make a commitment toward understanding completely a technology before they begin to play with it.

II. TRANSMISSION LINE LOCATION

The second major area for handling geographic data involves transmission line location. The company has been working for many years in deciding on transmission lines and in fact, is very active in transmission line development at this time. These include both within their service territory as well as development of transmission within the Lignit belt of coal where it is expected that many of the future generation facilities for Texas will come from, and in conducting these transmission line studies, they do a several step mapping effort to focus on specific corridors for construction. This includes the following:

1. Siting of general corridor

   Initially highway maps usually 1" equals 2 miles (1:63,360) are used to look at a large area and identify a broad corridor from the origin to destination of a given line. This broad-based corridor is selected using the generalized information of town, location and highway; population density; and large government ownerships to select out a generalized corridor on plus or minus ten miles in width. This corridor is being used in subsequent more detailed mapping and data assessment studies.

2. Focused Corridor Study

   The two mile corridor is plotted out at 1:24,000 mapping and a more focused corridor of maximum two miles in width is selected. This is done using generalized ownership pattern, existing established corridors of utility lines, gasline pipes, etc.; location of severe conditions and important features; and in a general way the land uses within which it would be too expensive to locate the line. Also visual impacts are considered in a minor way.

Having established the narrower corridor, a precise line is located on more detailed map (i.e., 1:1,000 all the way down to 1:200 scale maps). In doing this, the engineering section plots out the specific line using air photos and a variety of existing maps. When the final line has been designed, has been sited, it is subsequently designed and turned over to the right-of-way section for planned acquisition.

In discussing the siting process with the engineer it was felt that remotely sensed information might be able to be used (it is currently not being used) at two scales: At the overall study area scale. (It was mentioned that the visually enhanced landsat scenes specifically at 1:100,000 or 1:250,000 scale would be useful for general communication and presentation of the information, both within the management of HL & P as well as to other more sophifisticated organizations. In the past, they have used on at least one occasion, high altitude imagery (UT photos) to assist them in getting a general orientation of the study area. They were less interested at the concept of using landsat for that, but were impressed by several of the visual products produced by commercial vendors such as Earthsat, geopec(?) images. They felt that such products are in general good public relations, would provide a good impression to the people they work with, and could be used effectively as a communication tool. They felt also, that in the general screening work there may be an application for landsat, but at this time it is yet unproven.

It should be noted that the HL & P engineers had appreciation for the general concept of developing a data base and selecting out a more detailed corridor from an origin and destination. However, they mentioned that in Texas the landscape is so uniform (i.e., flat terrain, with in a general way homogeneous land uses and vegetation), it is better and far cheaper to simply use a manual method for siting the line. They did have appreciation, however, for the fact that it in more complex environments, the overlay method of multivariables could be more useful.

In discussing with the transmission engineer, it was pointed out that one of the advantages of doing transmission line siting using automated data bank approach would be the ability to generate map atlas of consistent data variables as well as consistent overlays and interpretations, so that for public presentations or presentations to management, they could very clearly and concisely express their criteria rather than have to explain and relay upon a less communicating methodology (i.e., engineers looking at air photos and maps to select out the best trails) This traceability of the methodology seemed to be an impressive element of what they had in mind.

COMPANY COMMITMENT OF RESOURCES

At current, the company commits two people (equivalent of two people) full time on landsat efforts. This includes one full time geographer with image processing experience and a half time assistant and several other individuals who are working on a part time basis in addition to approximately $40,000 a year of computer time is extended on off-hours of machine (both PRIME and IBM). In addition, approximately $5,000 of outside budget expenditures are consumed.

THE OVERALL ECONOMETRIC MODEL

The overall econometric model for the company is non-spatial and uses as inputs things such as the general economy, interest rate, number of meters within the overall company, Houston market activity, basic business activities, etc. Resulting from it, are forecasts of aggregate growth which are then used to determine forecasts of revenue. These forecasts of aggregate demands for power and aggregate revenues are used for the management planning of the overall company. These statistics are provided to the engineering dept. for allocating geographically landuse growth to various subcompartments within the region.

This function is a very vital one within the company because it provides the basic management planning data for financial management of the organization. The accuracy of land use forecasts by subregion (i.e, disaggregation of overall forecasts)does not require high accuracy in the long term. Short term forecast, however, particularly those less than 5 years, are significant because on them is based the allocation of company resources in terms of commitment of funds for people, facilities, etc. for serving forecasted demand. The long range forecasts are also used for commitments, but the time frame allows for flexibility and readjustment in development plans.

III. AUTOMATED MAPPING

The automated mapping section does automated base map and overlays various types of facilities maintained by the company in an automated form.

The mapping system at HL & P consists of approximately 6,000 map sheets and 1" = 400'. These map sheets have been under development for many years as a manual system. They are based on state plane coordinates and have been developed from traverse control data as well as air photos. Initially, HL & P developed the base maps and began developing a series of overlay maps to these base maps; overlays containing the primary distribution network, the secondary distribution network, street lights, underground distribution, and underground residential. Before these maps were completed in the manual system, they began experiencing major problems with costs of draftsmen and management of a drafting group. Labor competition in Houston, particularly for a draft staff, is extremely competitive and therefore they conducted a cost analysis and determined that a computer system for storage and retrieval of all of their maps, as well as an aid in the preparation of maps could substantially improve their position with respect to the base map program.

In developing this system, management determined approximately a 5 year payback period in which the cost would exceed the benefits, but in subsequent years the cost/benefit ratio would be 2 - 3 times greater; that is greater benefits than cost. The decision was made to go automated system, not only because of the long-term cost saving, but also because of the substantial difficulties in obtaining and maintaining a labor pool.

FIGURE 1

DATA ELEMENTS ON THE AUTOMATED MAPPING BASE MAP

1. X,y coordinates tied to state plane mapping system.
2. Roads
3. Lots and blocks
4. Easement information
5. Control survey if available
6. Rail lines
7. Name of subdivision
8. Transmission lines and towers
9. Major landscape features, such as streams or floodways
10. Large building (in downtown areas)

The system which has been developed is a centercom system based on DEC equipment and with a CALCOMP plotter. The specific maps include a base map and a series of overlays previously mentioned. On the base maps, the data elements displayed are outlined in figure 1.

As far as base mapping is concerned, the company had completed all of their service territory with maps before any automation was begun. This is unlike most utility companies who not only have to conquer the automation battle but also have to be doing base mapping at the same time.

Following is a description of the overlays:

1. "Secondary Map". This map includes various facility data such as:

   A. Transformers (size and type)

   B. All poles (HL & P poles, as well as non-HL & P poles; i.e., ownership)

   C. Address of the lots (for all businesses and residential lots)

   E. The GLN Number (The GLN number is a geographic location number associated with a master grid which fits graphically onto each map. This partitions each map sheet into 40 grids within which all facilities are geocoded.

It should be noted that all of the secondary map features have ties to other data files by way of the coding structure. For example, the addresses on the lots (?) in the map file can be keyed to a file on customer service file data. Also, the pole information can be tied back to construction dates and maintenanc einformation. Finally, the GLN number provides the opportunity to track various facilities by geocoded location.

2. Overlay #2 - Schematic map of key lines. This map sheet is another overlay showing schematic information on all the primary or key lines running through these map sheets.

3. Underground

4. Street Lights. The street lights geocode can be traced to their

installation date which is maintained on another file which is a facility management file.

THIS IS THE RESULTS OF THE INTERVIEW WITH PENNSYLVANIA POWER AND LIGHTING
WIM SCHOONHOVEN, DOUG, AND JERRY FARBER

Like other utility companies, PP & L has a series of so-called geographic information files, the most significant of which is called ELUDUS (check with Bill Matteson to get the details). ELUDS is partially an environmental and partially a land use data bank. It is used for a variety of applications both in-house in the company, as well as addressing requests from outside agencies.

IN-HOUSE APPLICATIONS

The following is a list of applications of the ELUDUS system that occurred in-house within the agency:

1. Pump Storage

The company needed to locate a pump storage facility within their service territory. One half of the ELUD data bank was searched and analyzed with respect for selecting out a site for pump storage. A request came to the ELUD manager for generating a series of maps, both manual and computer. 65 quad based map sheets, each containing the following variables were generated over a three-day period. They included: 1) Prime ag land soil 2) Public Lands 3) stream codes 4) urban areas 5)geologic conditions 6) vegetation and land cover 7) Critical natural areas 8) wetlands 9) Historic sites. Also these data items were extracted from the system in a very short time period, it took another 3 months to assemble other data variables which were not in the system. It was generally felt that the system functions sufficiently for extracting a series of information items in a timely manner. In this case, the system basically functioned for data extraction.

NUMBER 2. TRANSMISSION LINE CORRIDOR STUDIES

A series of requests has been made of the ELUDS data file concerning data and information for transmission line corridor studies. Primarily, these have involved extracting single data variables from the data file and providing this information as background study data for evaluating what features the transmission lines cross.

Within the planning section, the ELUD information is generally thought of being a front-end data summary which is for evaluating the constraints analysis. The following items are plotted out: floodplains, slopes, public lands, critical natural areas. At present time, these data items are merely used as single variables to evaluate the corridor. In the future they feel that this major area that the ELUD data bank will serve is to develop suitability models for assisting in selecting candidate corridors for power line siting.

In writing up this report, transmission line siting is one of five sitings, so number 2 of this report sequence should be siting.

SITING

There are five key facilities which require environmental mapping information. They include:

A. Substations

B. Transmission Lines

C. Power Plants

D. Reservoirs

E. Pump storage facilities

Each of these is documented below.

PP & L envisions two types of information that could be provided through these types of studies:

A. Basic data maps. These include data items of physical and land use characteristics which might represent constraints or opportunities for the construction or siting of one of these facilities.

B. A second level of sophistication which is just beginning to obtain acceptance within the company is to model these information layers in an overlay composite in assist in providing direction to the siting engineers in selecting candidate sites and candidate routes.

A third use of this information associated with the siting function involves public communication. This requires that maps be produced at a 7½ minute quad scale and occasionally a one to 1,000 scale to be used for briefing public advisory groups. These briefings are set up to obtain comment and direction from a citizen advisory committee and the data is generally used to provide background on environmental conditions and characteristics associated with proposed sites and alternative sites for various facilities.

It could be a more useful tool in the future where final plots are produced. It slows the time down from transmission line siting activities that involved very short lines and therefore did not require the great amount of geographic data to be brought to bear for the selection of a given facility. Because of this, they were more satisfied with just obtaining the basic data maps and doing the manipulation manually in order to obtain composite displays. Recently a citizen group hired a computer graphics consultant to assist them in evaluating one of PP & L's proposals. This involvement resulted in the PUC asking PP & L if they had a system of computer and environmental mapping. Subsequently, this resulted in engineers becoming more interested in the use of such a system , because some of the benefits of application of this type of system became better known.

A general comment is that the ELUDS system over the past several years has been used substantially for extraction of basic data and is now at the state where it is just beginning to be used for actual planning and siting applications.

NUMBER 4. MAP DOCUMENTATION OF HISTORIC AND CULTURAL SITES

This system was used to pull off a listing of all the cultural and historic sites and used as basic background data and reference information in several reports.

NUMBER 5. FLOOD POTENTIAL STUDIES FOR POWER PLANT RESEVOIRS

This involved a request to generate the areas (acreages)of soil types within water sheds so as to determine watershed runoff that may be generated to power plant resevoirs.

NUMBER 6. DEVELOPMENT TREND REPORTING (FORECASTING)

This is a potential application of great interest to the company. It involves being able to take landuse coverage and existing land use forecast of land use, and compare it with regional capacity of various PP & L infrastructure capabilities. Figure 1 is a conceptual diagram of a plan application of ELUDS which would overlay existing land use and monitor growth as well as future land use on top of maps of the existing PP & L infrastructure. These maps presently exist for capacity and they are generated by capacity planners and have information associated with each substation.

It is felt that the resulting overlay of future land use forecast on top of their capacity maps of the PP & L infrastructure would flag and identify those areas which need new capacity and would fit directly into the overall planning process. It is also felt that this information could help PP & L serve industries locate in areas where sufficient capacity exists to serve them. For example, if an aluminum plant wishes to locate in a territory, maps can help pinpoint those areas which are suitable (i.e., considering regional plans and also with capacity for PP & L power supply).

Regional planners in the field have recently requested a map which shows all of the unused land which is suitable for development and acceptable given zoning or development. THis map will then show the ultimate urban development window. Therefore, they can plan for what the ultimate capacity that will be necessary over time that the company must apply to an area.

NUMBER 7. REGIONAL PLANNING

PP & L has a system of regional planners in local field offices which provide services of working with the local government and going development plans. These regional planners frequently request ELUDS maps and use the system basically as the mapping service. They specify a given scale and a given data variable and between 1 and 4 weeks are necessary for getting these maps back to the planner for use by the local entity or in conjunction with the local entity decision. This is a good first step in developing computer mapping use in the field. It is felt that it will ultimately lead to more overlay composite mapping for land use suitability/capability.

INVOLVEMENTS WITH NASA

In the past, PP & L has had two involvements with NASA. The first involvement was a request by NASA for their basic data banks to assist Goddard Space Center's technical staff in providing ground truth information, and the training material for their automated classification. A Mr. Bill Campbell, who is an analyst at NASA Goddard worked with this data base and generated series of products which are subsequently being shared with PP & L.

The second effort has involved to date a request to cooperate on subsequent studies. This began with conducting an assessment of what possible applications Landsat might have in the future with PP & L. Following possible applications for research included:

1. New transmission line up-dating
2. Land use growth monitoring
3. Assessment of vegetation underneath transmission lines
4. Cooperation within NRC to assess land use change around nuclear power plants

Each of these applications is described below:

1. <u>New transmission Line Up-dating</u>

On an on-going basis PP & L has difficulty mapping at a small scale in composite form all of the various transmission lines which are being constructed. Therefore, they felt that perhaps Landsat may be able to detect transmission lines as they are built or on an annual basis. Because of the narrow corridor of transmission line, wherein vegetation is removed it is doubtful that could be accomplished with acceptable accuracy using existing Landsat system. However, given the finer resolution capabilities of Landsat B, such detection is felt to be worth exploring. In summary, this would involve the evaluation of classification techniques for transmission lines, producing thematic maps of these and subsequently, either manually remapping the new transmission lines or using a rastor smoothing device to automatically create vector lines for a data base.

At the present time, they must go through all 84 of their quads and match them with drawings and update all of their drawings of their transmission lines.

2. Land Use Growth Monitoring

It is felt that there needs to be a better system for monitoring land use growth within the overall region. If the GIS system were combined with land use change analysis technology, it is felt worthy to explore how land use growth monitoring/forecasting might be applicable. They are unsure whether this will work out for them or not, but they feel it may be worth a try.

3. Monitoring of Vegetation Conditions under Transmission Lines

Currently PP&L is faced with the problem of delineating the vegetation, age and type of growth occurring under transmission lines. THis must be done in order to manage and dispatch crews which do cut and slash maintenance of the vegetation to keep from overgrowing a transmission line system. It was felt that perhaps landsat could, by using Change analysis, detect changes in the vegetation status over time. These transmission line corridors are frequently 200' ranging up to 200' in width and run at many different angles in the __?__ orientation. This application might be able to be useful with landsat B technology. However, it should be noted that because of the narrow resolution width of the transmission lines, and the inherent geometric and geographic referencing problems of the current landsat technology it is doubtful that two seams could be matched with sufficient accuracy and with the first ____________ of clarity to develop a automated classification indicating vegetation stages of growth. Given Landsat D technology, however, with high resolutions may be an interesting possibility.

4. Nuclear Regulatory Commission Need for Land Use Monitoring

This particular regulatory commission (NRC) would like to cooperate with NASA and PP & L to develop a methodology for monitoring land use growth and change around nuclear power plants. The need for this monitoring information will be to periodically re-evaluate and readjust emergency evacuation plans for citizens living within the region which necessarily might have to be evacuated given an emergency at the nuclear power plant. Problems stem from the fact that when a plant is built, the power company is required to make an emergency evacuation plan and evaluate that this is a safe plan and operable.

However, over a 10 - 20 year period, the land use conditions for a given region may entirely change and the evacuation plan may become obsolete. Therefore, new evacuation procedures must be developed.

It is felt that maybe landsat change analysis may be a useful technique for quickly assessing and monitoring change of land uses around each of these nuclear power plant sites.

NRC has said that they had money and NASA said that they will cooperate and PP & L has said that they will also cooperate. NASA will, as part of the proposed program that is currently being discussed, NASA said they will apply a simulated flight using the thematic mapper and therefore, this experiment could be helpful considering that this could be a simulation of landsat D. As part of this program, they will re-grid 6 - 8 quads around the nuclear site and subsequently landsat will be used to monitor the urban growth within that site. By using the combined GIS and multi-temporal landsat data, visual products will be produced to identify areas of change.

Visual Products

PP & L has the following application for visual products of the landsat analysis:

1. Provide an overview of a region as a first step for corridor definition. This application would involve the production of a color enhanced landsat scene as a basic data image for briefing a study team and even selecting out an overall corridor for broad base selection of transmission line. It is a visual product that can provide a general context for possible orientation. It should

should be stressed that this is a maybe application and has never really been tried.

2. As a visual product to hang in a number of management offices to orient the company to the visual territory of PP & L it could be quite useful.

3. Providing some tie to federal programs in the landsat area is evident by visual products and it does better than any other medium express how the geographic mapping efforts of the company are being tied to the landsat program, which is not an actual use; the visual products are merely a way to show the relationship and indicate the possibility.

The Environmental Section of PP & L

The environmental Section of PP & L is largely focused on environmental regulations and monitoring and makes very little use of maps. It does not focus on the bigger question of siting and planning; therefore, is not a user of ELUDS or geographic data.

Several of the other reasons why there is reluctance yet to use the system, is that it doesn't provide enough data. There are data items which are not on the system including for example:

1. Topographic data
2. Air quality

In the past year, 37 requests were made by users of the ELUDS system. One half of these were internal requests and one half of them were from external agencies.

PP & L does a broad based econometric modeling effort conducted by an outside consultant, Cambridge Assoc. of Cambridge Mass. This is based on broad based socio-economic parameters, census data and other indicators.

Following is a description of some of the external uses, that is non-company uses, for the ELUDS system:

1. Local governments

   Requests have come in from a series of local government agencies for data items to assist them in conducting their comprehensive planning efforts. These have ranged from townships, to counties, to regional agencies. They have largely asked for base maps with overlays of soil, slope, vegetation, urban area delineation and so forth. These have typically been made at 1 to 62,500 scale (15 minute base map). In addition, maps were prepared for a highway corridor study, a drainage basin organization, department of environmental resources, the national parks service, soil conservation service, and NASA. In the case of National Parks Service, and NASA, automated data files were also provided as well as basic maps from the ELUDS system.

National Parks Service used the basic maps for land use studies and management studies associated with the Scenic River Study and of land resources in the upper Delaware. These maps, and ultimately the data base, are being used in-house within a NPS.

Soil Conservation Service has involved production of a series of map items for the various counties. They have included landform, vegetation, land cover, and other basic data items in the ITUM data file.

It is expected that Pennsylvania State Univ. will also be requesting the data base and using it under a cooperative agreement.

CUSTOMER INFORMATION SYSTEM

PP & L maintains a comprehensive customer information system with address and related customer information including historic energy use for each user of the PP&L network. The records contain two geographic references:

A. Street Address

B. x,y coordinate to the nearest pole or transformer on a pole. These coordinates are in state planning measurement units.

Recently, there has been a growing request for programs which can summarize this data to geographic units. Specifically, summaries are being requested for use by the counties to better understand energy use consumption. The company plans to use the coordinated information with a search to determine which of these customer records fall within which counties, so that summary and aggregate statistics can be produced and listed.

There is potential for integrating this address based information with the ELUDS system, associating address records to a overall grid file which would have the advantages of doing energy consumption density maps using computer graphic display.

FACILITY MAPPING WITH THE AUTO-TROL SYSTEM

In the engineering services section, there is an automated drafting system based on the Auto-trol cadcam system. This system has two digitizer stations and one flat bed plot and is based on the mini computer primarily used for engineering drafting. It is not tied directly into the mainframe computer. This system has a potential for converting over to the ELUDS system and making it operational and has a integrated unit with the automated drafting function. At this time institutional barriers may restrict that kind of usage; particularly this system is being used on a 3-shift basis

APPENDIX B

Mail Survey

1. Copy of cover letter, questionnaire, Landsat description
2. List of Utilities on mailing list, annotated by response
3. Utility responses

N/A-E
November 10, 1980

Dear -----

ESRI is under contract to NASA (Contract NAS2-10716) to survey the data needs and land use forecasting methods in the utility industry. Your company has been selected to assist us in this survey. The purpose of the enclosed questionnaire is to determine the following characteristics of the industry:

1. Characteristics of the utility and its service area.
2. Types of geographically oriented data acquired and their format.
3. Uses made of these data.
4. Methods used to project future energy and facility needs.
5. Data-handling capacity of the utility.

Your answers to these questions will be compiled with those from other companies (see attached list) to provide a summary of the industry in the United States. A final report to NASA will include a summary evaluation of the data types and methods currently used by the industry to support various projections and operational decisions. Each participating utility will also receive a copy of this report.

Please respond within a week to each item, using resources available to you. If you have questions regarding any item, contact Don Chambers or myself at (714) 793-2853, 9:00 a.m. to 5:00 p.m., PST. Please indicate any items which should be held confidential - these will be used for summary purposes only. A stamped return envelope is enclosed for your convenience.

Thank you for taking the time to participate in this survey. We expect the entire industry to benefit from the results of this analysis.

Sincerely,

Bill Hodson, PhD
Environmental Analyst

BH:jc
Enclosure

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company____

2. Respondent's Name____

Title____

Address____

Contact Telephone____

3. Describe the service area of the company:
Size (sq. miles/acres, etc.)____________________________

Location (include sketch map if available)______________

Number of customers:
Residential____________________________

Commercial____________________________

Gov't/Institutional____________________________

Industrial____________________________

Other____________________________

4. Indicate (X) which of the following responsibilities are required of this company.

( ) Provide adequate power for existing users
( ) Provide adequate power for projected future users
( ) Promote efficient power use
( ) Minimize adverse impacts to environment
( ) Allow public utilities access to data for planning
( ) Other:____________________________

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area			
( ) Census			
( ) Economic			
( ) Land Use			
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   ( ) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   ( ) Accurate enough for small-area analysis and demand projections
   ( ) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial acquisition?

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery).
   ( ) No experience
   ( ) Remotely sensed data considered, not evaluated
   ( ) Remotely sensed data considered, rejected- please state reasons: ______________________________
   ( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

    Small Area Analysis:

    System-wide Analysis:

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

    ( ) Availability of source data
    ( ) Data at appropriate scale
    ( ) Hardware availability
    ( ) Software availability
    ( ) Technical staff expertise
    ( ) Limited mandate
    ( ) Time
    ( ) Budget
    ( ) Base map precision
    ( ) Data not kept current

14. Check the items which apply to your use of automated geographic information.

    ( ) Spatial data automated in-house.
        Number of persons required ________
    ( ) Data files are referenced to x,y coordinate system
    ( ) Stored data planes can be overlaid using an automated technique
    ( ) Image processing and classification capabilities are being used.
        Describe specific functions________________
    ( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

    Systems________________
    Data Files______________

16. Describe your current hardware/software configuration. Specify model of computer.

APPENDIX A

LANDSAT SYSTEM DESCRIPTION

Landsat represents the first satellite data acquisition and analysis system dedicated to a global Earth resource investigation program. There are several major components to the system, but for the purpose of simplifying its operational characteristics from the viewpoint of end users, it can be described in terms of three segments: system characteristics and data acquisition, data organization and distribution, and data analysis.

SYSTEM CHARACTERISTICS AND DATA ACQUISITION

The first Earth Resources Technology Satellite (ERTS-1, since renamed Landsat-1) was launched on July 23, 1972 (as of November 1977, it was still operating but without MSS band). Landsat-2 was launched on January 22, 1975. Each Landsat is in a circular (near polar) orbit at an altitude of 920 km (500 nmi). It circles the Earth every 103 minutes, or approximately 14 times per day. The daytime orbital pass is from north to south. From such a vantage point, each Landsat can cover the entire globe, except for the poles, every 18 days. Because of this orbit, a unique feature of each satellite is that it views the Earth at the same local time, approximately 9:30 a.m. at the Equator, on each pass.

The nominal forward overlap between consecutive Landsat images is approximately 10 percent. The sidelap between adjacent orbits ranges from 14 percent at the Equator to 85 percent at the 80° parallels of latitude (Figure A-1). Landsats-1 and -2 were originally phased to provide repetitive coverage over the same area every 9 days. The orbit of Landsat-1 has recently been changed so that the repetitive coverage provided by the two satellites over the same area on the ground is now alternately 6 days and 12 days, instead of 9.

Landsat presently carries 3 data acquisition systems: (1) a multispectral scanner (MSS), (2) a return beam vidicon (RBV) or television system, and (3) a data collection system (DCS) to relay environmental data from ground-based data collection platforms (DCP's) to one of NASA's receiving stations on the ground.

The MSS is the primary sensor system and acquires images 185 km on a side in four spectral bands in the visible and near-infrared portions of the electromagnetic spectrum. These four bands are:

Band 4 - 0.5 to 0.6 micrometers Band 5 - 0.6 to 0.7 micrometers	visible
Band 6 - 0.7 to 0.8 micrometers Band 7 - 0.8 to 1.1 micrometers	near-infrared

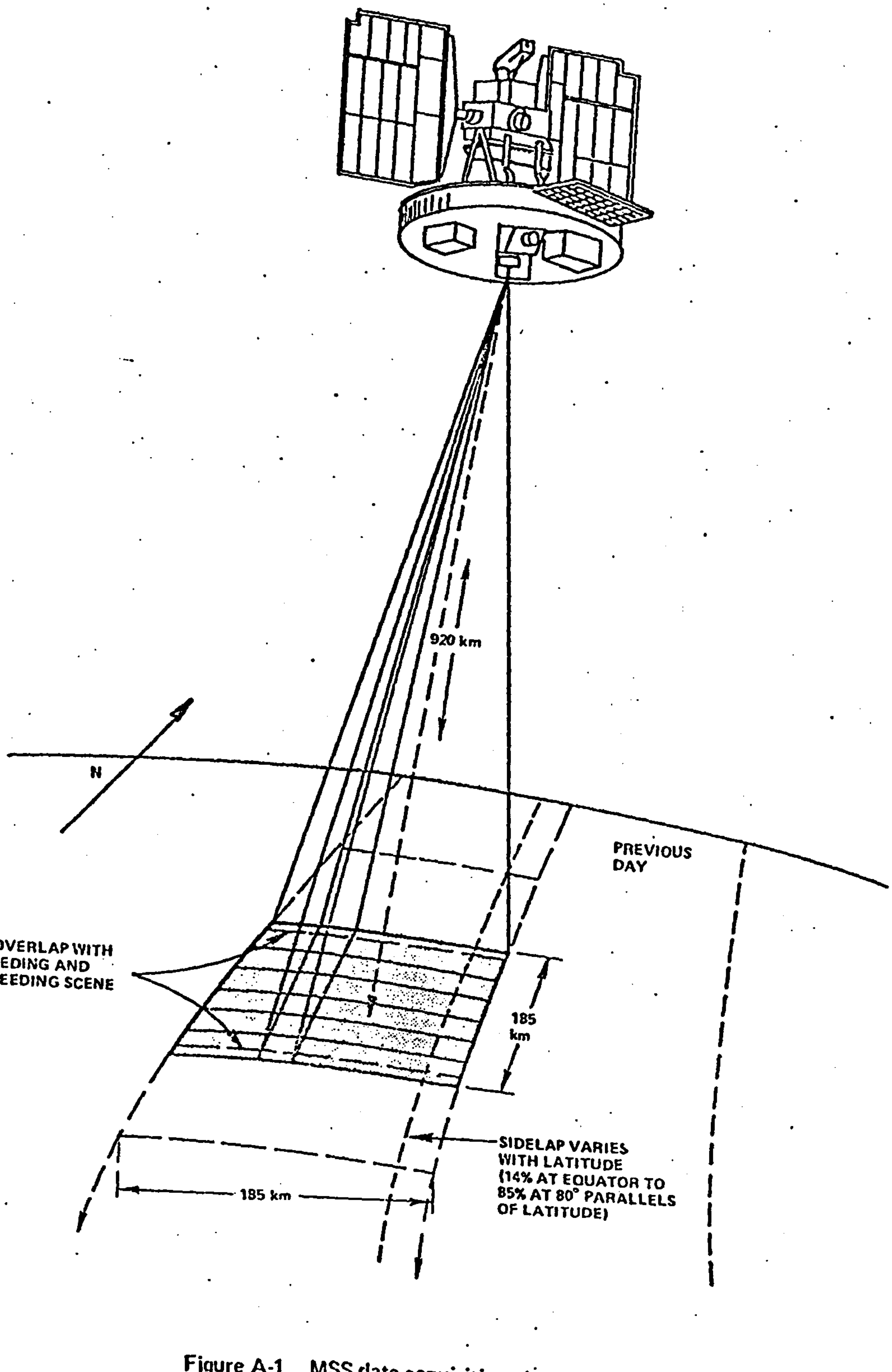


Figure A-1. MSS data acquisition characteristics.

Basically, the MSS consists of an oscillating mirror that scans the ground in a direction perpendicular (west to east) to the satellite orbit path, and a set of focusing optics that transmits the mirror's energy onto detectors filtered for the four spectral bands just described. The output of each detector for each mirror oscillation is a scan line of video data 185 km in length. The motion of the satellite along its orbital path provides for the continuous sequence of scan lines of incoming data that ultimately produce a Landsat scene.

These data are transmitted either directly to NASA receiving stations in Alaska, California, or Maryland (for North America), or stored on a tape recorder for subsequent transmission to the ground (rest of the globe). Several foreign operated stations (Canada, Brazil, and Italy) receive data directly from Landsat, and several new foreign receiving stations are planned.

Landsat photography consists of both paper prints and transparencies (negative and positive), normally produced at a scale of 1:1,000,000 (about 25.5 kilometers or 16 miles to the inch), but larger scale products are available from EROS. Figure A-2 is an example of a Landsat black and white print for just one of the four available bands. Part of the annotation has been numbered as a guide to interpreting the image, and the relevant information is as follows:

1. Date on which the scene was acquired by the satellite.

2. Latitude and longitude of center point of the photograph.

3. Band identification, 5 in this instance. One can request individual prints of all four bands or a color composite of any three (usually 4, 5, and 7).

4. Sun elevation and azimuth at the time of data acquisition.

5. Frame identification number, unique for each Landsat scene, in the format 1286-16083-5

   1 = Landsat mission: 1,5 - Landsat-1; 2,6 - Landsat-2; 3,7 - reserved for Landsat-3

   286 = Number of days from launch to scene acquisition; add 1000 if the Landsat mission digit (above) is 5, 6, or 7.

   16083 = Hours, minutes, and tens of seconds, Greenwich Mean Time, of scene acquisition

   5 = Sensor code: 1, 2, 3 = RBV; 4, 5, 6, 7 = MSS

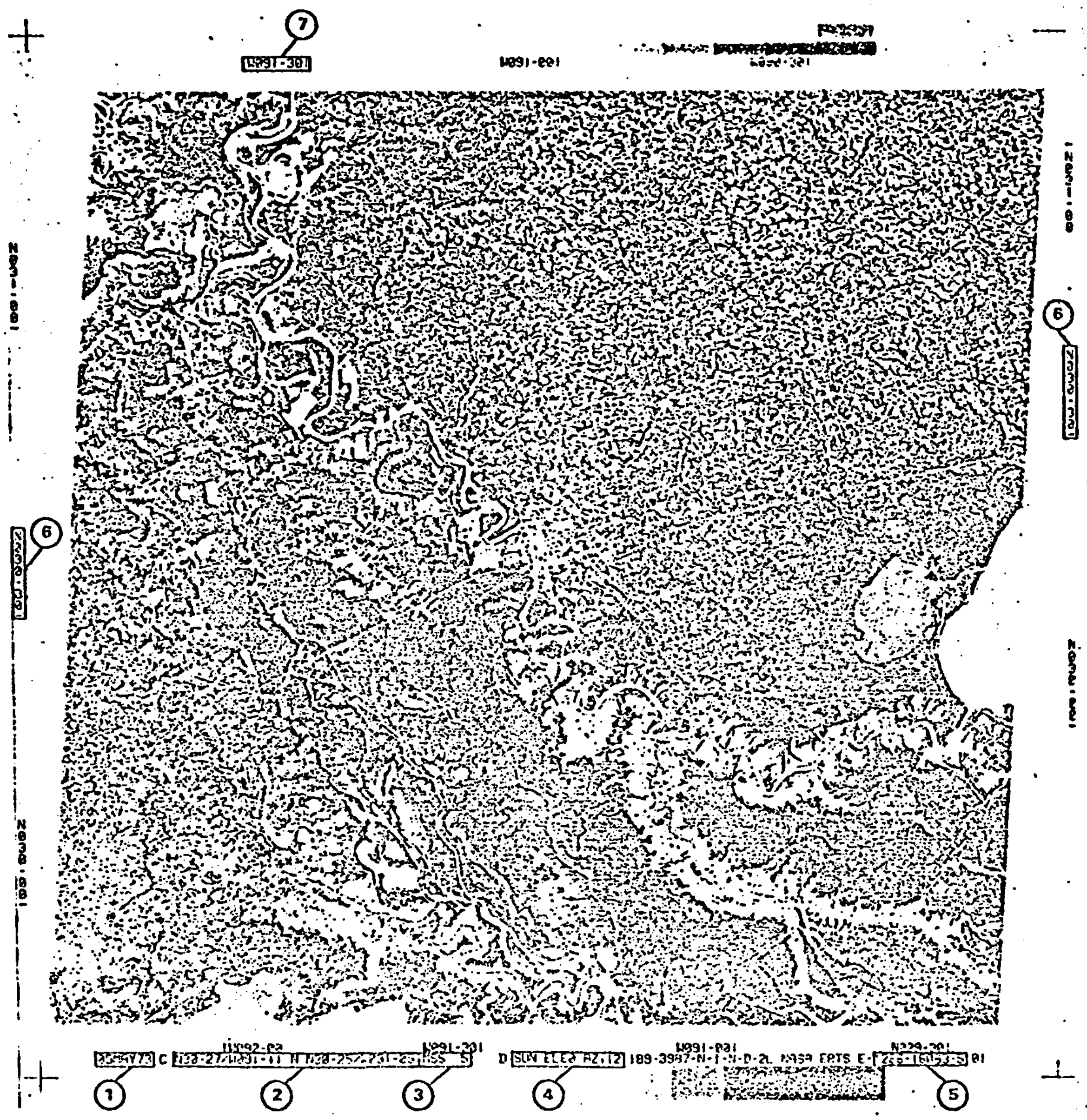


Figure A-2. Landsat black and white print.

6. Latitude in degrees and minutes. In this instance, 30 degrees, 30 minutes north latitude (measured from the largest bar).

7. Longitude in degrees and minutes. In this instance, 91 degrees, 30 minutes west longitude.

DATA ORGANIZATION AND DISTRIBUTION

All data collected by Landsat is processed initially at the NASA/Goddard Space Flight Center's National Data Processing Facility (NDPF) located at Greenbelt, Maryland. The purpose of this processing is to produce archival copies of all data prior to public distribution. The EROS Data Center, administered and operated by the Geological Survey of the U.S. Department of the Interior, distributes all Landsat data to the public*. Two basic Landsat data products are available from EROS: CCT's and photographic products.

Computer compatible tapes are generated from the video data transmitted from Landsat. The scan-line data is in the form of a serial stream of discrete digital data values with corresponding ground dimensions of 79 by 57 meters (1.1 acres or 0.44 hectare). The CCT's are standard ½ inch, 7 or 9 track, with either 800 or 1600 bits-per-inch (bpi) packing density.

A Landsat scene is divided into four north/south strips. Thus four CCT's are required for a complete digital tape record of a Landsat scene (Figure A-2). The current cost of a set of four CCT's from EROS is $200.

*To place an order, or to request information about Landsat and other remote sensing data products, contact: User Services Unit, EROS Data Center, Sioux Falls, South Dakota 57198, 605-594-6511, Extension 151.

ADDRESS LIST

R.A. Abdoo *
Assistant Vice President
Wisconsin Electric Power Company
231 W. Michigan
Milwaukee, Wisconsin 53201

Mr. Don Bourcier ***
New England Power Planning
174 Brush Hill Avenue
West Springfield, Massachusetts 01089

Mr. R.H. Burley **
Carolina Power and Light
Box 1551
Raleigh, North Carolina 27602

Mr. R.K. Campbell, President **
Texas Power and Light
P.O. Box 226331
Dallas, Texas 75766

Mr. Ron Clark ***
Public Service of Indiana
1000 East Main Street
Plainfield, Indiana 46168

Mr. Fred P. Esbrandt *
Baltimore Gas and Electric
Energy Services - Meadows
P.O. Box 1475
Baltimore, Maryland 21203

Mr. Larry Esswein ***
Union Electric Co.
P.O. Box 149
St. Louis, Missouri 63166

W.E. Farris, Manager **
Planning Department
Georgia Power Co.
270 Peachtree Street 18th Floor
Atlanta, Georgia 30303

Mr. William H. Gray ***
Duke Power Co.
P.O. Box 33189
Charlotte, North Carolina 28242

Mr. John Grote ****
Attn: Electric Planning
P.O. Box 960
Cincinnati, Ohio 45201

Dr. Jimmy Guy **
Houston Light and Power
P.O. Box 1700
Houston, Texas 77001

Mr. Scott Hannigan *
Pacific Power and Light
920 S.W. 6th Street
Portland, Oregon 97204

Alan Hardy **
Arkansas Power and Light
P.O. Box 551
Little Rock, Arkansas

Mr. Allen Hill ***
Dayton Power and Light
P.O. Box 1247
Courthouse Plaza, S.W.
Dayton, Ohio 45401

Mr. John Houston ***
Southern Companies Services
P.O. Box 720071
Atlanta, Georgia 30346

Mr. Steven J. Jack, System Forecasting **
San Diego Gas and Electric Co.
Box 1831
San Diego, California 92112

Aklesh Kaushiva, Manager **
Potomac Electric
System Planning Department, Room 302
1900 Pennsylvania Avenue, N.W.
Washington, D.C. 20006

Kathleen Kelly ***
P Block A
Boston Edison Co.
800 Boylston Street
Boston, Massachusetts 02199

Mr. Joseph Kerestly ***
Manager, Economic Studies and Planning Departments

Ohio Edison Company
76 South Main Street
Akron, Ohio 44308

J. Robert Kissner *
Allegheny Power Service Corp.
800 Cabin Hill Drive
Greensburg, Pennsylvania 15601

Mr. John Kutz ***
New York State Electric and Gas Company
4500 Vestel Parkway East
Binghampton, New York 13902

Mr. G. Marchbanks, Mgr. **
Power Systems Planning
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, Oklahoma 74102

Mr. Ben Marguglio ***
Consumers Power Company
1955 West Tarnall Road - Room JSC-220
Jackson, Michigan 49201

Mr. Wm. J. Martin, Manager **
Electric Systems Planning and Analysis
Public Service of Colorado
P.O. Box 840
Denver, Colorado 80201

Mr. Daryl McCloud **
Central Vermont Public Service
77 Grove Street
Rutland, Vermont 05701

Mr. Joe Miller *
Minnesota Power
30 W. Superior Street
Deluth, Minnesota 55802

Mr. Roy Murdock ****
Rochester Gas and Electric
89 East Avenue
Rochester, New York 14649

Mr. Paul G. Parker ****
Statistical Research Department
Commonwealth Edison
P.O. Boc 767
Chicago, Illinois 60690

Mr. Richard Peterman **
Gulf State Utilities Co.

P.O. Box 2951
Beaumont, Texas 77704

Mr. Rick Sergel ***
New England Power Service
20 Turnpike Road
Westborough, Massachusetts 01581

Mr. Bob Tennant **
Portland General Electric
121 S.W. Salmon Street
Portland, Oregon 97204

Rhoda Terwilliger ***
Tampa Electric
P.O. Box 111
Tampa, Florida 33601

Mr. Donald R. Weidner **
Indianpolis Power and Light
P.O. Box 1595 B
Indianapolis, Indiana 46206

* Sent November 13, 1980
** Sent November 14, 1980
*** Sent November 19, 1980
**** Sent November 26, 1980

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Boston Edison

2. Respondent's Name Kathleen A. Kelly

Title Senior Forecasting Analyst

Address 800 Boylston St Boston MA 02199

Contact Telephone 617-424-2462

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 590 sq miles

Location (include sketch map if available) [illegible]

Number of customers:
Residential 493,146

Commercial 65,640

Gov't/Institutional ——

Industrial 1,614

Other 1679

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
(X) Allow public utilities access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit	x		PLANNING
( ) Electrical load/area			
(X) Census	x		FORECASTING
(X) Economic	x	x	FORECASTG; SPECIAL PROJ
( ) Land Use			
( ) Land Cover			
(X) Zoning			FORECASTING
(X) Proposed Land Use			PLANNING
(X) Legal Property Descriptions			PLANNING
(X) Topography			FORECASTING, PLANNING ENGINEERING
( ) Land Resources (soils, geology)			
(X) Environmental Data (air, water, etc.)			PLANNING ETC.
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
   (X) yes
   ( ) if no -- please describe
   ~~CENSUS → EVERY 10 YRS.~~
   ~~ECONOMIC~~

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data? NOT ALWAYS UPDATED IN TIME FOR US TO USE
MOST OF THE DATA IS UPDATED INFREQUENTLY

9. How accurate are the land use/land cover spatial data elements?
   (✓) Accurate enough for site-specific analysis
   (✓) Accurate enough for small-area analysis and demand projections
   (✓) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial acquisition?
    UNKNOWN.

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery).

( ) No experience
(X) Remotely sensed data considered, not evaluated for mapping
( ) Remotely sensed data considered, rejected- please state reasons: ______
( ) Remotely sensed data used regularly - please describe:
for Rights of Way - utilized occasionally

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: SMALL AREA FORECASTING STARTS BY TRYING TO MESH STATION MAPS AND LAND USE/ZONING MAPS OF THE AREA UNDER STUDY. TYPICALLY THIS AREA WOULD INCLUDE PORTIONS OF TWO TOWNS BORDERING EACH OTHER. DATA AND INFORMATION ABOUT THE PLANNING AND EXPECTED GROWTH IS OBTAINED FROM TOWN REPORTS + THE SALES PEOPLE WHO ARE RESPONSIBLE FOR CONTACTS WITH THE TOWNS. ALL THE → ①

System-wide Analysis:

② → OVER

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

(X) Availability of source data
( ) Data at appropriate scale
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
(X) Time
( ) Budget
( ) Base map precision
(X) Data not kept current

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ______
( ) Data files are referenced to x,y coordinate system
( ) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions ______
( ) Being investigated. Describe needs ______

15. How many data processing systems and files are currently maintained by your utility?

Systems ______
Data Files ~~OVER~~ 11 DISC PACKS FULL OF FILES INCLUDING BILLING AND REVENUE SYSTEM

① COLLECTED DATA IS CHECKED WITH VARIOUS STATE AND FEDERAL HOUSING AND PLANNING AGENCIES. ONCE THIS IS COMPLETED EXPERT TERRITORY KNOWLEDGE IS INPUT VIA THE ACTUAL ANALYST DOING THE WORK, OR A SUPERVISOR, TO CHECK THE VALIDITY OF THE ASSUMPTIONS VERSUS WHAT IS KNOWN. AS A FINAL STEP THE SMALL AREA GROWTH IS CHECKED FOR CONSISTENCY WITH SYSTEM WIDE FORECASTS.

② RESIDENTIAL

(DEMOGRAPHICS)

BIRTHS + DEATHS − MIGRATION = POPULATION

HOUSEHOLDS = POPULATION / NUMBER OF PEOPLE PER HOUSEHOLD

(RESIDENTIAL CONSUMPTION)

SATURATION OF APPLIANCES 1972 – 1995 → ANNUAL USAGE OF APPLIANCES → NUMBER OF HOUSEHOLDS W/APPLIANCES → AVERAGE USE PER HOUSEHOLD

FORECAST = HOUSEHOLDS x AV USE PER HOUSEHOLD ± (EFFECTS OF NEW TECHNOLOGIES + ALTERNATE ENERGY)

③ COMMERCIAL

A SINGLE EQUATION ECONOMETRIC MODEL BASED ON AVERAGE PRICE, RESIDENTIAL HOUSEHOLDS AND LAGGED SALES.

④ INDUSTRIAL

MODEL: EMPLOYMENT x INTENSIVENESS = SALES (FOR EACH OF 19 SIC'S)

EMPLOYMENT IS BASED ON REGRESSION VS STATE EMPLOYMENT OR GNP.

INTENSIVENESS IS BASED ON A REGIONAL MODEL

STREETLIGHT, RAILROAD + MUNICIPALS BASED ON EXPERT INDUSTRY KNOWLEDGE

16. Describe your current hardware/software configuration. Specify model of computer.

IBM 370 RUNNING ON OS/VS SYSTEM SOFTWARE

DEC 1170 SUPPORTS TIMESHARING

PUBLIC SERVICE INDIANA

February 4, 1981

Mr. Kenneth Gardels
Environmental Analyst
ESRI
380 New York Street
Redlands, California 92373

Dear Mr. Gardels:

After reviewing the NASA Energy Utility Data Needs Survey, I found that most of the questions are not applicable to Public Service Indiana.

Sorry we could not have been of some assistance.

Sincerely,

R. E. Clarke

R. E. Clarke
Corporate Planner

REC:np

1000 East Main Street, Plainfield, Indiana 46168 317 .. 839 . 9611

POTOMAC ELECTRIC POWER COMPANY
1900 PENNSYLVANIA AVE., N. W.
WASHINGTON, D. C. 20068

W. F. TRAPP
MANAGER
SYSTEM PLANNING

February 6, 1981

Mr. Kenneth Gardels
Environmental Analysts
Environmental Systems Research Institute
380 New York Street
Redlands, CA 92373

Dear Mr. Gardels:

Reference to your letter of January 27, 1981 concerning the NASA Energy Utility Data Needs Survey. Attached is the completed questionnaire per your request.

Sincerely,

William F. Trapp

William F. Trapp
Manager-System Planning

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Potomac Electric Power Company

2. Respondent's Name Mr. William F. Trapp

Title Manager, System Planning

Address 1900 Pennsylvania Ave., NW Washington, DC 20068

Contact Telephone 202-872-2627

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 643 square miles

Location (include sketch map if available) See attached map.

Number of customers:

Residential 448,756

Commercial 51,281

Gov't*/Institutional Residential-301; Comm.-2,137; Street Lighting-31; Outdoor Lighting-14

Industrial None

Other Railroad-23; Wholesale-1; Street Lighting-159; Outdoor Lighting-1,371

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
(   ) Allow public utilities access to data for planning
(   ) Other:

*Included in respective categories.

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
(X) Electrical load/unit	X		System Planning
(X) Electrical load/area	X		System Planning
(X) Census			System Planning
(X) Economic			System Planning
(X) Land Use			System Planning
( ) Land Cover			
(X) Zoning		Real Estate,	System Planning
(X) Proposed Land Use			System Planning
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
(X) yes
(   ) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data? The data is updated on a daily or an annual basis depending on the type of data and our needs. The frequency and timing is adequate to serve our requirements.

9. How accurate are the land use/land cover spatial data elements?
(X) Accurate enough for site-specific analysis
(X) Accurate enough for small-area analysis and demand projections
(X) Accurate enough for regional analysis and demand projections
(   ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial acquisition? Not readily available

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery).
   (X) No experience
   ( ) Remotely sensed data considered, not evaluated
   ( ) Remotely sensed data considered, rejected- please state reasons: ______
   ( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

   Small Area Analysis: Not Applicable

   System-wide Analysis: (1) Trend analysis by class of customer for each jurisdiction
   (2) Econometric Model

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

   (1) Availability of source data
   (X) Data at appropriate scale
   ( ) Hardware availability
   ( ) Software availability
   ( ) Technical staff expertise
   ( ) Limited mandate
   ( ) Time
   ( ) Budget
   ( ) Base map precision
   ( ) Data not kept current

14. Check the items which apply to your use of automated geographic information. Not Applicable

   ( ) Spatial data automated in-house.
   Number of persons required ______
   ( ) Data files are referenced to x,y coordinate system
   ( ) Stored data planes can be overlaid using an automated technique
   ( ) Image processing and classification capabilities are being used.
   Describe specific functions ______
   ( ) Being investigated. Describe needs ______

15. How many data processing systems and files are currently maintained by your utility?

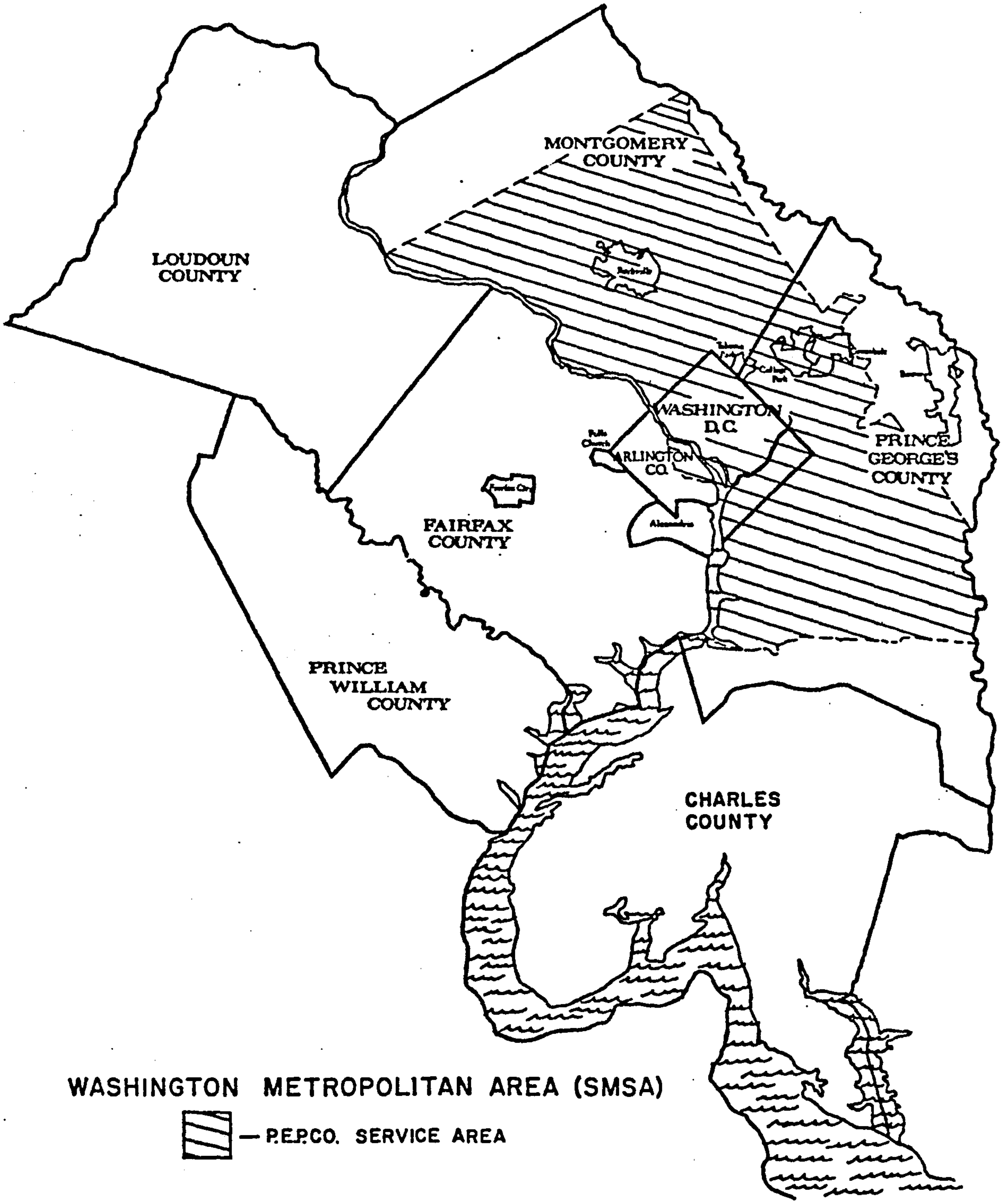
   Systems ______
   Data Files ______

   PEPCO has large number of data processing systems and files on line. A major effort would be required to answer this question.

16. **Describe your current hardware/software configuration. Specify model of computer.**

Two IBM 370 Model 158 MP

One IBM 3031 UP



WASHINGTON METROPOLITAN AREA (SMSA)

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company New York State Electric & Gas

2. Respondent's Name Mr. John V. Kutz

Title Manager - Transmission & Distribution Operations

Address 4500 Vestal Parkway East
Binghamton, New York 13902

Contact Telephone (607) 729-2551

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 17000 sq. miles

Location (include sketch map if available)________

Number of customers:

Residential	596237
Commercial	57546
Gov't/Institutional	
Industrial	1340
Other	9744

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
( ) Allow public agencies access to data for planning
( ) Other:________

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area	No Automated Data System		
( ) Census			
( ) Economic	exists - Aerial Photographs		
( ) Land Use			
( ) Land Cover	and Land Use and Natural		
( ) Zoning			
( ) Proposed Land Use	Resource Overlays are used		
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
( ) yes
( ) if no -- please describe

We do not have an Automated System

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

N/A

9. How accurate are the land use/land cover spatial data elements?
( ) Accurate enough for site-specific analysis
( ) Accurate enough for small-area analysis and demand projections
( ) Accurate enough for regional analysis and demand projections
( ) Accuracy limited to system-wide analysis and demand projections

N/A

10. What is the approximate annual cost to the utility of spatial data acquisition?

$5000

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
   ( ) No experience
   ( ) Remotely sensed data considered, not evaluated
   ( ) Remotely sensed data considered, rejected- please state reasons:

   ( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis:

SEE ATTACHED

System-wide Analysis:

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

   ( ) Availability of source data
   ( ) Data at appropriate scale
   ( ) Base map precision
   ( ) Data not kept current
   ( ) Hardware availability
   ( ) Software availability
   ( ) Technical staff expertise
   ( ) Limited mandate
   ( ) Time
   ( ) Budget

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ________

( ) Data files are referenced to x,y coordinate system

( ) Stored data planes can be overlaid using an automated technique

( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files______________ N/A

16. Describe your current hardware/software configuration. Specify model of computer.

N/A

CROSS REFERENCE INDEX

SEO Regulation Requirements vs. Section of Methodology

Regulation	Methodology Section	Table
7861.2		
a.		
1.	–	V-1, V-2, X, XI
2.	–	V-1, V-2, X, XI
3.	–	XII, XIII
4.	–	XII, XIII
5.	III-IV-B	
8.	II-I	VIII
9.	II-I	IX
b.		
1.	–	III, IV-2
2.	–	III, IV-2
3.	–	VII
4.	II-H	
c.		
1.	I	
2.		
i.	VIII-C-2, 3	
ii.	VIII-C-1	
iii.	VIII-C-1	
iv.	VIII-C-4	
3.	VI, IX, X	
d.	VII-I	
e.	VII-E	
f.	–	XXVIII
g.	VII-F	
h.	VII-G	
7861.5		
a.		
11.	VII-H-1-4	

I. SERVICE AREA DESCRIPTION

New York State Electric & Gas (NYSE&G) serves a basically suburban and semi-rural area encompassing 17,000 square miles which is approximately 35% of the land area of New York State with about 9% of the State's population. This upstate electric service area includes all or part of 42 counties, 11 cities and 141 villages, with a population of 1,700,000 of which 84% live outside the corporate limits of cities. Some 38% of the residential customers are located outside of the company's contiguous central operating region.

A system map is included in this section for reference purposes.

NYSE&G is divided into eight operating areas, most of which are further divided into operating districts. The operating areas correspond to specific geographical areas within the State and vary significantly in size.

The Binghamton Area is in southern New York, near the Pennsylvania border. This area includes one of the system's largest employers (IBM) and contains the system's largest city (Binghamton). The Binghamton area also includes much farm and rural land, typical of the whole system. Binghamton is at the intersection of Routes I-81 and 17, which offer transportation in every direction. I-88 to the capital region is nearing completion. This should stimulate additional growth.

The Elmira Area is west of Binghamton, but still in the "Southern Tier." The Elmira Area includes Elmira and Corning, and extends westerly to include Hornell and Dansville. There is much industry in this area with Corning Glass being the largest employer. Elmira is served by an excellent highway system including the recently constructed Route 17 – The Southern Tier Expressway. The Elmira area will eventually be served by a North-South artery called the Appalachian Thru-way.

The North Central Area is in the central "Finger Lakes" region of the state and includes the Auburn and Geneva districts. This area is agricultural but also includes a significant amount of industry. The Auburn district in particular has been the scene of the largest recent industrial customer additions such as Auburn Steel and Miller Brewing. The North-Central area is in close proximity to the New York State Thruway which serves as the major transportation corridor.

The Ithaca Area is almost precisely in the middle of the State. There are several major higher education centers in this area, such as Cornell University and Ithaca College. This area is also considered a prime recreational area due to the proximity of the Finger Lakes.

NYSE&G's Western Area includes the Lancaster and Lockport districts. This area is in Western New York State bordering on Buffalo. The slow economic growth of the City of Buffalo contrasts with the rapid expansion in the suburban areas served by NYSE&G. The Western Area is an important industrial center and has an extensive highway and rail system for shipment of goods. The Harrison Radiator Division of General Motors is the area's largest employer.

The East Central Area of NYSE&G includes the Oneonta and Berkshire districts. This is an area whose prominent economic activities include agriculture, industry, and recreation. Interstate 88 will soon provide an excellent transportation link for the rural Oneonta district. The Berkshire District continues to grow in response to the suburban expansion of the capital region.

NYSE&G's Southeast Area probably has the most metropolitan influences of any of NYSE&G's areas, being in very close proximity to New York City. Despite this, Brewster and the Liberty districts still exhibit characteristics more typical of the small towns they are than the metropolis they are near. There is only a very small industrial base in the Liberty area, as it tends to be more of a residential and recreational area. Recently, the Brewster area has begun to benefit from residential construction sparked by the movement of many corporate offices from New York City to Connecticut, which is within easy commuting distance. Two well-known resort hotels in the Liberty District are the Concord and Grossinger's.

NYSE&G's North East Area borders on Canada. This area is characterized by small towns and villages, and a generally small but growing industrial base. The largest employer is the National Lead mine. The Adirondack Northway is accessible as a major highway link.

Table I shows the growth rates and other information for NYSE&G's operating areas. This demonstrates that all of NYSE&G's operating areas have experienced growth in excess of the New York State average. This indicates that growth is not an isolated occurrence on the NYSE&G system but is spread throughout the service area.

Within NYSE&G's service areas, industrial activity is generally centered within branch manufacturing facilities of large national firms. The variety of manufacturing activities ranges from producing automobile radiators to computers, from mining to glass production, and from steel manufacturing to aircraft simulators. This aids NYSE&G industrial sales as the markets for the goods produced tend to be national rather than regional.

The NYSE&G Service Area Map is shown as Map A.

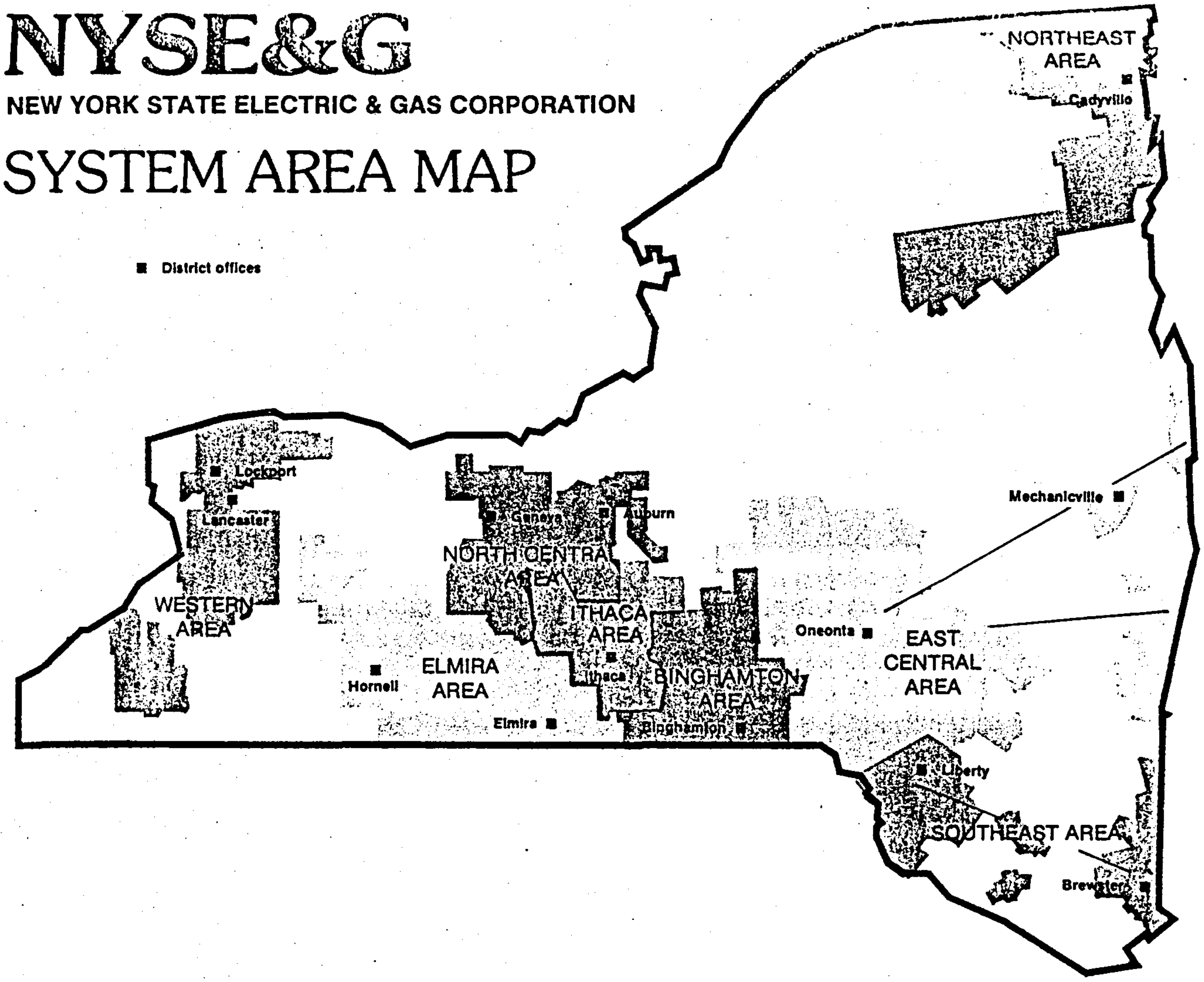
TABLE I NYSE&G OPERATING AREA DATA

Operating Area	Residential Customers (1979)	Total Sales 1979 (GWH)	Annual Sales Growth (1960-1973)	Annual Sales Growth (1973-1979)
North East	25,000	300	4.7%	4.0%
South East	78,000	1,160	9.6%	2.8%
East Central	89,000	1,350	7.1%	3.1%
Western	120,000	2,140	7.7%	2.6%
Ithaca	36,000	720	8.3%	2.8%
North Central	68,000	1,520	5.9%	5.6%
Elmira	82,000	1,800	5.7%	2.1%
Binghamton	87,000	1,700	6.4%	1.9%
NYSE&G	585,000	10,790	6.9%	2.9%
New York State			5.6%	1.1%

NYSE&G

NEW YORK STATE ELECTRIC & GAS CORPORATION

SYSTEM AREA MAP



The five largest industrial electric customers on the NYSE&G sy... are Corning Glass Company, International Business Machines, Harrison Radiator Division of General Motors, Auburn Steel Company, and Mobil Chemical Company. These five largest customers account for only 36% of NYSE&G's industrial electric sales. As such no one customer has an undue leverage on sales and, because the product lines of the largest customers are diversified, a slowdown in a particular national market will not drastically affect NYSE&G's total industrial sales.

The climate of the NYSE&G Service Area also influences load growth on the system. The combination of mild summers which limit the saturation of residential air conditioning and the growth of electric space heating have combined to make NYSE&G a winter peaking company. This should continue for the forecast period.

II. SUMMARY AND RESULTS OF LOAD FORECASTING METHODOLOGY

Following is a brief summary of the load forecasting methodology used in reaching the accompanying conclusions.

The first year of the three year short term forecast was prepared by each of the 13 operating districts for that district. These individual forecasts were combined into a total company forecast for 1980. The second and third years (1981, 1982) of the short term forecast were prepared jointly by the Market Research and Corporate Budgets and Forecasts groups. The resulting short term forecast was approved by the Company's Load Forecast Committee.

Following are the assumptions adopted for the long range forecast contained in this submission.

Long Range Forecast Assumptions

A. Non-Price Related Conservation

1. Mandatory residential appliance efficiency standards will exist throughout the forecast period.

2. Energy-conserving building codes will exist throughout the forecast period.

B. Energy Price and Availability

1. Electricity, natural gas and oil will be available throughout the forecast period.

2. The real price of electricity will increase at 2.3% per year until 1985, decrease by 1.4% per year until 1990, and then decrease by 4.6% per year for the remainder of the forecast period.

In current dollars this would mean approximate annual increases of 9.5% until 1985, 5.5% until 1990, and 2.1% for the remainder of the forecast period. This means that electric rates are expected to increase by a factor of 2.5 times between 1979 and 1995. These growth rates are based on a twenty year financial analysis performed by NYSE&G on 8/20/79.

3. The real price of natural gas will increase by 2.6% per year over the forecast period. This is based on a 20 year financial analysis of the NYSE&G gas system which reflects historic patterns and anticipation of gas deregulation.

4. The growth rate of electric applications not subject to government efficiency regulations will vary in response to electric price changes. The electric price elasticity is -0.5.

C. Data Base

1. The historic period modeled and analyzed included all hours from October 1969 through July 1979.

D. Demographics and Economic Growth

1. Population and household growth will be lower than currently forecast by the New York State Commerce Department.

2. The past relationship between NYSE&G industrial growth and national economic growth will not continue. NYSE&G industrial growth will slow towards the levels found in other areas of upstate New York.

E. Temperature – Sensitive Load

1. The percentage of new homes choosing electric heat will rise moderately in response to higher oil prices.

2. The number of conversions to electric heat will stabilize at approximately 1,300 units per year.

3. Heat pumps will continue to be installed in relatively few new homes.

4. Central air conditioning will continue to be installed in relatively few new homes.

F. Non-Temperature – Sensitive Base Load

1. Commerical Class

a. Public Authority base load will increase at 2.5% per year throughout the forecast period and will not respond to the electric price declines forecast for the period after 1985.

b. Non-government base load will grow at rates slower than in the past.

2. Street lighting load will grow at 2% per year.

3. The industrial base load growth will be dependent on New York State economic trends and on electric price.

4. The residential base load will be dependent on appliance ownership and use.

5. No electric vehicles are considered over the forecast period.

G. Load Management and Time-of-Use-Rates

1. The NYSE&G residential time-of-use rate will be in effect throughout the forecast period.

The forecast model will be described in detail later in this exhibit. It reflects the effects of energy prices, household growth, appliance saturations, growth in the NYSE&G economy, growth in electrically heated homes and other winter temperature sensitive load, growth in summer temperature sensitive load, variations in weather, and energy conservation.

The model is separated into a cold weather model and a warm weather model. For each model, a separate set of coefficients was developed for each hour of the week. This method of modeling each hour gives the model the ability to directly forecast peak demand as well as energy sendout. As an additional aid in capacity planning, the model has the ability to forecast typical daily and monthly load profiles as well as daily and monthly energy sendouts.

The model was developed from hourly sendout data for the period October 1969 through July 1979. This period, unlike prior periods, was characterized by increasing *real* electricity prices and moderate electricity growth rates. The forecast is based on the expectation that real electricity prices will rise until 1985, and then decline.

A history of customer growth from 1969 through 1979 is displayed in Table II.

A history of peak loads and energy requirements from 1969 through 1979 is included as Table III.

The Forecast of energy and peak loads are displayed in Tables IV and V. Table VI is a comparison between the long-term historic and the Forecast energy growth rates.

H. Energy Sales By End Use

Table VII presents an estimate of energy sales data broken down by end uses for the preceding year, the current year, and the fifth, tenth and fifteenth succeeding years. Changes in the mix of sales by customer class are expected to be relatively minor over the forecast period.

The percentages are based on the forecast.

I. Load Factor Data

Table VIII lists the monthly system load factors by month and annual system load factor for 1979. Table IX lists forecast estimates of: (1) the monthly system load factors for the months of the summer and winter peak, and (2) the annual system load factors.

The monthly system daily load factor is calculated by dividing the monthly net energy by the product of 24 hours times the number of days in the month times the peak load for the month. The annual system load factor was calculated by dividing the annual sendout by the product of 8760 times the peak hourly load for the year. The estimates of monthly and annual load factors result directly from the NYSE&G forecasting model.

TABLE II HISTORICAL AVERAGE NUMBER OF CUSTOMERS

	RESIDENTIAL						
YEAR	HEATING	NON-HEATING	TOTAL	COMMERCIAL	INDUSTRIAL	OTHER	TOTAL
1969	6.7	476.5	483.2	63.9	1.2	0.8	549.1
1970	8.9	485.3	494.2	64.6	1.2	0.8	560.8
1971	11.5	494.0	505.5	65.7	1.2	0.8	573.2
1972	14.8	503.0	517.8	66.9	1.2	0.8	586.7
1973	18.8	511.7	530.5	68.2	1.2	0.8	600.7
1974	23.6	516.9	540.5	69.2	1.2	0.8	611.7
1975	28.4	520.0	548.4	70.0	1.2	0.8	620.4
1976	33.5	522.7	556.2	70.8	1.3	0.8	629.2
1977	39.0	524.7	563.7	71.3	1.3	0.9	637.1
1978	44.3	526.6	570.9	72.9	1.3	0.9	645.2
1979	49.6	529.1	578.7	73.1	1.3	0.9	654.0

TABLE III HISTORICAL WINTER PEAK LOADS AND ENERGY REQUIREMENTS

(Millions of Kilowatt Hours)

YEAR	WINTER PEAK LOAD (MW)	RESIDENTIAL HEATING	RESIDENTIAL NON-HEATING	RESIDENTIAL TOTAL	COMMERCIAL	INDUSTRIAL	HIGHWAY & STREET LIGHTING	SALES FOR RESALE	TOTAL SALES	COMPANY REQUIREMENTS	TOTAL SENDOUT
1969	1404	157	2464	2621	2151	1974	91	21	6859	821	7679
1970	1496	221	2642	2863	2349	1977	95	23	7307	860	8167
1971	1556	290	2780	3070	2520	2045	98	23	7756	939	8695
1972	1724	379	2941	3320	2784	2192	100	25	8421	966	9387
1973	1701	448	3046	3494	3073	2352	102	26	9047	913	9960
1974	1768	554	3025	3579	3076	2240	108	26	9029	902	9931
1975	1993	649	3144	3793	3238	2221	110	25	9387	961	10348
1976	2070	803	3219	4022	3372	2369	111	26	9900	1231	11131
1977	2034	885	3241	4126	3437	2515	111	26	10215	1101	11316
1978	2118	973	3247	4220	3510	2632	109	22	10493	1230	11723
1979	2072(Prel)	995	3257	4252	3556	2843	109	10	10770	1343	12113

TABLE IV FORECAST OF ANNUAL ENERGY REQUIREMENTS

(Millions of Kilowatt Hours)

YEAR	RESIDENTIAL HEATING	RESIDENTIAL REGULAR	RESIDENTIAL TOTAL	COMMERCIAL	INDUSTRIAL	ST & HWY LIGHTING	FOR RESALE	COMPANY REQUIREMENTS	TOTAL	LOAD FACTOR
1980	1,036	3,261	4,297	3,686	2,970	107	10	1,230	12,300	62%
1981	1,093	3,273	4,366	3,767	3,154	106	10	1,297	12,700	62%
1982	1,171	3,284	4,455	3,848	3,324	106	10	1,357	13,100	62%
1983	1,259	3,308	4,567	3,996	3,457	111	11	1,358	13,500	62%
1984	1,359	3,318	4,677	4,150	3,596	114	11	1,352	13,900	61%
1985	1,458	3,336	4,794	4,309	3,740	116	12	1,429	14,400	61%
1986	1,568	3,375	4,943	4,476	3,883	118	12	1,468	14,900	61%
1987	1,681	3,414	5,095	4,648	4,031	120	13	1,493	15,400	61%
1988	1,799	3,452	5,251	4,827	4,185	123	14	1,600	16,000	62%
1989	1,921	3,487	5,408	5,013	4,345	125	14	1,695	16,600	62%
1990	2,041	3,523	5,564	5,206	4,510	128	15	1,777	17,200	62%
1991	2,166	3,600	5,766	5,407	4,658	130	16	1,823	17,800	62%
1992	2,289	3,661	5,950	5,615	4,811	133	16	1,875	18,400	62%
1993	2,411	3,721	6,132	5,831	4,968	136	17	1,916	19,000	62%
1994	2,530	3,779	6,309	6,056	5,131	138	19	2,047	19,700	62%
1995	2,652	3,837	6,489	6,289	5,300	140	20	2,162	20,400	62%
GROWTH										
1980-1995	6.5%	1.1%	2.8%	3.6%	3.9%	1.8%	4.7%		3.4%	

TABLE V FORECAST – WINTER DEMANDS, SUMMER DEMANDS

SUMMER (JUNE-SEPTEMBER)		WINTER	
1980	1850	1980/81	2260
1981	1920	1981/82	2340
1982	2010	1982/83	2420
1983	2080	1983/84	2500
1984	2150	1984/85	2590
1985	2220	1985/86	2680
1986	2300	1986/87	2770
1987	2380	1987/88	2860
1988	2460	1988/89	2960
1989	2540	1989/90	3060
1990	2630	1990/91	3160
1991	2720	1991/92	3270
1992	2810	1992/93	3380
1993	2900	1993/94	3500
1994	3000	1994/95	3620
1995	3100	1995/96	3740

TABLE VI NYSE&G ELECTRICAL ENERGY SALES

Historic Growth	Residential Class	Commercial Class	Industrial Class	Total Sales
1960-1973	6.9%	9.3%	5.2%	6.9%
1973-1979	3.3%	2.5%	3.2%	2.9%
NYSE&G Forecast				
1979-1995	2.7%	3.6%	4.0%	3.3%

TABLE VII FORECAST – CUSTOMER END USE

CUSTOMER CLASS	1979	1980	1985	1990	1995
Residential					
Space Heating	5.6%	5.5%	6.6%	6.8%	6.8%
Water Heating	4.2%	4.1%	3.8%	3.8%	3.5%
Air Conditioning	.5%	.5%	.6%	.7%	.9%
Refrigerators	5.9%	5.8%	4.9%	4.2%	3.8%
Freezers	2.6%	2.6%	2.3%	2.1%	2.0%
Televisions	1.9%	1.9%	1.5%	1.3%	1.1%
Electric Ranges	1.3%	1.3%	1.0%	1.0%	.8%
Other	13.1%	13.2%	12.6%	12.4%	12.9%
Subtotal	35.1%	34.9%	33.3%	32.3%	31.8%
Commercial					
Space Heating	1.5%	1.7%	2.3%	2.8%	2.9%
Air Conditioning	2.3%	2.3%	2.5%	2.6%	2.4%
Other	25.5%	26.0%	25.1%	24.9%	25.5%
Subtotal	29.3%	30.0%	29.9%	30.3%	30.8%
Industrial					
Space Conditioning	0.0%	0.0%	0.0%	0.0%	0.0%
Other	23.5%	24.1%	26.0%	26.2%	26.0%
Subtotal	23.5%	24.1%	26.0%	26.2%	26.0%
Street & Highway Lighting	0.9%	0.9%	0.8%	0.7%	0.7%
Sales for Resale	0.1%	0.1%	0.1%	0.1%	0.1%
Company Requirements	11.1%	10.0%	9.9%	10.4%	10.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Forecast	12,113 GWH (actual)	12,300 GWH	14,400 GWH	17,200 GWH	20,400 GWE

TABLE VIII MONTHLY AND ANNUAL SYSTEM LOAD FACTORS – 1979

Month	Monthly L.F.
JAN	75.2%
FEB	79.2%
MAR	74.0%
APR	73.9%
MAY	79.2%
JUN	74.5%
JUL	77.7%
AUG	77.2%
SEP	75.5%
OCT	78.1%
NOV	75.4% est.
DEC	67.1% est.

Annual System L.F.* = 65.3% est.

*Calculated from 1979 Sendout Data and the January 1979 System Peak.

TABLE IX MONTHLY AND ANNUAL SYSTEM LOAD FACTORS – FORECAST

YEAR	MONTHLY SYSTEM L.F. SUMMER PEAK MONTH	WINTER PEAK MONTH	ANNUAL SYSTEM L.F.
1980	72%	73%	62%
1985	72%	70%	61%
1990	73%	71%	62%
1995	73%	76%	62%

III. FUTURE MODIFICATIONS TO METHODOLOGY

In any viable forecasting procedure, the methodology must be flexible to allow modifications as conditions change or new data becomes available. The methodology used in this forecast is quite flexible and it is, therefore, to be expected that slight changes in the forecast will occur periodically. A new industrial electric sales model described later in this exhibit provides an example of such development.

IV. PEAK LOAD INFORMATION

A. Temperature Adjusted Historical Data

Regression coefficients are developed annually to adjust historical peak demands to normal weather conditions. Over time, the sum of the positive and negative adjustments is expected to be approximately zero.

Method of Adjustment – Winter

1. All January weekday peaks are currently adjusted to 0°F. and 15 knots average wind speed. These adjusted daily demands are averaged to obtain the overall winter adjusted peak.

Table X lists the actual and adjusted peaks.

Method of Adjustment – Summer

The 2:00 PM demands for each weekday in August are currently adjusted to 80°F. daily average temperatures. The adjusted summer peak demands were determined by averaging the daily adjusted demands.

Table XI lists the actual and adjusted peaks.

B. Customer End Use Peak Contributions

Table XII lists the winter peak for the preceding year, the current year, and the fifth, tenth and fifteenth succeeding years by the percentage of peak contributed by the major customer classifications and sub-divisions within those classifications. This information was estimated from he forecast and does not directly result from the NYSE&G forecast model.

Table XIII lists the same information for summer peaks on the NYSE&G system derived from the forecast.

As seen in Tables XII and XIII, no major change is expected in the contribution to peak by customer classification in the fifteen-year forecast, 1980-1995. At the time of the winter peak, the residential contribution changes from 54.1% in 1980/81 to 52.5% in 1995/96, a decrease of 1.6% in 16 years. The commercial and industrial combined increases by 2.1% over the same period.

Similar changes occur at the time of the summer peak. Residential contribution to peak decreases by 1.6% from 1980 to 1995, while the commercial and industrial combined contribution increases by 1.6%.

These forecasted changes are quite small and merely show the commercial and industrial sectors growing at a slightly faster rate than the residential classification.

Within the classifications, residential space heating is increasing its contribution to winter peak, as is commercial space heating. These changes are consistent with assumptions made about the future saturation of electric space heating. Air conditioning shows a modest growth in contribution to summer peak, again consistent with assumed future saturations of this end use.

V. RESIDENTIAL DATA

The NYSE&G household forecast is based on the 1978 New York State Department of Commerce demographic projections. These are 25-year projections of population and households. Table XIV lists the historic demographic data while Table XIV-1 lists the projections of populations, households and residential customers.

Table XV is a comparison of NYSE&G service area population, New York State population, and United State population. This data is presented for the historic period and for the forecast period.

Table XVI is a compilation of residential home appliance saturations for homes constructed in 1977 and 1978. This data was derived from the 1977 NYSE&G "New Home Survey" and the 1978 "New Home Survey."

Tables XVII-1, XVII-2, XVII-3 list projected appliance-customer saturation of selected residential appliances by type of space heat in the NYSE&G service area.

Table XVIII details the average number of residential customers by heating fuel for 1979 and the forecast period.

Table XIX details the historic and forecasted residential customer counts and electric sales.

Table XX details the historic and forecasted number of residential electric heating customers.

Table XXI details the choice of heating fuel made for newly constructed homes in the NYSE&G service area by years from 1966 to 1978. Table XXII lists the estimated numbers of gas heating customers by major supplier for the NYSE&G service area as of March 1979. Table XXIII shows the results of a survey which determined the distance from homes built during 1978 to the nearest natural gas mains. It has been assumed that 200 feet is the maximum distance economical for a main extension.

TABLE X ACTUAL AND TEMPERATURE ADJUSTED WINTER PEAKS

	ACTUAL			ADJUSTED	
WINTER	DEMAND	GROWTH	MONTH	DEMAND	GROWTH
1968/69	1,307 MW	--	DEC	1,289 MW	--
1969/70	1,404	7.4%	DEC	1,388	7.7%
1970/71	1,496	6.6%	DEC	1,477	6.4%
1971/72	1,556	4.0%	DEC	1,595	8.0%
1972/73	1,724	10.8%	JAN	1,738	9.0%
1973/74	1,701	-1.3%	DEC	1,718*	-1.2%
1974/75	1,768	3.9%	JAN	1,803	4.9%
1975/76	1,993	12.7%	JAN	1,940	7.6%
1976/77	2,070	3.9%	DEC	1,994	2.8%
1977/78	2,034	-1.7%	DEC	2,027	1.7%
1978/79	2,118	4.1%	JAN	2,153	6.2%
1979/80	2,072**	-2.2%	DEC	2,132	-1.0%

* Includes a 79 MW adjustment from daylight savings time to eastern standard time.

** Preliminary

TABLE XI ACTUAL AND TEMPERATURE ADJUSTED SUMMER PEAKS

	ACTUAL		ADJUSTED	
SUMMER	DEMAND	GROWTH	DEMAND	GROWTH
1969	1,182 MW	--	1,197 MW	--
1970	1,277	8.0%	1,277	6.7%
1971	1,343	5.2%	1,370	7.3%
1972	1,424	6.0%	1,442	5.3%
1973	1,585	11.3%	1,558	8.0%
1974	1,501	-5.3%	1,493	-4.2%
1975	1,565	4.3%	1,576	5.6%
1976	1,578	.8%	1,635	3.7%
1977	1,700	7.7%	1,681	2.8%
1978	1,729	1.7%	1,736	3.3%
1979	1,700	-1.7%	1,804	3.9%

TABLE XII CUSTOMER END USE CONTRIBUTION TO WINTER PEAK

CUSTOMER END USE
ESTIMATED PERCENT
CONTRIBUTION TO SYSTEM PEAK
(CLASSES INCLUDE RELATED COMPANY REQUIREMENTS)

WINTER PEAK

CUSTOMER CLASS	1979/80	1980/81	1985/86	1990/91	1995/96
Residential					
Space Heat	14.3%	14.7%	16.6%	17.4%	17.4%
Water Heating	3.9	3.8	3.1	2.5	1.9
Air Conditioning	0	0	0	0	0
Other	36.6	35.6	33.7	33.4	33.2
Subtotal	54.8%	54.1%	53.4%	53.3%	52.5%
Commercial					
Space Heat	3.4%	4.0%	5.4%	6.6%	6.8%
Air Conditioning	0.0%	0.0%	0.0%	0.0%	0.0%
Other	20.4%	20.4%	19.8%	19.1%	18.7%
Subtotal	23.8%	24.4%	25.2%	25.7%	25.5%
Industrial					
Space Conditioning	0.0%	0.0%	0.0%	0.0%	0.0%
Other	19.9%	20.0%	20.2%	19.9%	21.0%
Subtotal	19.9%	20.0%	20.2%	19.9%	21.0%
Street & Highway Lighting	1.4%	1.4%	1.1%	1.0%	.9%
Sales for Resale	.1	.1	.1	.1	.1
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Load Forecast	2072 MW (Prelim)	2260 MW	2680 MW	3160 MW	3740 MW

TABLE XIII CUSTOMER END USE CONTRIBUTION TO SUMMER PEAK

CUSTOMER END USE
ESTIMATED PERCENT
CONTRIBUTION TO SYSTEM PEAK
(CLASSES INCLUDE RELATED COMPANY REQUIREMENTS)

	SUMMER PEAK				
CUSTOMER CLASS	1979	1980	1985	1990	1995
Residential					
Space Heat	0%	0%	0%	0%	0%
Water Heating	4.2	4.0	3.3	2.7	2.1
Air Conditioning	3.2	3.3	3.9	4.7	5.4
Other	21.5	20.9	19.3	18.9	19.1
Subtotal	28.9%	28.2%	26.5%	26.3%	26.6%
Commercial					
Space Heat	0.0%	0.0%	0.0%	0.0%	0.0%
Air Conditioning	15.7%	16.2%	18.3%	19.4%	18.9%
Other	29.2%	29.2%	28.5%	27.7%	26.9%
Subtotal	44.9%	45.4%	46.8%	47.1%	45.8%
Industrial					
Space Conditioning	0.0%	0.0%	0.0%	0.0%	0.0%
Other	26.1%	26.3%	26.6%	26.5%	27.5%
Subtotal	26.1%	26.3%	26.6%	26.5%	27.5%
Sales for Resale	.1%	.1%	.1%	.1%	.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Load Forecast	1686 MW (Actual)	1850 MW	2220 MW	2630 MW	3100 MW

TABLE XIV DEMOGRAPHIC HISTORIC DATA

YEAR	SERVICE AREA POPULATION (1)	SERVICE AREA HOUSEHOLDS(2)	AVERAGE TOTAL RESIDENTIAL CUSTOMERS(3)	INCREASE PER YEAR	PERSONS PER CUSTOMER
1965			445,400	8,600	
1966	1,521,400		454,900	9,500	3.34
1967			464,900	10,000	
1968			472,800	7,900	
1969			483,200	10,400	
1970	1,571,200	461,737	494,200	11,000	3.18
1971	1,599,100		505,500	11,300	3.16
1972	1,620,800		517,800	12,300	3.13
1973	1,629,800		530,500	12,700	3.07
1974	1,635,100		540,500	10,000	3.03
1975	1,652,000	509,351	548,400	7,900	3.01
1976	1,657,400		556,200	7,800	2.98
1977	1,656,900		563,700	7,500	2.94
1978	1,653,700		570,900	7,200	2.90
1979			578,800	7,900	

(1) U.S. Department of Commerce, Bureau of Census, "Current Population Reports", P-25 #'s 427, 517, 527, 709, 771, 845. P-26 #78-32

(2) NYS Department of Commerce "1978 Official Household Projections for New York State Counties."

(3) NYSE&G Records.

TABLE XIV-1 DEMOGRAPHIC PROJECTIONS

	COMMERCE DEPARTMENT PROJECTIONS			NYSE&G PROJECTIONS	
	SERVICE AREA POPULATION(1)	SERVICE AREA HOUSEHOLDS(2)	YEARLY INCREASE 5 YR AVG.	SERV. AREA CUSTOMERS(3)	PER YEAR
1980	1,714,900	563,417	10,813	585,700	6,900
1981				593,000	7,300
1982				600,800	7,800
1983				608,300	7,500
1984				615,800	7,500
1985	1,785,700	620,958	11,508	623,500	7,700
1986				631,300	7,800
1987				639,300	8,000
1988				647,600	8,300
1989				655,500	7,900
1990	1,860,100	675,129	10,834	663,300	7,800
1991				670,800	7,500
1992				678,100	7,300
1993				685,100	7,000
1994				691,800	6,700
1995	1,927,900	719,590	9,600	698,300	6,500

Calculated From

(1) NYS Department of Commerce, "MCD Projections" based on "1978 Official Population Projections for New York State Counties."

(2) NYS Department of Commerce "1978 Official Household Projections for New York State Counties."

(3) NYSE&G projections.

TABLE XV COMPARISON OF NYSE&G SERVICE AREA POPULATION TO NEW YORK STATE AND U.S. POPULATION

YEAR	NYSE&G SERVICE AREA POP. (1)	NY STATE POPULATION (1)	% OF STATE POP. SERVED BY NYSE&G	U.S. POP. (THOUSANDS)(2)	% OF U.S. POP. SERVED BY NYSE&G
1970	1,571,200	18,241,400	8.6%	203,235	.77%
1971	1,599,100	18,349,000	8.7%	206,219	.78%
1972	1,620,800	18,367,000	8.8%	208,234	.78%
1973	1,629,800	18,209,200	9.0%	209,859	.78%
1974	1,635,100	18,103,000	9.0%	211,389	.77%
1975	1,652,000	18,075,500	9.1%	213,051	.78%
1976	1,657,400	18,073,200	9.2%	214,680	.77%
1977	1,656,900	17,931,700	9.2%	216,383	.77%
1978	1,653,700	17,748,000	9.3%	218,059	.76%
NYS COMMERCE DEPARTMENT PROJECTIONS					
1980	1,714,900	18,082,000	9.5%	221,651	.77%
1985	1,785,700	18,343,000	9.7%	232,371	.77%
1990	1,860,100	18,761,000	9.9%	243,004	.77%
1995	1,927,900	19,236,000	10.0%	252,241	.76%

Years	Calculated From
(1) 1966, 1970-1978	U.S. Department of Commerce, Bureau of Census, "Current Population Reports" P-25 #s 427, 517, 527, 709, 771, 845. P-26 #78-32.
1980-1995	NYS Department of Commerce, "MCD Projections" based on "1978 Official Population Projections for New York State Counties".
(2) 1970-1978	US Department of Commerce, Bureau of The Census, "Current Population Reports, P-25 #802. Table 6. Resident population.
1980-1995	US Department of Commerce, Bureau of The Census, "Illustrative Projections of State Populations by Age, Race, and Sex: 1975-2000", Series II.

TABLE XVI HOME APPLIANCE – CUSTOMER SATURATION

Appliance	Year Home Constructed	
	1977 (1)	1978 (2)
House Heating		
Natural Gas	11%	15%
Bottled Gas	2%	2%
Electricity	59%	50%
Oil	24%	23%
Wood Stove	4%	10%
	100%	100%
Air Conditioning		
One Room Unit	11%	9%
Two or More Units	3%	5%
Central	4%	5%
Heat Pump	3%	1%
	21%	20%
Water Heating		
Natural Gas	12%	15%
Bottled Gas	4%	4%
Electricity	71%	66%
Oil	13%	15%
	100%	100%
Cooking		
Natural Gas	N/A	7%
Bottled Gas	N/A	14%
Electricity	N/A	78%
		100%
Refrigerator		
Frost-Free	N/A	71%
Manual Defrost	N/A	30%
Freezer	N/A	36%
Dishwasher	N/A	54%
Dryer		
Natural Gas	N/A	9%
Bottled Gas	N/A	3%
Electricity	N/A	63%
		74%
Dehumidifier	N/A	20%

(1) "1977 New Home Survey"
(2) "1978 New Home Survey"

TABLE XVII-1 HOME APPLIANCE – CUSTOMER SATURATIONS – ELECTRIC HEAT

ALL RESIDENTIAL CUSTOMERS BY TYPE OF HEATING FUEL

ELECTRIC HEAT

Temperature Sensitive Load	1982 % of Homes	1982 KWH Per Home	1982 Weighted Use	1995 % of Homes	1995 KWH Per Home	1995 Weighted Use
Air Conditioner - Room	24	300	72 KWH	43	230	99 KWH
Air Conditioner - Central	7	1,300	91	12	1,050	126
Electric Heat-Year Round	83	11,400	9,462	83	11,400	9,462
Electric Heat-Seasonal	8	7,700	616	8	7,700	616
Supplemental Heating	9	1,500	135	9	1,500	135
Heating Auxiliaries	0	400	0	0	400	0
			10,376 KWH			10,438 KWH
Other Load						
Water Heating-Year Round	86	3,700	3,182 KWH	86	2,800	2,408 KWH
Water Heating-Seasonal	9	500	45	9	350	32
Electric Range	92	530	488	92	500	460
Electric Dryer	70	840	588	78	810	632
Gas Dryer	3	80	2	3	70	2
Freezer-Regular	34	1,000	340	34	780	265
Freezer-Frost-free	13	1,300	169	22	1,010	222
Dishwasher	59	300	177	72	240	173
Refrigerator-Regular	37	700	259	31	500	155
Refrigerator-Frost-free	66	1,500	990	72	1,080	778
Clothes Washer	76	85	65	76	60	46
Television	100	420	420	100	300	300
Dehumidifier	26	340	88	26	290	75
Farming	.7	12,700	89	.7	29,200	204
Lighting & Other-Regular	91	1,600	1,456	91	2,620	2,384
Lighting & Other-Seasonal	9	500	45	9	820	74
			8,403 KWH			8,210 KWH
Total Per Home			18,779 KWH			18,648 KWH

*Percent of homes with one or more of listed appliances

TABLE XVII-2 HOME APPLIANCE – CUSTOMER SATURATIONS – GAS HEAT

	1982			1995		
Temperature Sensitive Load	% of Home	KWH Per Home	Weighted Use	% of Homes	KWH Per Home	Weighted Use
Air Conditioner - Room	24	300	72 KWH	43	230	99 KWH
Air Conditioner - Central	4	1,300	52	10	1,050	105
Electric Heat-Year Round	0	11,400	0	0	11,400	0
Electric Heat-Seasonal	0	7,700	0	0	7,700	0
Supplemental Heating	3	1,500	45	3	1,500	45
Heating Auxiliaries	100	380	380	100	380	380
			549 KWH			629 KWH
Other Load						
Water Heating-Year Round	3	3,700	111 KWH	3	2,800	84 KWH
Water Heating-Seasonal	0	500	0	0	350	0
Electric Range	40	530	212	40	500	200
Electric Dryer	39	840	328	41	810	332
Gas Dryer	40	80	32	42	70	29
Freezer-Regular	34	1,000	340	34	780	265
Freezer-Frost-free	12	1,300	156	22	1,010	222
Dishwasher	44	300	132	64	240	154
Refrigerator-Regular	39	700	273	32	500	160
Refrigerator-Frost-free	67	1,500	1,005	74	1,080	799
Clothes Washer	88	85	75	88	60	53
Television	100	420	420	100	300	300
Dehumidifier	26	340	88	26	290	75
Farming	0	12,700	0	0	29,200	0
Lighting & Other-Regular	99	1,600	1,584	99	2,620	2,594
Lighting & Other-Seasonal	1	500	5	1	820	8
			4,761 KWH			5,275 KWH
Total Per Home			5,310 KWH			5,904 KWH

*Percent of homes with one or more of listed appliances

TABLE XVII-3 HOME APPLIANCE – CUSTOMER SATURATIONS – OIL HEAT

	1982			1995		
Temperature Sensitive Load	% of Homes	KWH Per Home	Weighted Use	% of Homes	KWH Per Home	Weighted Use
Air Conditioner - Room	24	300	72 KWH	43	230	99 KWH
Air Conditioner - Central	1	1,300	13	3	1,050	32
Electric Heat-Year Round	0	11,400	0	0	11,400	0
Electric Heat-Seasonal	3	7,700	231	3	7,700	231
Supplemental Heating	5	1,500	75	5	1,500	75
Heating Auxiliaries	100	380	380	100	380	380
			771 KWH			817 KWH
Other Load						
Water Heating-Year Round	33	2,900	957 KWH	40	2,800	1,120 KWH
Water Heating-Seasonal	5	500	25	5	350	18
Electric Range	53	530	281	60	500	300
Electric Dryer	55	840	462	68	810	551
Gas Dryer	8	80	6	9	70	6
Freezer-Regular	38	1,000	380	35	780	273
Freezer-Frost-free	14	1,300	182	23	1,010	232
Dishwasher	34	300	102	58	240	139
Refrigerator-Regular	48	700	336	31	500	155
Refrigerator-Frost-free	56	1,500	840	73	1,080	788
Clothes Washer	78	85	66	78	60	47
Television	100	420	420	100	300	300
Dehumidifier	16	340	54	16	290	46
Farming	5	12,700	635	4.1	29,200	1,197
Lighting & Other-Regular	88	1,300	1,144	88	2,130	1,874
Lighting & Other-Seasonal	12	500	60	12	820	98
			5,950 KWH			7,144 KWH
Total Per Home			6,721 KWH			7,961 KWH

*Percent of homes with one or more of listed appliances

TABLE XVIII AVERAGE NUMBER OF RESIDENTIAL CUSTOMERS BY HEATING FUEL

Year	Electric Heat	Natural Gas Heat	Oil Heat	Total
1979	49,600	253,400	275,800	578,800
1982	62,200	257,600	281,800	600,800
1985	78,400	263,300	281,800	623,500
1990	110,300	273,300	279,700	663,300
1995	142,200	282,100	274,000	698,300

TABLE XIX RESIDENTIAL ENERGY SALES FORECAST

	Residential Heating			Residential Non-Heating			
	Avg.#Customers for Year	KWH per Customer	Total Sales	Avg.#Customers for Year	KWH per Customer	Total Sales	Total Sales
1969	6,700	23,400	157 GWH	476,500	5,170	2,464	2,621 GWH
1970	8,900	24,800	221	485,300	5,440	2,642	2,863
1971	11,500	25,200	290	494,000	5,630	2,780	3,070
1972	14,800	25,600	379	503,000	5,850	2,941	3,320
1973	18,800	23,800	448	511,700	5,950	3,046	3,494
1974	23,600	23,500	554	516,900	5,850	3,025	3,579
1975	28,400	22,900	649	520,000	6,050	3,144	3,793
1976	33,500	24,000	803	522,700	6,160	3,219	4,022
1977	39,000	22,700	885	524,700	6,180	3,241	4,126
1978	44,000	22,100	973	526,600	6,170	3,247	4,220
1979	49,600	20,100	995	529,100	6,160	3,257	4,252
1980	53,300	19,400	1,035	532,400	6,125	3,261	4,296
1981	57,400	19,000	1,092	535,600	6,110	3,273	4,365
1982	62,200	18,800	1,170	538,600	6,100	3,284	4,454
1983	67,300	18,700	1,259	541,000	6,115	3,308	4,567
1984	72,700	18,700	1,359	543,100	6,110	3,318	4,677
1985	78,400	18,600	1,458	545,100	6,120	3,336	4,794
1986	84,300	18,600	1,568	547,000	6,170	3,375	4,943
1987	90,500	18,575	1,681	548,800	6,220	3,414	5,095
1988	97,000	18,550	1,799	550,600	6,270	3,452	5,251
1989	103,700	18,525	1,921	551,800	6,320	3,487	5,408
1990	110,300	18,500	2,041	553,000	6,370	3,523	5,564
1991	116,900	18,525	2,166	553,900	6,500	3,600	5,766
1992	123,400	18,550	2,289	554,700	6,600	3,661	5,950
1993	129,800	18,575	2,411	555,300	6,700	3,721	6,132
1994	136,000	18,600	2,530	555,800	6,800	3,779	6,309
1995	142,200	18,650	2,657	556,100	6,900	3,837	6,489

TABLE XX ELECTRICALLY HEATED DWELLING UNITS – FORECAST

YEAR ACTUAL	ADDED DURING YEAR NEW	CONVERSIONS	TOTAL	CUMULATIVE END OF YEAR	% INCREASE	% SATURATION
1968	1,113	563	1,676	5,679	41.9	1.20
1969	1,408	607	2,015	7,694	35.5	1.59
1970	1,724	737	2,461	10,155	32.0	2.05
1971	2,024	731	2,755	12,910	27.1	2.55
1972	2,768	854	3,622	16,532	28.1	3.19
1973	3,506	915	4,421	20,953	26.7	3.95
1974	3,919	1,013	4,932	25,885	23.5	4.79
1975	3,998	824	4,822	30,707	18.6	5.60
1976	4,640	826	5,466	36,173	17.8	6.50
1977	4,390	965	5,355	41,528	14.8	7.37
1978	3,952	1,392	5,344	46,872	12.9	8.21
1979	3,362	1,200(E)	4,562	51,434	9.7	8.89
PROJECTED						
1980	3,286	1,100	4,386	55,820	8.5	9.47
1981	3,020	1,100	4,120	59,940	7.4	10.11
1982	3,600	1,200	4,800	64,740	8.0	10.78
1983	3,900	1,300	5,200	69,940	8.0	11.50
1984	4,200	1,300	5,500	75,440	7.9	12.25
1985	4,540	1,300	5,840	81,280	7.7	13.04
1986	4,760	1,300	6,060	87,340	7.5	13.83
1987	5,040	1,300	6,340	93,680	7.3	14.65
1988	5,400	1,300	6,700	100,380	7.2	15.50
1989	5,300	1,300	6,600	106,980	6.6	16.32
1990	5,300	1,300	6,600	113,580	6.2	17.12
1991	5,250	1,300	6,550	120,130	5.8	17.91
1992	5,180	1,300	6,480	126,610	5.4	18.67
1993	5,040	1,300	6,340	132,950	5.0	19.41
1994	4,890	1,300	6,190	139,140	4.7	20.11
1995	4,810	1,300	6,110	145,250	4.4	20.80

TABLE XXI NEW CONSTRUCTED HOMES BY HEATING FUEL

-ESTIMATED-

Year	Electric Heat	Natural Gas	Oil & Other	Total
1966	700	5,500	3,100	9,300
1967	900	5,800	4,000	10,700
1968	1,100	4,200	2,900	8,200
1969	1,400	5,700	4,000	11,100
1970	1,700	5,200	4,400	11,300
1971	2,000	4,800	4,800	11,600
1972	2,800	4,100	7,000	13,900
1973	3,500	3,700	3,600	10,800
1974	3,900	2,700	2,200	8,800
1975	4,000	1,400	2,200	7,600
1976	4,600	300	2,500	7,400
1977	4,400	800	2,100	7,300
1978	4,000	1,100	2,400	7,500
TOTAL	35,000	45,300	45,200	125,500

SOURCE: 1966-1976 Based on an analysis of NYSE&G customer records.
1977-1978 Annual NYS&EG "New Home Survey"

TABLE XXII NYSE&G ELECTRIC SERVICE AREA – CUSTOMERS SERVED BY GAS SUPPLIERS

Estimated as of March 1979

SUPPLIER	CUSTOMERS
NYSE&G	109,800
National Fuel Gas	97,300
Columbia	46,400
Corning	9,600
Other	5,700
	268,800

Source: NYSE&G "1979 Residential Appliance Survey"

TABLE XXIII DATA ON PROXIMITY TO GAS MAINS

HOMES CONSTRUCTED DURING 1978
NYSE&G COMBINATION & ELECTRIC ONLY SERVICE AREAS

Distance from Gas Main	% of New Homes
Less than 200 ft.	29.8%
200 to 1000 ft.	9.2%
1000 ft. to 1 mile	10.0%
Greater than 1 mile	51.0%

SOURCE: Site inspection as part of the "1978 New Home Survey"

For the historic period, NYSE&G analyzed the Census Bureau Minor Civil Division Estimates which are published in "Population Reports." This data was published by town for the years 1970, 1973, 1975, 1976 and 1977. County census estimates were used to develop years 1971, 1972, 1974, and 1978. The 1978 NYS Department of Commerce demographic projections were allocated to the NYSE&G service area utilizing the Minor Civil Division forecasts. From these population forecasts, household forecasts were developed from ratios taken from the 1978 Department of Commerce Household Projections. The NYSE&G customer forecast contains the assumption that recent economic conditions will continue. This would result in household growth in NYSE&G's service area being approximately two-thirds of the level forecast by the Commerce Department.

VI. LOAD FORECAST METHODOLOGY

The NYSE&G load forecasting model is based on a multiple regression model of NYSE&G sendout for a data base period of October 1969 through July 1979. A different regression model was developed for each hour of the week for both warm and cold days. Thus, there are 336 possible models. In practice, the number of models was reduced to less than half that number because of the similarity between loads at different hours during the year. For example, the noon weekday model is essentially the same Monday through Friday while the noon Saturday model is valid for only one day per week.

A. Data Base Period

The data base period (October 1969 – July 1979) has a number of characteristics which help to improve the accuracy of the resulting forecast model. Several of these characteristics are listed below:

1. The period is long enough to include two full business cycles.
2. The real price of electricity during the period rose at 1.4% per year.
3. Household sizes declined throughout the base period. A similar rate of decline is forecast during the planning period.
4. The data base period included major energy conservation campaigns by NYSE&G, other utilities, industry and government. Therefore, the forecast model implicitly includes the effects of these, or similar programs in the future.
5. The period was one in which government construction was sharply reduced from earlier levels. A similar slow rate of government construction is forecast during the planning period.
6. The rate of population and customer growth within the NYSE&G service territory was similar to that forecast during the planning period.

The data base period does not, in itself, determine the NYSE&G load forecast. The base period does, however, allow alternative forecast models to be tested against historic data. This testing procedure has resulted in a model which clearly defines the characteristics of the various components of load on the NYSE&G system. These components include the various customer classes, each of which is further subdivided into summer and winter temperature sensitive load, light level related load and base load. The model further indicates the magnitudes of these components during different hours of the week, during different seasons and during different weather conditions.

B. Planning Period

After developing the forecast model through the use of the data base period, explicit assumptions were used to estimate the magnitude of the various load components during the forecast period.

Most of the load components are forecast to grow at rates differing from the data base period. For example, the real electric price is forecast to decline after 1985, as compared to an increase of 1.4% per year during the data base period. Therefore, certain components of load are expected to grow at faster rates in the latter portion of the forecast period.

C. Base Non-Weather Sensitive Load

The base (non-weather sensitive) load in both the warm and cold day models is analyzed through the use of both light level variables and variables for all other base load. The model for the hours of 4:00 AM through 9:00 AM includes a morning lighting variable. This variable reflects the increasing demand as sunrise occurs later in the day. A comparable evening lighting variable is incorporated for the hours of 4:00 PM through 9:00 PM. This variable accounts for the additional evening lighting occurring with earlier sunset times. The third light level variable is based on cloud cover. This measures the increased demand which occurs during cold weather as the sky becomes more overcast.

The remaining base load was correlated to a "base load growth factor." This factor is created from a detailed analysis of the base load components and is used by itself as an independent variable. It is also applied to forecast the growth of the light level variables.

The growth factor is totaled from the various components of base load. For the purposes of the study, the average estimated base load in December 1968 was arbitrarily selected as the base and set to one. The actual use by the various customer classifications was expressed as a percentage at that time.

The model currently uses the same growth factor for each hourly model. With the future analysis of load research data, however, the model may be designed to use different customer use ratios in different hours. This would better reflect the true situation. Nevertheless, the regression coefficients tend to largely compensate for this problem. Thus, an hour in which the growth rate has been estimated too low will show a slightly high regression coefficient and a negative constant. The model for an hour which is growing slower than the norm will produce the opposite result. The model was designed to best describe the growth components during the hours of the summer and winter system peaks. The results from analyzing other hours (particularly nights and weekends) indicated that the peak hours have grown at rates slightly below average. This base load relationship of low on-peak growth and slightly higher off-peak growth was assumed to continue throughout the forecast period.

Following is a discussion of the treatment of the non-temperature sensitive load of each customer class. See Appendix "A" for a definition of customer classes.

1. Commercial Class

a. Public Authority Load

The major loads in this category are schools, government office buildings, and other government services. The decisions which control the growth of these customers are, therefore, influenced by the number of students and the growth of government programs.

While the exact relationships which influence the growth of public authorities are not known, it is believed that reduced school construction and reduced growth of government will tend to hold the growth rate at a relatively low level. In addition, it is believed that government energy conservation codes will keep the growth rate at this low level even during the period when electric prices are expected to decline and economics would justify higher growth rates.

The growth of the base load of public authorities was at an average rate of approximately 2.7% during the October 1969 through July 1979 data base period. This low growth is believed to be the result of both government budget limitations and major programs to upgrade building energy efficiencies.

b. Other Commercial Load

This is a very diverse customer category which has exhibited no proven and stable relationship with any economic or demographic indicators. The growth rate over the data base period of October 1969 until July 1979 was approximately 2.4%. The future growth rate for this category was determined by the use of a composite factor. The data base period growth rate of 2.4% reduced to account for an assumed slowing of the upstate economic growth. One-half of the growth was assumed to continue at the rate which is consistent with the continuation of the 2.3% real price increase expected each year until 1985 and a price elasticity of -0.5. The other one-half of the growth was allowed to vary with the forecasted decrease in real price forecast after 1985.

This composite growth rate considers both increased growth which can occur as the real price declines, and the expected nonprice related conservation which is assumed over the entire forecast period.

c. Summary

The commercial class consists of public authority load and other commercial load. These components are forecast separately and combined for reporting purposes.

2. Industrial Load

The NYSE&G industrial load is characterized by a highly diverse group of manufacturing operations such as electronics, automotive equipment, glassmaking and mining. The load is assumed to be entirely non-temperature sensitive base load. A review of the growth history of this class reveals a clear response to national economic cycles. Furthermore, the NYSE&G industrial electric sales growth tends to more closely follow the pattern of national economic trends than the New York economy. For example, as of July 1979, the New York State Business Activity Index of Factory Output was at a level of 111 (1967 = 100). In contrast, the United States total industrial production index was at a level of 153 (1967 = 100) as of July 1979. NYSE&G industrial electric sales tended to follow national trends and had increased to a level of 161 (1967= 100) by the year 1979. This and similar comparisons result in the conclusion that the economy of the NYSE&G service area exhibits a closer resemblance to the overall national economy than to the New York State economy.

There are a number of reasons to believe this relationship to national economic trends is valid. These are:

a. The major NYSE&G industries serve national markets and are, as such, directly affected by national economic trends.

b. The industries manufacture a good cross section of products. While several of the manufacturers are quite large, no one individual employer is large enough to significantly distort the overall growth rate.

c. The NYSE&G service area has a relatively low population density and contains many plant site locations attractive to new industries. Industries locating in the service area have the further advantage that land is available for expansion.

d. Industries are attracted by the wage rates which are below those of most United States metropolitan areas.

e. The industrial plants tend to be relatively new and in good condition. Thus, the NYSE&G service area has not been greatly affected by the general slowdown in statewide economic growth.

The model used to forecast NYSE&G industrial sales is based on explanatory variables reflecting industrial productivity and the costs of the three major fuels. Specifically the data used in the model were:

1. Industrial production as measured by the Federal Reserve Board's Index of Industrial Production.

2. Real marginal cost of electricity calculated with data from the U.S. Department of Energy's report of "Typical Electric Bills" for NYSE&G industrial customers.

3. Real price of natural gas based on gas sales revenues for industrial customers of three major gas utilities in NYSE&G's electric franchise area.

4. Real price of oil computed from the U.S. Bureau of Labor Statistics (BLS) Wholesale Price Index.

All fuel costs were deflated using the BLS "Index of Wholesale Prices, All Commodities."

Several variations of the above variables were used in the least squares procedure to develop a regression model. The following model of the period 1962 through 1978 was selected as being most statistically significant in explaining NYSE&G industrial sales:

$$\underset{}{\text{Ln IS}} = \underset{(22.6)}{1.03 \text{ Ln IP}} - \underset{(-2.1)}{0.16 \text{ Ln EL1}} + \underset{(.9)}{0.03 \text{ Ln OG2}} + \underset{(14.0)}{2.77}$$

("t" values shown in parenthesis)

IS = NYSE&G Industrial sales

IP= industrial production

EL1 = real marginal electric price lagged one year

OG2 = ratio of real price of alternate fuels to real marginal price of electricity. The real price of alternate fuels is an average of oil and gas prices which are then lagged two years. Electric price is lagged one year.

Table XXIV lists the data used in the model and the forecast.

The alternate fuel ratio (OG2) was the only independent variable in the selected model which did not have a significant "t value" (.9). Since the value of the coefficient was only 0.03, changes in the ratio of alternate fuel prices to electric price would have only a small effect in the NYSE&G industrial sales forecast. This variable was retained, however, to show that the effect of alternate fuel costs were considered in the forecast.

Electric price variables lagged one year and alternate fuel prices lagged two years produced the most statistically significant results for those particular inputs in the model. A dummy variable to represent gas restrictions in effect from 1972 to 1978 was included in some of the attempts to produce an acceptable model. This variable was eliminated because its use tended to cause the coefficients of other variables to be of the wrong sign or to lose significance.

The chosen model explained 99.2% of the variation in NYSE&G industrial sales as indicated by the coefficient of determination. The industrial production index had the greatest effect on industrial sales of all the independent variables in the model. NYSE&G's previous industrial model used GNP, another national indicator, as the sole determinant of the industrial sales forecast. Although the Index of Industrial Production (IIP) was not believed to be an improvement over GNP as a predictor of industrial sales, it was used because the components of the index should in theory relate more particularly to industrial sales. In addition, the U.S. Department of Energy relies heavily on the Index of Industrial Production as an input variable for forecasts in the National Energy Plan II. Forecasted values for the IIP were taken from the Department of Energy's Annual Report to Congress 1978.

The annual growth rate in the forecast for IIP is 5.0% through 1985 and 4.3% for the remainder of the forecast.

The NYSE&G industrial electric forecast includes the assumption that the past ratio of NYSE&G service area

TABLE XXIV INDUSTRIAL SALES MODEL — INPUT DATA

YEAR	(IS) NYSEG INDUST. SALES	(IP) INDEX OF INDUSTRIAL PRODUCTION (1967=100)	(EL1) REAL PRICE OF ELECTRICITY (1) (¢/KWH)	(O2) REAL PRICE OF OIL (2)	(G2) REAL PRICE OF GAS (2)	(OG2) FUEL PRICES TO ELECTRIC PRICE (3)
1962	1268	72.2	2.32	95.4	114.1	45.2
1963	1301	76.5	2.31	100.4	114.3	46.5
1964	1394	81.7	2.31	98.7	113.4	45.9
1965	1548	89.8	2.27	99.4	106.4	45.3
1966	1737	97.8	2.22	91.3	103.5	43.9
1967	1770	100.0	2.14	95.1	103.0	46.3
1968	1867	106.3	3.15	93.9	100.0	45.2
1969	1974	111.1	2.10	100.0	100.0	47.6
1970	1977	107.8	2.02	99.4	96.5	48.5
1971	2045	109.6	1.95	96.2	93.4	48.6
1972	2192	119.7	2.03	96.5	93.4	46.8
1973	2352	129.8	2.01	96.6	101.3	49.2
1974	2240	129.3	1.88	93.5	106.9	53.3
1975	2221	117.8	1.65	103.7	96.6	60.7
1976	2369	129.8	1.91	169.9	101.3	71.0
1977	2525	137.1	2.22	176.9	124.7	67.9
1978	2632	145.2	2.17	184.2	141.2	75.0

(1) 1967 dollars, lagged one year.
(2) Index where 1967=100, lagged two years.
(3) OG2 is the ratio of the average price of alternate fuels (oil and gas) to electric price (((O2 + G2)/2)/EL1)

economic growth to national economic growth will decline by approximately one-fourth from the 1962 to 1978 level.

3. Residential Load

Residential KWH sales accounted for 39% of all NYSE&G sales in 1979. Of this amount, 78% is believed to be "base non-temperature sensitive load". Fortunately, this major component most easily lends itself to analysis. Unlike most customer classes, the residential class is made up of a relatively homogeneous set of customers with known electrical usage patterns. Appliance saturation data has been available every ten years from the U.S. Census Bureau. In addition, NYSE&G has performed several surveys including the "1977 Residential Appliance Survey" and the "1979 Residential Appliance Survey". Appliance electrical usage estimates are available from several sources and have served as guides in estimating the usage patterns on the NYSE&G system.

NYSE&G has identified 16 non-temperature sensitive residential electric applications and 6 temperature sensitive applications. These applications accounted for an estimated 79% of the average annual use of residential customers in 1979. The remainder of the usage was assumed to fall in the non-temperature sensitive "Lighting and Other" category. The modeled history and forecast of the appliance usages and saturations are shown in the examples in Tables XVII-1 to XVII-3. Table XVIII is the forecast of residential customer additions by type of heating fuel. The portion of use attributed to non-temperature sensitive applications was multiplied by the forecast of residential customers (shown in Table XIV) to determine the growth of the base non-temperature sensitive load of the residential class.

The growth of residential appliance saturation and usage was influenced by the interaction of many factors during the 1969 to 1979 period. Four of these factors are listed below:

a. The growth of electric heat and the shortage of natural gas resulted in the installation of increased numbers of electric water heaters, electric ranges, and electric dryers in new homes.

b. The introduction of more efficient appliances has helped to generally reduce the KWH use per appliance. This reduction may have also been aided by reduced household size.

c. Increased income and changing consumer preferences has resulted in a stock of appliances which are larger in size and contain added energy options.

d. Major energy conservation campaigns have helped reduce growth rates to levels significantly below historic trends.

In general, the interaction of various trends is believed to have resulted in declining KWH usage per appliance. This decline is forecast to continue over the entire forecast period due to mandated government appliance efficiency standards. Farming KWH usage per farm is expected to continue to increase at 5.3% per year, but this growth is expected to be largely offset by a decline in the number of farms. The KWH usage for the "Lighting and Other" category is forecast to continue to increase at 2.2% per year.

The forecast of the appliance saturations is based on an analysis of changes in the stock of appliances in both existing and new homes. Electric water heaters and electric ranges are forecast to be included in the majority of all new electrically heated homes and in a substantial number of oil heated homes.

4. Street and Highway Lighting

This minor load is entirely base, non-temperature sensitive. The growth rate was set at 2% per year over the entire period of the forecast.

D. Temperature Sensitive Load

Temperature sensitive load is forecast because this load is expected to contribute a large portion of the absolute growth of both the summer and winter peaks.

1. Summer Temperature Sensitive Load One input data source is the projected growth in air conditioning and other summer temperature sensitive load. Unlike space heat, no detailed data is kept up to date on air conditioning load. The residential saturation data that is kept does not cover the very large commercial and public authority classes. The forecast model does, however, give an indication of the growth of this load over the data base period.

The best data source is the model regression coefficients obtained by separately analyzing each year between 1969 and 1979. This analysis showed that the amount of air conditioning load grew at a 12% per year rate between 1969 and 1973 and experienced a large drop in 1974 after which the growth resumed at the slower rate of 8% per year. The implication was that a major energy conservation effort has reduced the air conditioning load to a new, more efficient level from which growth is continuing. The forecast model made use of a temperature sensitive multiplier which was defined as 1.0 in the year 1968.

The historic growth rate cannot be sustained indefinitely as it must trend toward the overall growth rate of construction. For this reason, the absolute amount of growth in the summer temperature sensitive load multiplier was assumed to increase at a rate slightly greater than he growth rate of new construction. This is based on the observation that most commercial and public authority construction has for some time been air conditioned. The practical effect of this assumption is to slowly reduce the rate of growth while slowly increasing the absolute year-to-year growth.

The growth rates shown in Table XXV were based on the above assumptions.

2. Winter Temperature Sensitive Load Winter Temperature Sensitive Load (WTSL) is another name for heating load. The electrical demand associated with heating load may be caused by the direct conversion of electrical energy to heat by resistance heating units or by other heating equipment using fossil fuels with electric auxiliaries such as fans or circulating pumps.

TABLE XXV SUMMER TEMPERATURE SENSITIVE LOAD

1980	7%	1988	6%
1981	7%	1989	5%
1982	7%	1990	5%
1983	7%	1991	5%
1984	7%	1992	5%
1985	6%	1993	5%
1986	6%	1994	5%
1987	6%	1995	5%

WTSL is the primary reason NYSE&G peaks in the winter. One way of modeling WTSL is to determine its contribution to winter peak over the data period to develop a growth factor to relate to the actual value of the load. This growth factor can then be used with other independent variables such as temperature and wind speed to define the value of WTSL at various hours during the data period.

The determination of total WTSL was the result of a regression analysis. To enable this load to be forecast, the breakdown into individual components was estimated through the use of NYSE&G records.

There have been major increases in the application of resistance heating systems in the residential, commercial, and other public authority classifications over the data period. Electrical usage for heating auxiliaries has declined in recent years.

For this analysis, the WTSL was assumed to consist of three components: residential space heat, other space heat, and other load. The amount of residential space heat was related to the number of residential electric heating customers. The contribution of the other space heating load components was developed with the aid of NYSE&G records of new commercial and other public authority customers, assuming 4000 hours use of heating equipment per year. The value of the "other load" component was estimated.

Table XXVI shows the estimates of contribution to peak by the three categories for January of the years of the data period. Table XXVII shows the breakdown by base load and WTSL for each of the weather adjusted peaks over the data period.

The actual calculation of the WTSL growth factor is performed by setting the value of the WTSL for December 1968 (145) equal to 1.000. Thus, the WTSL factor for January 1969 becomes 146 divided by 145 or 1.007, and the January 1979 factor is 3.354.

This method of modelling WTSL makes use of a maximum of available data, and results in he best possible approach to analyzing and forecasting this load component.

By using this approach to model the WTSL, the forecast of this component of demand is facilitated. The forecast of residential space heat is obtained from the analysis used to determine the heating fuel choice that new customers will make. This analysis is based on the historical price relationships between the major heating alternatives and consumer choice, and forecasts of future prices for these alternatives. Further information on this analysis is found in the Discussion of Important Assumptions (see Paragraph VII-A).

The absolute growth of the "other space heat" category is forecast to grow at approximately the growth rate of new construction. This assumption is similar to the one used to forecast commercial air conditioning. The assumption has the effect of slowly reducing the growth rate of "other space heat" over time, while slowing increasing the absolute year-to-year growth.

When the forecast of the individual components was made, they were totaled and the sum represents the WTSL for the January peak hour of each year. These numbers were then divided by the December 1968 value to develop the future WTSL growth factor.

TABLE XXVI WINTER TEMPERATURE SENSITIVE LOAD

YEAR	RESIDENTIAL SPACE HEAT(1)	OTHER SPACE HEAT(2)	OTHER LOAD	TOTAL
1969	44	7	95	146
1970	63	14	111	188
1971	85	22	108	215
1972	111	35	105	251
1973	140	55	103	298
1974	174	69	98	341
1975	214	77	88	379
1976	247	86	86	419
1977	277	94	81	452
1978	295	97	76	468
1979	313	100	73	486

(1) Based on NYSE&G records of heating customer counts

(2) Estimated from NYSE&G records

TABLE XXVII PEAK LOAD ANALYSIS

Winter Peak

Year	Temperature Sensitive Load	Other Load	Total
1968/69	146 MW	1,143 MW	1,298 MW
1969/70	188	1,215	1,403
1970/71	215	1,270	1,485
1971/72	251	1,355	1,606
1972/73	298	1,423	1,721
1973/74	341	1,340	1,681
1974/75	379	1,402	1,781
1975/76	419	1,508	1,927
1976/77	452	1,571	2,023
1977/78	468	1,574	2,042
1978/79	486	1,692	2,178

VII. DISCUSSION OF IMPORTANT ASSUMPTIONS

A. Price Elasticity

The forecast assumes a price elasticity of negative -.5 for most price sensitive applications. The one exception is the forecast of the saturation of electric heat in new homes. This quantity is based on a relationship developed from historic data within the NYSE&G service territory.

The forecast relationship is as follows:

$$YT = .64YT1 - 1.85\ LGEO + .45$$
$$(4.58) \quad (-2.33) \quad (2.72)$$

("t" values shown in parenthesis)

YT = Electric Heating Saturation
YT1 = Electric Heating Saturation lagged 1 year
LGEO = Log of the Electric Price to Oil Price Ratio
.45 = Constant

This relationship is considered valid over the range of historic data which included years when the cost of electric heat has been more expensive than the comparable fuel cost of home heating oil, and years when the electric heat cost was less than the oil heat.

For some applications, the adoption of energy efficient standards is expected to reduce or eliminate the effect of price changes on load growth. As an example, a number of appliances are subject to efficiency standards. Therefore, declining electric price should not result in a significantly less efficient stock of appliances. In like manner, increasing electric prices would not be expected to significantly improve the efficiency from the already efficient base. A similar situation exists for new construction because of the expected adoption of energy conservation building codes.

Table XXVIII presents a forecast estimate of the average fuel prices for all customer classifications.

Future real electric prices are based on NYSE&G estimates showing the real price to rise by 2.3% annually until 1985, decrease by 1.4% until 1990, and then decrease by 4.6% annually for the remainder of the forecast period. Table XXIX lists the current price of electricity by years for the forecast. This data was taken from the electricity price study performed on August 20, 1979, based on the Company construction plan at that time.

For the first six years of the forecast, electric price is one of many trends observed during the October 1969 to July 1979 data base period which is expected to continue. Thus, the past trends toward more efficient appliances and energy conserving buildings will continue to reduce the growth of non-temperature sensitive load.

Beyond the first six years of the forecast, electric prices are expected to decline at a rate of 1.4% per year until 1990, and then decline by 4.6% per year until 1995. No similar decline is forecast for oil or natural gas. The result, all other things being equal, should be a substantial increase in the electric sales growth during the latter part of the planning period. Two non-price related factors tend to offset this effect. First, the growth of the non-temperature sensitive load of the residential class is expected to begin to slow down due to reduced customer growth and less rapid accumulation of appliances. Second, the adoption of energy conserving building codes is expected to sharply reduce the effective price elasticity of the commercial class. During this nine-year period, 1986-1995, the price elasticity of -.5 is assumed to affect only one-half of the non-temperature sensitive load of the non-public authority commercial customers, and the farming and lighting and other components of the residential category.

B. Rate Modification

The extent to which rates could change over the fifteen-year period of the forecast are unknown, of course, as are the effects potential changes might have on the consumption of electricity. For this forecast, it is assumed that the existing residential time of day rate will remain in

TABLE XXVIII AVERAGE ELECTRICITY, NATURAL GAS AND FUEL OIL PRICES

YEAR	ELECTRICITY ¢ per KWH CURRENT $	ELECTRICITY ¢ per KWH CONSTANT $	NATURAL GAS $ per Dt CURRENT $	NATURAL GAS $ per Dt CONSTANT $	FUEL OIL (#2) ¢ per Gallon CURRENT $	FUEL OIL (#2) ¢ per Gallon CONSTANT $
1979	4.42	4.13	3.24	3.03	.72	.67
1980	4.96	4.35	3.84	3.35	.85	.75
1985	7.61	4.73	6.28	3.91	1.35	.84
1990	9.95	4.42	9.55	4.24	2.14	.95
1995	10.81	3.42	14.06	4.45	3.40	1.08

NOTES:
1) Constant $, 1978 = 100
2) Inflation assumed at 7% per year.
3) Dt = Dekatherms
4) Real Price Electricity - average of all classes:
   +2.3%/yr 1979-1985, -1.4%/yr 1985-1990, -4.6%/yr 1990-95
   Individual class data:
   Residential Regular = 1.20 times amount shown
   Residential Heating = .95 times amount shown
   Commercial = 1.01 times amount shown
   Industrial = .76 times amount shown
5) Real Price Natural Gas:
   +2.6%/yr 1979-1995
6) Real Price Fuel Oil:
   +3.0%/yr 1979-1995

TABLE XXIX CURRENT PRICE OF ELECTRICITY BY YEARS

YEAR	¢ PER KWH
1977	3.61
1978	4.07
1979	4.42
1980	4.96
1981	5.66
1982	6.37
1983	6.92
1984	7.22
1985	7.61
1986	8.19
1987	8.83
1988	9.49
1989	9.43
1990	9.95
1991	9.85
1992	9.81
1993	10.47
1994	10.23
1995	10.81

effect, and that there will be some development of time of day rates for the other classes as well. The absolute effects of these changes are unknown.

C. Energy Conservation

NYSE&G has assumed both price related and non-price related energy savings. The energy conservation discussed here is not price related. As such, the energy conservation measures are not economically motivated and would not have taken place in the absence of government regulations.

In the non-residential area, NYSE&G has assumed that government mandated energy conservation measures will be designed to be consistent with projected NYSE&G increases in real electric prices of 2.3% per year through 1985. During the first years of the forecast, this rate of price rise and the associated energy conservation is implicit in the model. The downward trend in use per residential appliance is expected to continue for several more years in anticipation of federal and state appliance efficiency standards.

After 1985, NYSE&G real electric prices are expected to decline at 1.4% per year until 1990, and then decline at 4.6% per year until 1995. A large part of the load growth was assumed to not react to these lowered prices because of mandated energy conservation standards. The commercial class is assumed to be the most affected by these standards. Within this class, the public authority growth rate is expected to remain at the lowered levels consistent with rising real prices. One-half of the remaining commercial load is also expected to continue at this lowered rate of growth.

The remaining commercial load and the industrial load is not expected to be constrained by energy conservation standards.

D. Load Management

This forecast assumes that no direct load management will be in effect over the forecast period. Customer application of load management is considered as a conservation impact.

E. Government Programs

This section will describe the effect on the forecast of peak load, sales and sendout of conservation tax credits, lighting standards, construction codes, and appliance standards.

1. Tax Credits No major effect on he NYSE&G electric system would be expected from a program of conservation tax credits. This analysis is based on the assumption that a great amount of insulation retrofitting has already occurred. The effect of these efforts exist in the data base and have been implicitly included in the NYSE&G forecast.

Electrically heated homes are normally very well insulated when built. The potential for electrical savings in fossil fueled heating auxiliaries is believed to be relatively minor.

2. Lighting Standards The data used to develop the forecast regression factors contains years before the Arab oil embargo, as well as several years of lower lighting levels in commercial establishments. A continuation of this trend towards more efficient lighting standards is, therefore, implicit in the forecast. Future buildings will undoubtedly come under close scrutiny to ensure the lowest lighting level possible consistent with good practice and safety. The NYSE&G model is believed to include the effects of this increased efficiency.

3. Construction Codes This forecast was developed assuming energy efficient construction codes would be in effect for the forecasting period.

4. Appliance Standards This forecast was developed assuming the existence of residential appliance standards.

F. Co-generation

NYSE&G currently has one clear example of cogeneration on its system. This is an industrial plant purchasing extraction steam from a power plant. This steam is used for process as well as space heating needs. NYSE&G is receptive to cogeneration proposals which are based on sound economics and result in mutually beneficial savings to participating parties.

NYSE&G will consider cogeneration plans from its commercial and industrial customers. Because large, concentrated industrial and commercial installations do not predominate on the system, no major impact to the forecast is expected from cogeneration. This is a forecast of customer electrical needs. Cogeneration is simply one method to answer those needs.

G. New Natural Gas Attachments

This forecast was developed assuming natural gas would be readily available and would claim an increased share of the market relative to other fuels. Because of this, no changes would occur to the forecast of peak demand and sales if the lifting of the State governmental regulations on new natural gas attachments was assumed.

H. Electricity and Natural Gas Comparison

This section is a brief comparison of the consequences of meeting increases in end use demands with either electricity or natural gas where these two sources are substitutable. It should be recognized that NYSE&G serves natural gas in a relatively small portion of its electric service territory.

1. Price of Energy to End-Users At current prices, natural gas has lower operating costs than electricity and higher initial equipment costs. Where NYSE&G supplies both gas and electricity, the customer is normally encouraged to choose natural gas heating. This forecast is based on the assumption that electric prices will not begin to compete with those of natural gas until the 1990's.

2. Economic and Fiscal Impact on the Utility This long-term forecast assumes NYSE&G will be economically viable in the future. This hinges on maintenance of an adequate rate of return on investment. It is believed that, regardless of whether NYSE&G meets a load with electricity or natural gas, the Company rates will be structured to allow an adequate return.

3. Availability of Energy It is believed that both electricity and natural gas will be available in quantities sufficient to meet the needs of non-interruptible load for the life of the customer's equipment.

4. Related Environmental Impacts Within the State A comparison of the environmental impact of natural gas versus electricity is a complex question which has never been fully answered. The production of electricity includes an environmental impact on specific areas in the state. The burning of natural gas, by comparison, is a relatively clean process, but is done within customer premises under varying conditions.

I. NYSE&G Conservation Program

This section will describe current and planned activities directed toward marginal cost pricing, peak load pricing, load management and conservation.

1. Marginal Cost Pricing

NYSE&G does not currently use the marginal cost pricing concept in developing its rates, nor has it assumed the implementation of such a procedure during the forecast period. The forecast was developed anticipating continuation of the current rate making practices, and therefore, no effect of marginal cost pricing has been assumed on peak load, sales, or send out.

2. Peak Load Pricing

NYSE&G has offered an off-peak residential rate for many years and its continuation is planned. This rate is expected to be utilized by virtually all electrically heated homes as well as a large portion of oil heated homes. The effects of this tariff are implicit in the NYSE&G model.

3. Load Management

The NYSE&G electric water heater load management program was unacceptable to the Public Service Commission and therefore has not been included in the forecast.

4. Conservation

NYSE&G has integrated conservation into its own operations to the extent possible with existing facilities and designs its new facilities to be efficient energy users.

The Company encourages its customers to practice conservation and educates by many means, such as distribution of brochures, talks to community groups and seminars for teachers. The Market Services personnel also work closely with commercial and industrial customers to aid them in conserving electricity at their facilities.

The effect of these conservation programs will be a better informed public. Because these programs have been on-going and because certain standards do already exist, the forecast of peak demand and sales and send-out incorporates the effects of the conservation effort.

NYSE&G believes that energy conservation makes as much sense for the Company as it does for its customers. The uncertainty over oil supplies and prices and the rising cost of fuel and new energy-producing facilities make conservation one of the best, most economical and available means of addressing this state's energy problem. It is available almost instantly. It will diminish the need for future oil imports and may delay the construction of new facilities.

Energy conservation programs directed to the residential customer and the general public have the following objectives:

1. To make available practical information on the reasons for and ways to eliminate wasteful practices in the use of electric energy in the home with particular emphasis on home insulation.

2. To provide individual consultation, including personal visits to all residential customers upon request.

3. To work with those community organizations that are directly involved with programs to winterize dwellings occupied by the low income and elderly groups.

4. To present the facts on the energy supply situation, present and future, to community groups.

5. To consult and work with builders, developers, building material suppliers, and insulating contractors and heating contractors.

The following are some of the activities designed to attain these objectives in energy conservation among residential customers.

A. A variety of publications are made available to the public through distribution at group meetings, office literature displays, bill inserts, personal visits, building material suppliers and exhibits at large group events such as home shows and county fairs.

B. NYSE&G has experienced personnel throughout the service area who consult with and advise residential customers on such matters as insulation, water heating and energy conservation measures. In addition, the field personnel have available for consultation a corporate staff of specialists who conduct training programs to update information and skills of the employees.

C. The Company maintains a program of consulting with and advising community agencies administering federal and state funds for the weatherization of homes of low income people. In some locations, company employees serve on qualification review committees.

D. Market Services personnel actively solicit opportunities to talk to community organizations.

E. Company personnel advise and consult with builders and developers, building material suppliers, insulating and heating contractors, to educate these tradesmen on the proper sizing of space heating equipment for residential use.

F. The Company participates in energy conservation and insulation exhibits at home trade shows, county fairs, and public energy exhibitions.

G. Through the Home Insulation and Energy Conservation Plan, consumers can complete at no charge energy audits of their homes to find out what additional insulation or other conservation measures their homes need. A Company representative can also perform the audit for $10.00. Once the audit is completed, the Company will help eligible customers obtain bank loans to finance the improvements.

H. In NYSE&G's Project Conservation, representatives conduct free energy audits and recommend conservation measures in the homes of low-income families. Those identified by the Energy Crisis Assistance Program (ECAP) as needing help in meeting their energy bills are being contacted.

Conservation programs relating to commercial and industrial customers are as follows:

A. Energy Management Action Course – A five-session course designed to teach building operators the techniques and methods for retrofitting energy systems in existing buildings. It covers the methods of how to perform an energy audit, and emphasizes the practical approach to energy savings in all systems. Topics covered include how to do a building heat loss, how to monitor and record energy use in the building, lighting, HVAC systems and control, demand control.

B. A periodic newsletter will be mailed to architects and consulting engineers informing them of new policies and energy conservation programs and products. This will allow us to work more closely with these designers to insure more energy efficient buildings.

C. NYSE&G'S Commercial/Industrial Representatives are prepared to spend extensive time with the customers to help them perform a walk-through energy audit, and establish an energy conservation program. This would include identifying areas of high energy waste, and discussing with the customer different options available for improving the efficiency of the system.

VIII. FORECAST SENSITIVITY ANALYSIS

This section is a discussion of the effect of varying the basic forecast assumptions. It should be recognized that many of the variables are interrelated. Therefore, the effect of simultaneously varying more than one assumption may differ from the sum of the effects of varying each assumption individually.

The sources of forecast deviations can generally be divided among: 1) model error, 2) random load variations, and 3) assumption errors. Model errors and random load variations are largely subject to statistical techniques. The probability of erroneous assumptions is, however, judgmental and not readily subject to mathematical analysis.

A. Model Errors

The forecast model tended to closely track the data over the October 1969 through July 1979 period. The average standard error of estimate of the various hours over this period was generally in the range of 2% to 3% of load.

The model error is caused by the failure to account for all factors influencing electric use. These factors include: 1) short-term industrial output variations, 2) erratic load growth patterns, and 3) unusual weather conditions.

The model error should continue at roughly the current percentage of load throughout the forecast period.

B. Random Load Variations

Random load variations are caused by factors which tend to vary in a statistically predictable manner. For example, the national economy has gone through a number of similar economic cycles. A related pattern of growth and recession has characterized the new home market. Beyond the immediate future, NYSE&G has assumed smooth growth of both the economy and new housing starts. Therefore, it is to be expected that the NYSE&G forecast will somewhat overestimate customer requirements during periods of recession and underestimate those requirements during periods of very low unemployment.

The major reason for short term forecast errors is weather variations. Weather differences currently cause the winter peak to vary within a range of approximately plus or minus 70 MW. This range is expected to increase with the increasing levels of electric heat.

C. Assumption Errors

Errors during the first years of a forecast are normally dominated by unexpected economic trends or random weather variations. Beyond this period, the major source of potential error is from imprecise assumptions. Following is a discussion of assumption errors related to: (1) economic growth; (2) fuel prices; (3) electrically heated homes; and (4) heat pumps.

1. Economic Growth – the NYSE&G forecast is based on the assumption that New York economic growth will continue at a level similar to that of the 1975 to 1979 period. A higher level of economic growth is implicit in the New York State Commerce Department "1978 Projections of Population and Households." A return to the economic and population growth levels forecast by the Commerce Department would cause the NYSE&G electric growth rate to increase from the forecasted level of 3.4% per year to a new level of approximately 4.2% per year. Economic growth below the levels assumed by NYSE&G would be unprecedented and are therefore believed to be unlikely.

2. Fuel Prices – The rising costs of fossil fuels have caused increased competition between electricity, oil, and natural gas. The NYSE&G forecast has assumed relatively little conversion from alternate fuels to electricity. Therefore, the electric forecast could be too low if: (1) cross-price elasticities have been underestimated; (2) oil or natural gas prices rise beyond the projected levels; or (3) oil or natural gas supplies become limited.

3. Electrically Heated Homes – The number of electrically heated homes is dependent on a large number of factors such as:

a. The availability and price of alternate fuels.

b. Consumer preferences

c. The price of electricity

d. The form of the electric rate

e. Technology

f. The rate or residential construction

g. Government regulations

Any one of these factors could have a major impact on the growth of electric heating.

The NYSE&G forecast is based on an assumed contribution to winter peak of 6.1 KW of temperature sensitive load per all electric homes. The addition of all electric homes is expected to add 570 MW to the winter peak from January 1980 to January 1996. This is based on the assumption that approximately 68% of new homes will include electric heating.

NYSE&G assumes natural gas to be available throughout the forecast period. Furthermore, the price of gas is assumed to remain at a level low enough to take virtually all of the market in the areas where gas distribution systems exist. These assumptions have the effect of fixing the percentage of natural gas at approximately one-quarter of the new home market. The current boundaries on natural gas distribution systems make it unlikely that this ratio can be greatly exceeded. The opposite possibility of less gas sales due to supply limitations or unexpectedly high gas prices is, however, of significant concern. This would, of course, increase the growth of electric heating beyond the projected levels.

4. Heat Pumps NYSE&G assumed that heat pumps will continue to be installed in very homes. The introduction of additional heat pumps should not affect the peak winter demand when compared with electric resistance heating. Heat pump systems (including supplemental resistance heat), are known to have relatively low efficiencies during the very cold weather at the time of the NYSE&G winter peak. The summer peak would be expected to increase due to the automatic availability of central air conditioning.

The introduction of heat pumps, when substituting for resistance heating, would be expected to reduce the annual electric use for electric heat by 3,000 to 5,000 KWH. This would be partially offset by increased air conditioning use. Substitution of heat pumps for fossil fuel heating systems would, of course, increase the electrical requirements on the NYSE&G system.

IX. EXAMPLE CALCULATIONS

The actual development and application of the forecast load model is quite involved. The following example attempts to explain the development and application of one of the many hourly equations. The example used in this case is 7:00 PM for Monday through Friday on cold days. "Cold days" are defined as those under 63°F at the Broome County Airport.

A. Example of Forecast Model Development

The first step in the forecast process was the analysis of the historic and current load components. This analysis was performed for each hour to gain more complete insight into patterns of energy use at different times of the day, week or season.

The following example illustrates the calculation of the regression coefficients for winter weekdays for the hour ending 7:00 PM. The example further specifies the calculation of one of the many data points used in this calculation.

The 7:00 PM hourly model made use of 770 data points over the period October 15, 1969 through June 18, 1979. The specific data point used in this example will be the hour ending 7:00 PM on January 19, 1979.

During the data base period, appliance saturation and customer growth was used to establish the non-temperature dependent load growth in the residential section. From October 1969 to January 1979, the non-temperature dependent residential load was calculated to have grown by about 42%. Thus, the residential base load growth factor was set at .382 x 1.420 = .541.

As shown in Table XXX, the base load of the Street Lighting and Commercial sectors were estimated to both have a growth of non-temperature dependent loads of approximately 2.2% per year. Applying these annual growth rates on a monthly basis, results in the January 1979 base load growth rates shown below:

Class	Base Growth Factor
Street Lighting	.018
Commercial	.438

The industrial class was evaluated through the use of a model described previously. The industrial base increased by nearly 40% from October 1969 to January 1979. Therefore, the industrial base load growth factor increased from .314 to .439.

To summarize the example, a calculation of the January 1979 base load growth factor is shown in Table XXXI.

The second set of data to be assembled was winter temperature sensitive load. This load can be generally subdivided into: 1) residential electric space heat, 2) non-residential electric space heat, and 3) furnace fans and miscellaneous loads. The NYSE&G analysis indicated that, prior to 1970, most winter temperature sensitive load was in the third category. For example, in January 1969, approximately 146 MW of the temperature adjusted peak was found to be temperature related. Of this value, 65% or 95 MW was found to be fans and miscellaneous load, while 35% or 51 MW was found to be from electric space heating. By January 1979, the space heating component had increased to 413 MW (313 MW residential plus 100 MW of other heat). The miscellaneous category had apparently declined slightly to 73 MW. Thus, the total temperature sensitive load had increased by 233% from 146 MW in January 1969 to 486 MW in January 1979.

The forecast model utilized, as data, a winter temperature sensitive growth factor based on the known changes in total temperature sensitive load. By January 1979, the growth factor had increased to a level of 3.354 based on a level of one (1.0) in December 1968.

The third group of data points to be determined were those of weather. For example, the temperature at 7:00 PM, Friday, January 19, 1979, was 8"°F at the Broome County Airport. Twenty-four hours earlier, the temperature had been 4°F. The sky cover over the previous 12 hours

TABLE XXX COMPONENTS – BASE LOAD GROWTH FACTORS – FORECAST

Class	October 1969	January 1979	Annual Growth Rate
Residential	.382	.541	3.5%
Public Authorities	.111	.141	2.4%
Other Commercial	.238	.297	2.2%
Total Commercial	.349	.438	2.3%
Industrial	.314	.439	3.4%
Street Lighting	.014	.018	2.5%
Total	1.058	1.436	3.1%

TABLE XXXI JANUARY 1979 BASE LOAD GROWTH FACTOR

Class	Base Load Growth Factor
Residential	.541
Commercial	.438
Industrial	.439
Street Lighting	.018
Total	1.436

had been 100%. The average wind speed during those 12 hours had been 5.25 knots.

The last data point to be determined was the time of sunset. For example, the sun sets at 5:00 PM on January 19. This data point was used to help determine the evening lighting factor.

After determining the original data points, the actual variables were calculated. This was necessary because the variables were often functions of the original data points.

The same procedure was used to determine the dependent and independent variables for all the other 769 data points for 7:00 PM on weekdays. This information was used in a multiple regression computer program which generated regression coefficients. The calculated coefficients were those that gave the smallest average standard error of estimate over the October 9, 1969 through June 18, 1979 period. The winter coefficients are listed in Table XXV. Refer to hour 19 under the listing of winter coefficients to determine the coefficients applicable to 7:00 PM.

The preliminary forecast coefficients applicable to winters at 7:00 PM on Friday are listed below:

Independent Variable	Regression Coefficient
Winter Temperature	2.212
Wind-Temperature Index	.531
Evening Lighting	1.288
Winter Temperature Lag	-30.8
Base Load Growth	732.0
Cloud Cover	1.822
Constant (Intercept)	5
Friday Dummy	-27

Applying the regression coefficient to the calculated variables gives the model estimate of the 7:00 PM, January 19, 1979 load. This comparison was performed for each of the 770 data points to evaluate the accuracy of the model. Table XXXII is the January 19, 1979 calculation.

B. Example of Forecast Model Application

After establishing the regression coefficients, the next step is to forecast the data used to "drive" the model to be able to use the regression coefficients to forecast loads. The two changing data points are the base load growth variable and the temperature sensitive load growth variable.

The base load growth variable is first adjusted for consistency with the 3-year short term forecast. The forecasted base load growth variable is then established as outlined in Section VI-C. The temperature sensitive load is forecast by estimating the growth in residential space heat, other space heat and other temperature sensitive load.

TABLE XXXII EXAMPLE CALCULATION

Variable Name	Regression Coefficient		Variable Calculation		Estimated Contributor
Winter Temperature	2.212	x	(3.354) x (63-8)	=	408
Winter-Temperature Index	.531	x	((3.354x(63-8))x21/100)	=	21
Evening Lighting	1.288	x	1.436 x 230	=	425
Winter Temperature Lag	-30.8	x	((3.354)x4-8)) 100	=	4
Base Load Growth	732.0	x	1.436	=	1051
Cloud Cover	1.822	x	1.436 x 40	=	105
Constant	5	x	1.0	=	5
Friday Dummy	-27	x	1.0	=	-27
			TOTAL	=	1992
			ACTUAL	=	1996

To forecast summer and winter peaks, the regression coefficients were related to sets of peak hour weather conditions.

The same level of winter and summer demands can be caused by significantly varying conditions. For example, the summer peak could occur on a very hot August day at 2:00 PM or on a slightly cooler September day at 9:00 PM. The winter peak would be similar regardless of whether it occurred prior to Christmas on an 8°F day or in January on a 0°F day.

The conditions at the time of the average summer peak peak are equivalent to those at 2:00 PM on an August day with an average daily temperature of 80°F.

The conditions at the time of the average winter peak are equivalent to those of a 0°F day at 7:00 PM on January 15. The equivalent day is assumed to have an evening temperature of 10°F cooler than the previous day, and an average wind of 20 knots.

To forecast send out, a standard model year was made up of actual weather conditions for 12 average months. For example, January 1972 was used along with February 1974 and March of 1974. It is particularly important that actual weather be used rather than average monthly temperatures because the spring and fall months contain a mix of heating and air conditioning.

The standard model year is used in conjunction with the model regression coefficients to forecast a typical set of demands for the 8,760 hours of a year. The sendout is totaled by day, month and year. Temperature sensitive sendout and base load are listed separately on an annual basis.

Since the total energy sendout is simply the sum of each hourly demand in the year, the model gives energy and demand forecasts which are derived from the same model.

X. MULTIPLE REGRESSION DATA

Tables XXXIII and XXXIV list the regression coefficients applicable for weekdays. Not shown are the regression coefficients for Saturday and Sunday.

Below is a brief description of the application of the variables included in the Model. Standard statistical tests were performed and all equations were judged to be acceptable. See Appendix B for a discussion of statistical tests.

TABLE XXXIII FORECAST MODEL REGRESSION COEFFICIENTS – WINTER WEEKDAYS

HOUR ENDING	TEMP.	LIGHTING	TEMP LAG	BASE LOAD	CLOUD COVER	WIND TEMP INDEX	DUMMY VARIABLES MONDAY	FRIDAY	CONSTANT
1	2.805	0	-78.8	627.0	.482	.626	-73.	7.	-23.
2	2.740	0	-71.7	630.6	.357	.573	-55.	6.	-67.
3	2.769	0	-71.2	596.6	.308	.578	-44.	5.	-60.
4	2.661	.124	-73.9	573.4	.222	.679	-41.	5.	-64.
5	2.737	.112	-73.9	582.7	.232	.651	-38.	3.	-77.
6	2.819	.168	-73.2	631.6	.299	.663	-32.	4.	-112.
7	2.849	.373	-87.7	782.9	.280	.541	-27.	0.	-197.
8	2.666	.539	-78.7	862.3	.544	.335	-17.	-3.	-122.
9	2.394	.404	-64.2	892.7	.730	.386	0	1.	-33.
10	2.490	0	-88.0	965.3	.509	.596	16.	5.	204.
11	2.326	0	-75.7	943.7	.793	.797	27.	5.	200.
12	2.181	0	-64.7	902.7	1.061	.920	29.	3.	195.
13	2.118	0	-68.6	968.5	1.192	.902	25.	-1.	-68.
14	1.963	0	-56.8	949.9	1.327	.966	19.	-6.	-40.
15	1.960	0	-48.6	907.7	1.518	.913	13.	-11.	-16.
16	1.851	.639	-46.2	775.5	1.905	.979	9.	-17.	-56.
17	1.954	1.302	-44.6	666.2	2.173	.870	7.	-30.	-59.
18	2.216	2.248	-47.0	483.4	1.901	.659	5.	-35.	8.
19	2.212	1.288	-30.8	732.0	1.822	.531	8.	-27.	5.
20	2.082	1.222	-34.5	757.4	.988	.617	6.	-39.	52.
21	2.244	.603	-42.8	811.2	.476	.509	2.	-44	86.
22	2.604	0	-62.5	777.3	.535	.437	-2.	-37.	134.
23	2.686	0	-58.9	744.1	.421	.400	-3.	-12.	56.
24	2.856	0	-68.1	693.0	.406	.456	-3.	8.	-13.

TABLE XXXIV FORECAST MODEL REGRESSION COEFFICIENTS – SUMMER WEEKDAYS

May-September

HOUR ENDING	TEMP.	LIGHTING	BASE LOAD	WEEKDAY DUMMY VARIABLES MONDAY	FRIDAY	MONTHLY DUMMY VARIABLES MAY	JUNE	JULY	CONSTANT
1	.081	0	799.1	-84.	6.	-66.	-19.	-17.	-174.
2	.076	0	778.4	-63.	4.	-52.	-10.	-19.	-199.
3	.069	0	736.4	-54.	0.	-47.	- 9.	-18.	-181.
4	.068	-.029	709.2	-48.	0.	-55.	- 7.	-19.	-172
5	.062	.081	712.8	-44.	-1.	-45.	0.	-17.	-190.
6	.055	.217	758.2	-38.	-2.	-39.	- 1.	-21.	-221.
7	.050	1.244	861.6	-35.	-6.	25.	65.	- 2.	-357
8	.059	1.611	888.5	-21.	-6.	90.	118.	14.	-276.
9	.066	1.234	907.4	- 7.	-3.	55.	101.	5.	-126.
10	.075	0	988.3	14.	4.	- 6.	15.	-46.	- 42.
11	.085	0	1016.3	26.	5.	-31.	4.	-46.	- 37.
12	.093	0	1017.8	32.	5.	-45.	- 4.	-40.	- 35.
13	.099	0	1017.7	26.	3.	-40.	- 4.	-36.	- 65.
14	.105	0	1001.3	22.	0.	-40.	- 3.	-37.	- 35.
15	.107	0	976.7	20.	-3.	-44.	- 4.	-39.	- 19.
16	.114	0	969.3	14.	-8.	-49.	- 6.	-41.	- 36.
17	.109	0	982.5	10.	-19.	-49.	- 9.	-39.	- 51.
18	.102	0	988.9	10.	-22.	-58.	-17.	-40.	- 59.
19	.107	.484	978.4	0.	-14.	-60.	0.	-24.	-117.
20	.105	1.539	904.7	0.	-17.	-38.	36.	5.	-122.
21	.096	1.351	884.3	- 2.	-27.	-46.	-14.	-43.	- 20.
22	.093	0	925.6	6.	-28.	-46.	-23.	-48.	10.
23	.095	0	874.1	0.	-14.	-40	1.	-22.	128.
24	.086	0	862.6	- 5.	2.	-55.	- 7.	-13.	-162

Winter Temperatures Factor: A X B X (63-T)
A = Regression coefficient
B = Winter temperature sensitive load growth factor (December 1968 = 1.0)
T = Coincident temperature at the Broome County Airport

Winter Wind – Temperature Index: A X B X (63-T) X C/100
A = Regression coefficient
B = Winter temperature sensitive load growth factor (December 1968 = 1.0)
T = Coincident temperature at the Broome County Airport
C = Four times the average wind speed in knots during the previous 12 hours at the Broome County Airport

Winter Temperature Lag Factor: (A X B X D-C)/100
A = Regression coefficient
B = Winter temperature sensitive load growth factor (December 1968 = 1.0)
C = Current Broome County Airport temperature
D = 24 hours previous temperature

Base Load: A X B
A = Regression Coefficient
B = Base Load Growth Factor (December 1968 = 1.0)

Winter Cloud Cover: A X B X C
A = Regression coefficient
B = 4 times the Average Sky Cover, in tenths, during the previous 12 hours at Broome County Airport (Overcast = 4 X 10 (tenths) = 40)
C = Base Load Growth Factor (December 1968 = 1.0)

Morning Lighting Factor: A X B X C
A = Regression coefficient
B = Time of sunrise in minutes later than 5 AM (e.g. 6:30 AM = 90)
C = Base Load Growth Factor (December 1968 = 1.0)

Evening Lighting Factor: A X B X C
A = Regression Coefficient
B = Base Load Growth Factor (December 1968 = 1.0)
C = Time of sunset in minutes before 9 PM (ex. 5 PM = 240)

NOTE: C is limited to certain bounds depending on the hour. Below are those limits:

	Lower Bound	Upper Bound
4 PM	205	None
5 PM	190	None
6 PM	175	None
7 PM	None	230
8 PM	None	195
9 PM	None	195

Summer Temperature Factor: A X B X $(T\text{-}45)^{2.1}$
A = Regression coefficient
B = Summer Temperature Dependent Load Growth Factor (December 1968 = 1.0)
T = Average Temperature over the previous 24 hours at the Broome County Airport

Weekday Dummy Variables: A X B
A = Regression coefficient
B = One (1.0) for weekday in question and Zero for other days

Summer Monthly Dummy Variable: A X B
A = Regression coefficient
B = One (1.0) for month in question and Zero for other months

APPENDIX A.
CUSTOMER CLASS DEFINITIONS

Residential: Sales to individually metered homes or apartments and sales to farms and religious institutions supplied under the residential rates, divided between:

a. Heating: Total sales to residential customers where electricity supplies the total space heating requirement.

b. Non-Heating: Total sales to residential customers where electricity does not supply the total space heating requirements.

Commercial: Sales to commercial enterprises and government facilities not included elsewhere.

Industrial: Sales to enterprises engaged principally in mining or manufacturing.

Street & Highway Lighting: Sales to governmental bodies for lighting streets and highways and other public places.

Sales for Resale: Firm sales to other utilities, such as borderline sales, that are included in the Company's peak load for which it must provide capacity.

Company Requirements: Includes interdepartmental sales, company use, franchise requirements, and losses.

NOTE: NYSE&G records include some master metered apartments in the residential class. For use in this report however, these customers have been included in the commercial class. In 1976, these 8,000 customers included 18,000 individual apartments which used 77,000 MWH. Prior to 1976, this data was estimated.

APPENDIX B. DISCUSSION OF STATISTICAL TESTS

The model was carefully designed to avoid some of the pitfalls common to multiple regression analysis. Of primary concern was correlation between "independent" variables. Excessive interaction between variables can cause faulty and erratic regression coefficients. For this reason, the base load growth factor was developed prior to its inclusion in the multiple regression program. The alternative would have been the introduction of demographic data directly into the multiple regression program. This could, however, lead to erroneous results since demographic data series such as gross national product and households tend to show a high interaction.

The second concern was the elimination of hours affected by events other than normal load growth. This included: most holidays, July 1972 after hurricane Agnes, evening lighting prior to Christmas, and several other clearly definable events.

Variables were normally rejected if their "t" values for more than a few of the hourly equations were less than two. Most "t" values were considerably higher than two. This is an indication that: 1) the variables are valid and 2) the regression coefficients are accurate.

Table XXXV lists the statistical tests for the forecast.

TABLE XXXV WINTER PEAK HOUR INFORMATION – STATISTICAL TESTS

		Winter Model 7 PM Weekdays			Summer Model. 2 PM Weekdays
Observations	=	770	Observations	=	452
T Values			T Values		
Temperature Factor	=	25.9	Temperature Factor	=	29.4
Wind-Temperature Index	=	4.0	Base Load	=	56.7
Temperature Lag Factor	=	-3.8	Std. Error Estimate	=	41.2
Base Load	=	42.7	Coef. of Determination	=	.922
Cloud Cover	=	15.3	F Value	=	747.2
Evening Lighting	=	45.8	Durbin-Watson	=	1.77
Std. Error of Estimate	=	48.6			
Coef. of Determination	=	.956			
F Value	=	2082			
Durbin-Watson	=	1.11			

TABLE XXXVI NYSE&G FORECAST vs. NEW YORK STATE ENERGY MASTER PLAN FORECAST AND NATIONAL ECONOMIC RESEARCH ASSOCIATES (NERA) FORECAST

WINTER PEAK (MW)

	ACTUAL 1978/79	FORECAST 1994/95	GROWTH RATE (%) (1978-1994)
NYSE&G	2118	3620	3.41
SEMP	2118	3534	3.25
NERA	2118	4343	4.59

SUMMER PEAK (MW)

	ACTUAL 1978	FORECAST 1994	GROWTH RATE (%) (1978-1994)
NYSE&G	1729	3000	3.50
SEMP	1729	2835	3.14
NERA	1729	3305	4.13

ENERGY (GWH)

	ACTUAL 1978	FORECAST 1994	GROWTH RATE (%) (1978-1994)
NYSE&G	10500	17665	3.30
SEMP	10500	16800	2.98
NERA	10500	21546	4.60

SEMP - State Energy Master Plan - August 1979

NERA - National Economic Research Associates - April 1980

MAIL OUT QUESTIONNAIRE

1. Name of Company Southern California Edison Co.

2. Respondent's Name H. William Grinnell Jr

Title Environmental Specialist

Address P.O. Box 800, Rosemead Ca 91770

Contact Telephone (213) 572-1424

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 50,000 sq mi

Location (include sketch map if available) So. Calif except for north Santa Barbara, San Luis Obispo, Imperial, San Diego Counties and City of LA.

Number of customers:

Residential 89% 3,000,000+ total

Commercial

Gov't/Institutional

Industrial

Other

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
( ) Allow public utilities access to data for planning
(X) Other: maintain financial strength to finance future projects

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical ~~Load~~ sales/unit	✓		Customer Service
( ) Electrical ~~Load~~ sales/area	✓		Customer Service
( ) Census (not yet)			
( ) Economic		✓	Treasurer's
( ) Land Use		✓	Environ. Affairs
( ) Land Cover		✓	Research & Devel.
( ) Zoning	✓		Right of Way
( ) Proposed Land Use	✓		Right of Way
( ) Legal Property Descriptions		✓	R&D
( ) Topography		✓	↓
( ) Land Resources (soils, geology)		✓	R&D – Regional
( ) Environmental Data (air, water, etc.)	✓		R&D/EA – site
( ) Other (please specify) SCE system	✓		Right of Way Mapping Proj

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5. (inquire at individual departments)

7. Are the automated data types uniform for the entire service area?
(✓) yes
( ) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data? Varys, I don't know.

9. How accurate are the spatial data elements? (which ones?)
( ) Accurate enough for site-specific analysis
(✓) Accurate enough for small-area analysis and demand projections
(✓) Accurate enough for regional analysis and demand projections
( ) Accuracy limited to system-wide analysis and demand projections

Land Use & Environ. Data

10. What is the approximate annual cost to the utility of spatial acquisition?

Land Use: $ 50,000
Environmental: varys $ 500,000 to be spent over 1.5 years

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery).

( ) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons: ________________

(✓) Remotely sensed data used regularly - please describe: Land use studies and environmental inventory data base built from remotely sensed data.

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: Land use studies. Service district level for distribution system planning.

System-wide Analysis: System forecast, up dated quarterly - not tied down geographically with in the system

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

( ) Availability of source data
( ) Data at appropriate scale
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
(1) Limited mandate
(1) Time
(1) Budget
( ) Base map precision
(1) Data not kept current

Land use area: impossible to stay current over the urbanized area in the service area with present resources.
Should be considering use of "system-wide" Landsat imagery to support system forecasts.

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ________
(✓) Data files are referenced to x,y coordinate system
(✓) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions ________________
( ) Being investigated. Describe needs ________________

15. How many data processing systems and files are currently maintained by your utility?

Systems ________________
Data Files ________________

I don't know

16. Describe your current hardware/software configuration. Specify model of computer. Land Use and Environmental Resources

IBM-370, access through TSO communication terminals

GISS/ PIOS Software system

CLIST interactive creation of JCL

RECEIVED
OCT 30
RESEARCH & DEVELOPMENT

MAIL OUT QUESTIONNAIRE

1. Name of Company [illegible]

2. Respondent's Name [illegible]

   Title RESEARCH [illegible]

   Address [illegible] P.O. Box [illegible]

   Contact Telephone [illegible]

3. Describe the service area of the company:
   Size (sq. miles/acres, etc.) map available from Customer Service

   Location (include sketch map if available)

   Number of customers: this information can be found in Electrical World Directory of Electric Utilities McGraw Hill

   Residential

   Commercial

   Gov't/Institutional

   Industrial

   Other

4. Indicate (X) which of the following responsibilities are required of this company.

   [illegible]

   (✓) Provide adequate power for existing users
   (✓) Provide adequate power for projected future users
   ( ) Promote efficient power use [illegible]
   ( ) Minimize adverse impacts to environment [illegible]
   ( ) Allow public utilities access to data for planning [illegible]
   ( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit	✓		Sys. Devel/
( ) Electrical load/area	✓		Customer Service
( ) Census [illegible]	✓	c	Sys. Area
( ) Economic	✓		Rch, E&E
( ) Land Use	✓		
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use	✓		
( ) Legal Property Descriptions	automated		
( ) Topography	✓	✓	
( ) Land Resources (soils, geology)	✓		
( ) Environmental Data (air, water, etc.)	✓		
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5. [illegible] -

7. Are the automated data types uniform for the entire service area?
   ( ) yes
   ( ) if no -- please describe [illegible]

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data? [illegible]

9. How accurate are the spatial data elements?
   ( ) Accurate enough for site-specific analysis
   (✓) Accurate enough for small-area analysis and demand projections
   (✓) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial acquisition?

for my projects
> $100,000

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery).
( ) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons: ______
(✓) Remotely sensed data used regularly - please describe:
side scan sonar U₂ photos
Tiros low altitude photos

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: ask Electric Systems Planning

System-wide Analysis: of System Development

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

( ) Availability of source data
( ) Data at appropriate scale
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
( ) Time
( ) Budget
( ) Base map precision
(✓) Data not kept current

resolution important
type of sensor important

14. Check the items which apply to your use of automated geographic information.
(✓) Spatial data automated in-house. maybe in the future
Number of persons required 2
(✓) Data files are referenced to x,y coordinate system
(✓) Stored data planes can be overlaid using an automated technique
(✓) Image processing and classification capabilities are being used.
Describe specific functions fields bed area
( ) Being investigated. Describe needs ______

15. How many data processing systems and files are currently maintained by your utility?

Systems 2
Data Files 3

16. Describe your current hardware/software configuration. Specify model of computer.

IBM 3033

use Geographic Information Software System with TSO user friendly access to run programs in batch mode – output on Calcomp, laser printer or line printer

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649

TELEPHONE
AREA CODE 716 546-2700

December 9, 1980

William Hodson, Ph. D.
Environmental Analyst
Environmental Systems Research Institute
380 New York Street
Redlands, CA 92373

Dear Mr. Hodson:

I am returning your questionnaire that you sent to us under cover letter dated November 26, 1980. The questionnaire has not been completed.

You indicated that a response within a week would be desirable. I doubt if we could provide such data within a period of months. In fact, I have not the faintest idea who I could contact to obtain answers to some of your questions.

With the above in mind, I am afraid we will not be able to participate in your questionnaire.

Sincerely,

Roy J. Murdock

Roy J. Murdock, Manager
Electric Trans. and Dist. Design
Electric Transmission and
Distribution Engineering Dept.

RJM:ked
Encl.

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company The Toledo Edison Company

2. Respondent's Name Chester J. Lipinski

Title Director, Corporate Planning

Address 300 Madison Ave.
Toledo, Ohio 43652

Contact Telephone (419) 259-5601

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 2500 sq. miles

Location (include sketch map if available) Northwestern Ohio

*Number of customers:
Residential 239,711

Commercial 23,547

Gov't/Institutional 2,096

Industrial 1,543

Other 208 (Street Lighting & Municipals)

* At end of October, 1980

4. Indicate (X) which of the following responsibilities are required of this company.

(x) Provide adequate power for existing users
(x) Plan to provide adequate power for projected future users
(x) Promote efficient power use
(x) Minimize adverse impacts to environment
( ) Allow public agencies access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Toledo Edison does not make use of any type of spatial data.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area			
( ) Census			
( ) Economic			
( ) Land Use			
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

N/A

7. Are the automated data types uniform throughout the entire service area?
( ) yes
( ) if no -- please describe

N/A

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

N/A

9. How accurate are the land use/land cover spatial data elements?
( ) Accurate enough for site-specific analysis
( ) Accurate enough for small-area analysis and demand projections
( ) Accurate enough for regional analysis and demand projections
( ) Accuracy limited to system-wide analysis and demand projections

N/A

10. What is the approximate annual cost to the utility of spatial data acquisition?

N/A

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
( ) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons: ________
(X) Remotely sensed data used regularly - please describe:

Toledo Edison utilizes aerial photography once each year to inventory Company coal piles at its power plants.

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: Appliance Saturation Surveys
Customer Surveys
Conservation Effect Surveys

System-wide Analysis: Econometric Modeling
Probability-Tree Analysis

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

N/A

( ) Availability of source data
( ) Data at appropriate scale
( ) Base map precision
( ) Data not kept current
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
( ) Time
( ) Budget

14. Check the items which apply to your use of automated geographic information.

N/A

( ) Spatial data automated in-house.
Number of persons required ________

( ) Data files are referenced to x,y coordinate system

( ) Stored data planes can be overlaid using an automated technique

( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

N/A

Systems________________
Data Files_____________

16. Describe your current hardware/software configuration. Specify model of computer.

IBM-370/145
0.5 MB
OS/VSI

12-2-80

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Public Service Co of Okla

2. Respondent's Name Frank J Meyer

Title Vice President

Address Box 201 Tulsa Ok
74102

Contact Telephone 918) 599 - 2373

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 1/3 state of Ok.

Location (include sketch map if available) East 1/3 and SW 1/4

Number of customers:

Residential 359,000

Commercial 44,000

Gov't/Institutional

Industrial 4,000

Other Total 409,000

4. Indicate (X) which of the following responsibilities are required of this company.

(✓) Provide adequate power for existing users
(✓) Provide adequate power for projected future users
(✓) Promote efficient power use
(✓) Minimize adverse impacts to environment
( ) Allow public agencies access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit	✓		all
( ) Electrical load/area	✓		all
( ) Census	✓		forecasting
( ) Economic	✓		
( ) Land Use			
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
( ) yes
(✓) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

various

9. How accurate are the land use/land cover spatial data elements?
( ) Accurate enough for site-specific analysis
( ) Accurate enough for small-area analysis and demand projections
( ) Accurate enough for regional analysis and demand projections
( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial data acquisition?

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
( ) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons:
( ) Remotely sensed data used regularly - please describe:

not used

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: ✓

System-wide Analysis: ✓

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

( ) Availability of source data
( ) Data at appropriate scale
( ) Base map precision
( ) Data not kept current
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
( ) Time
( ) Budget

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ________
( ) Data files are referenced to x,y coordinate system
( ) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files_____________

16. Describe your current hardware/software configuration. Specify model of computer.

UNION ELECTRIC COMPANY
1901 GRATIOT STREET - ST. LOUIS

MAILING ADDRESS:
P.O. BOX 149
ST. LOUIS, MO. 63166

November 26, 1980

Mr. Bill Hodson, PhD
Environmental Analyst
Environmental Systems Research Institute
380 New York Street
Redlands, CA 92382

Dear Mr. Hodson:

I received your undated communication concerning the survey as part of your NASA contract NAS2-10716 on November 21, 1980.

Considering the work load that we are confronting at present and for the near future, I see no way to respond to your questionnaire in any period of time which would be responsive to your needs in that you indicated a desire to have a response within a week.

Hopefully the other utilities which you have contacted will be able to meet your needs.

Very truly yours,

L. A. Esswein

L. A. Esswein
Director of
Corporate Planning

LAE/cbv

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Allegheny Power Service Corp.

2. Respondent's Name J. R. Kissner

Title Manager, System Load Forecasts

Address 800 Cabin Hill Drive
Greensburg, PA 15601

Contact Telephone (412)838-6871

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 29,100 sq. miles

Location (include sketch map if available) see attached map

Number of customers:
Residential 983,878

Commercial 102,721

Gov't/Institutional 4,688

Industrial 18,046

Other 923

4. Indicate (X) which of the following responsibilities are required of this company.

(x) Provide adequate power for existing users
(x) Provide adequate power for projected future users
(x) Promote efficient power use
(x) Minimize adverse impacts to environment
(x) Allow public agencies access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit		x	Load Forecasting
( ) Electrical load/area			
( ) Census		x	Load Forecasting
( ) Economic		x	Load Forecasting
(x) Land Use			Engineering Serv.
(x) Land Cover			Engineering Serv.
(x) Zoning			Engineering Serv.
(x) Proposed Land Use			Engineering Serv.
(x) Legal Property Descriptions			Engineering Serv.
(x) Topography			Engineering Serv.
(x) Land Resources (soils, geology)			Engineering Serv.
(x) Environmental Data (air, water, etc.)			Environmental Control
(x) Other (please specify) Archeological data			Engineering Serv.

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5. Not Available

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   (x) if no -- please describe

   Some variation due to local production of certain map or data types.

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

   Engineering Services: Annual updates, adequate frequency
   Environmental Control: Monthly updates, adequate frequency

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   (x) Accurate enough for small-area analysis ~~and demand projections~~
   (x) Accurate enough for regional analysis ~~and demand projections~~
   (x) Accuracy limited to system-wide analysis ~~and demand projections~~

   Not used for demand projection.

   For Environmental Control accuracy is adequate for site-specific analysis.

10. What is the approximate annual cost to the utility of spatial data acquisition?

Not Available

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
    ( ) No experience
    ( ) Remotely sensed data considered, not evaluated
    ( ) Remotely sensed data considered, rejected- please state reasons:
    ( ) Remotely sensed data used regularly - please describe:

Used, but not regularly. Evaluating automation of locations of archeological sites, parks, etc., to be avoided in line route selection. Environmental Control uses aerial imaging for pollution studies.

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis:

Econometric forecasts of energy sales and demand are being developed and will be in use in 1981.

System-wide Analysis:

Same

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

(x) Availability of source data
( ) Data at appropriate scale
( ) Base map precision
( ) Data not kept current
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
( ) Time
( ) Budget

Available data is too broad for our use in some site selection work.

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ________

( ) Data files are referenced to x,y coordinate system

( ) Stored data planes can be overlaid using an automated technique

( ) Image processing and classification capabilities are being used.
Describe specific functions________________

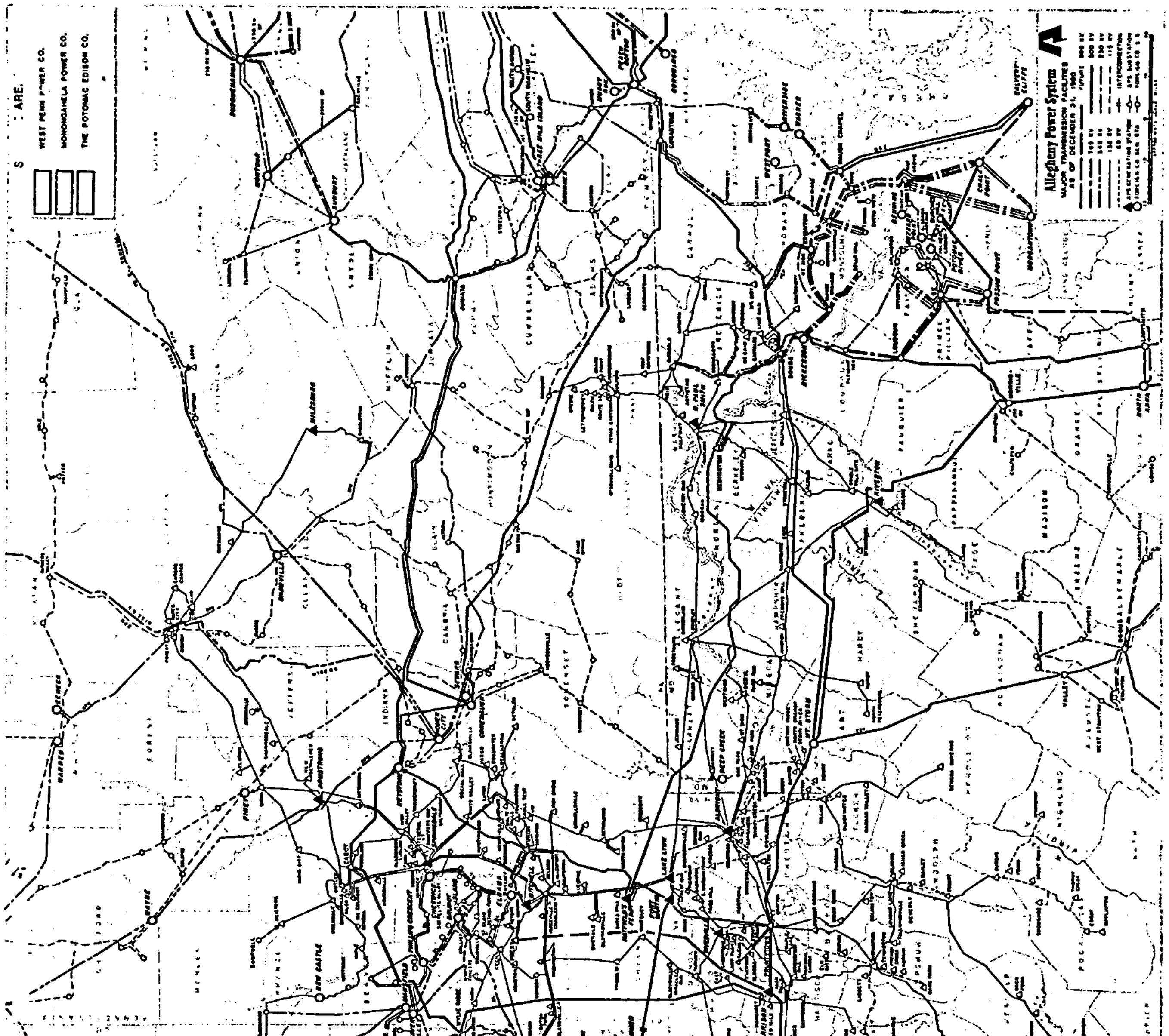
(x) Being investigated. Describe needs See response to #11.

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files______________ Not available, definition too vague.

16. Describe your current hardware/software configuration. Specify model of computer.

IBM 370 Model 158 AP


WEST PENN POWER CO.
MONONGAHELA POWER CO.
THE POTOMAC EDISON CO.
Allegheny Power System
MAJOR TRANSMISSION FACILITIES

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Tampa Electric Co.

2. Respondent's Name Edward W. Smith

Title Senior Engineer

Address P.O. Box 111
Tampa, Florida 33601

Contact Telephone 813-879-4111 x-1319

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 1900 sq. Miles

Location (include sketch map if available)

Number of customers:
Residential 283482

Commercial 31794

Gov't/Institutional —

Industrial 550

Other —

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
(X) Allow public agencies access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area			
(✓) Census		NON Automated	PLANNING
(✓) Economic		NON Automated	PLANNING
( ) Land Use			
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   ( ) if no -- please describe

   DNA - Does Not Apply

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

   Does Not Apply

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   ( ) Accurate enough for small-area analysis and demand projections
   ( ) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial data acquisition?

DNA

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)

(X) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons:

( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: DNA

System-wide Analysis: Detailed End Use Models
Econometric/Demographic Model

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

( ) Availability of source data
( ) Data at appropriate scale
( ) Base map precision
( ) Data not kept current
( ) Hardware availability
( ) Software availability
(X) Technical staff expertise
(X) Limited mandate
(X) Time
(X) Budget

14. Check the items which apply to your use of automated geographic information. DNA

( ) Spatial data automated in-house.
Number of persons required ________
( ) Data files are referenced to x,y coordinate system
( ) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files______________

16. Describe your current hardware/software configuration. Specify model of computer.

IBM 3031

DOS/VS

BALTIMORE
GAS AND
ELECTRIC

Economic Development

Fred P. Esbrandt
Director

December 1, 1980

Dr. Bill Hodson
Environmental Analyst
Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

Dear Dr. Hodson:

This letter is to advise that Baltimore Gas & Electric Company will not participate in this project.

Sincerely,

Fred P. Esbrandt

Encl.

FPE:ltb

Energy Services Department
Business Location | Mailing Address
Phone 301 265-7500 | P.O. Box 1475
1508 Woodlawn Drive • East of Beltway at exit 17 | Baltimore, Maryland 21203

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Georgia Power Company

2. Respondent's Name W. E. Farris

Title Manager, Planning & Budget Department

Address 270 Peachtree St.-P.O.Box 4545
Atlanta, Ga. 30302

Contact Telephone (404) 522-6060 X-2401

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 57,000 Sq. Miles

Location (include sketch map if available) Almost entire state of Ga.

Number of customers:
Residential 1,052,129

Commercial & Industrial 139,116

Gov't/Institutional________

Industrial________

Other________

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
(X) Allow public agencies access to data for planning
( ) Other:________

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area			
( ) Census			
( ) Economic	GPC does not use		
( ) Land Use	remotely sensed		
( ) Land Cover	data such as		
( ) Zoning	computer compatable tapes		
( ) Proposed Land Use	or other similar		
( ) Legal Property Descriptions	information		
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5. N/Applicable

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   ( ) if no -- please describe

   N/Applicable

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

   Not used

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   ( ) Accurate enough for small-area analysis and demand projections
   ( ) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

   Not Applicable

✓10. What is the approximate annual cost to the utility of spatial data acquisition?

Since the company does not use information in such form, negligible cost is incurred.

✓11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)

( ) No experience
( ) Remotely sensed data considered, not evaluated
(X) Remotely sensed data considered, rejected- please state reasons: Cost
( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: Secular compound growth curve $Y=AB^{X}$ constrained by allocation from the system demand forecast.

System-wide Analysis: Econometric based on state forecast of economic variables driven primarily by Wharton econometric model - adjusted for oil & gas substitution and new technologies.

✓13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

(2) Availability of source data
(1) Data at appropriate scale
( ) Base map precision
(5) Data not kept current
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
(3) Time
(4) Budget

✓14. Check the items which apply to your use of automated geographic information. Not used

( ) Spatial data automated in-house.
Number of persons required ________

( ) Data files are referenced to x,y coordinate system

( ) Stored data planes can be overlaid using an automated technique

( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files_____________

16. Describe your current hardware/software configuration. Specify model of computer.

No Mainframe computers in-house. IBM 370 Series and Amdahl V-7 available at Southern Co. Services. The following peripheral hardware is on site:

Current configuration/software (run in Remote Job Entry Mode)

IBM 512K VM Software
Data 100 - Model 78 with 2 Model 74 22 Keyentry stations 64K
Data 100 - Model 78 - PCL software 64K
Data 100 - Model 74 Gerts 355 software 32K

Mohawk Data Science - Key Entry 30 Keystations

Public Service Company of Colorado
P.O. BOX 840 · DENVER, COLORADO 80201

December 12, 1980

Mr. Don Chambers
Environmental Systems Research Institute
380 New York Street
Redlands, California 92382

Dear Mr. Chambers:

As we discussed earlier by phone, Public Service Company of Colorado (PSC) will be unable to respond to your questionnaire dated November 10, 1980. PSC, as other utilities, is being faced with more required responses from governmental entities. Escalating energy costs and corresponding rate increases have resulted in a substantial increase in the number of intervenors and Commission staff's questions requiring almost immediate responses. Manpower normally allocated to respond to a questionnaire such as yours has been shifted to the required responses. This situation is expected to be short-term and we certainly hope to be able to respond to your questionnaires in the future.

Thank you for including PSC in your program.

Cordially,

Don Basler

Don Basler

DJB:mt

cc: W. J. Martin

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Wisconsin Electric Power Company

2. Respondent's Name Frank Boucher

Title Director-Environmental Dept.

Address 321 W. Michigan St.
Milwaukee, WI 53201

Contact Telephone 414/277-2150

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 12,600 sq. mi.

Location (include sketch map if available) see attachment 1

Number of customers:

Residential & Farm	approx.	730,000
Commercial	approx.	71,000
Gov't/Institutional	---	---
Industrial	approx.	600
Other	approx.	1,400

4. Indicate (X) which of the following responsibilities are required of this company.

(x) Provide adequate power for existing users
(x) Provide adequate power for projected future users
(x) Promote efficient power use
(x) Minimize adverse impacts to environment
(x) Allow public agencies access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
(x) Electrical load/unit			Corp. Plan
(x) Electrical load/area			Corp. Plan
(x) Census			Env., Corp. Plan
(x) Economic			Env., Corp. Plan
(x) Land Use			Env., Real Estate
(x) Land Cover			Env., Real Estate
(x) Zoning			Env., Real Estate
(x) Proposed Land Use			Env., Corp. Plan, Real Estate
(x) Legal Property			Real Estate
Descriptions			Real Estate
(x) Topography			Env.
(x) Land Resources			Env.
(soils, geology)			Env.
(x) Environmental Data			Env.
(air, water, etc.)			Env.
(x) Other (please specify) see attachment 2			Env.

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5. see attachment 2

7. Are the automated data types uniform throughout the entire service area?
( ) yes
(x) if no -- please describe

Wisconsin Electric Power Company does not handle and/or process spatial data on an automated basis.

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

Spatial data updated approximately every five years and as required on project basis. Frequency and Timing are adequate for the departments using the data.

9. How accurate are the land use/land cover spatial data elements?
(x) Accurate enough for site-specific analysis
( ) Accurate enough for small-area analysis and demand projections
( ) Accurate enough for regional analysis and demand projections
( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial data acquisition?

Approximately $100,000

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)

(x) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons: ______________________________
( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis:

System-wide Analysis:

see attachment 3

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

(x) Availability of source data
(x) Data at appropriate scale
(x) Base map precision
(x) Data not kept current
(x) Hardware availability
(x) Software availability
(x) Technical staff expertise
( ) Limited mandate
(1) Time
(1) Budget

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house.
Number of persons required ________
( ) Data files are referenced to x,y coordinate system
( ) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions________________

(x) Being investigated. Describe needs________________

Pilot study underway for computer base map records system for distribution facilities.

15. How many data processing systems and files are currently maintained by your utility?

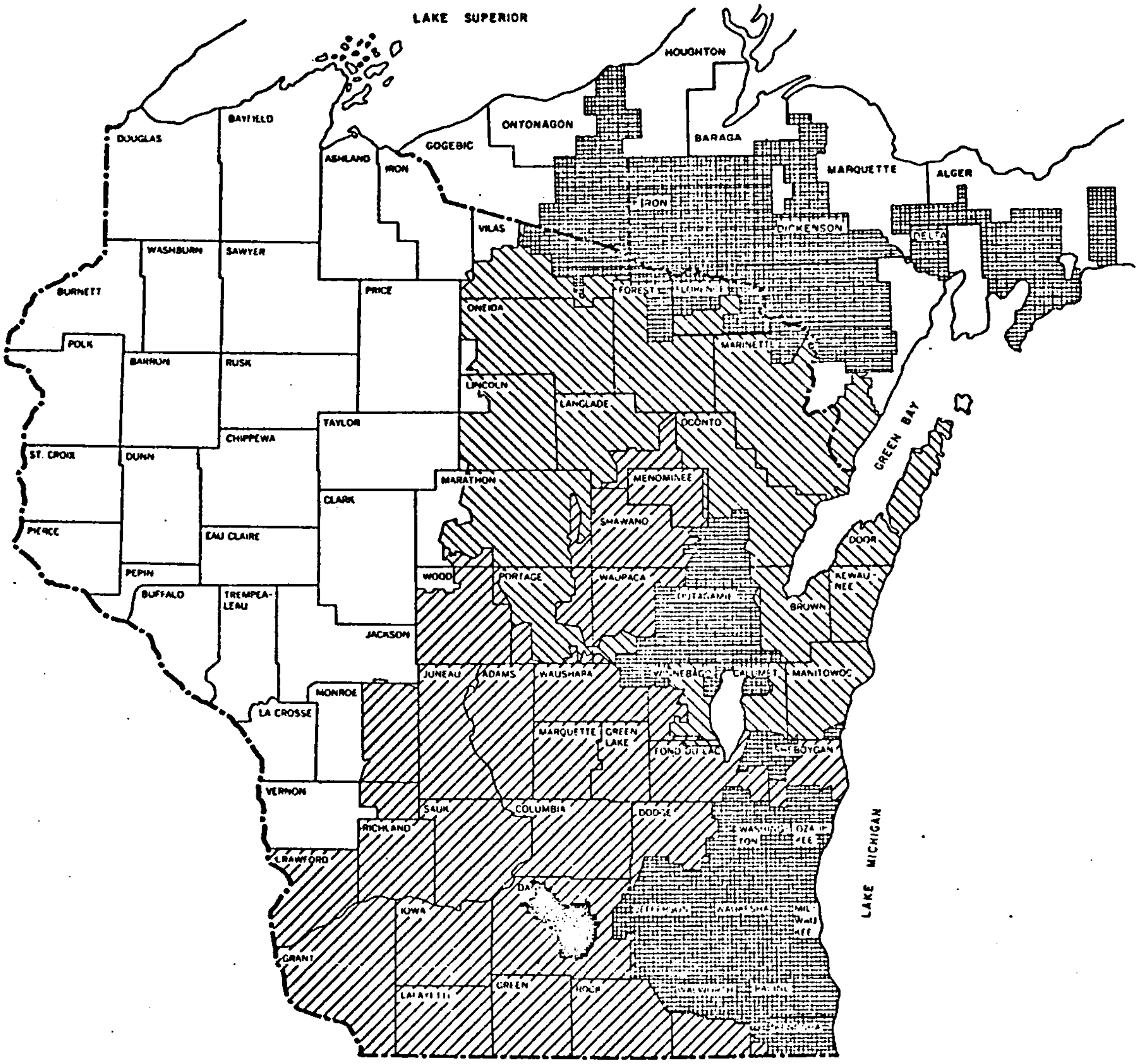
Systems approx. 100*
Data Files tens of thousands*
*only pilot study (item 14 above) is a spatial data processing and file system.

16. Describe your current hardware/software configuration. Specify model of computer.

hardware/software configurations is MVS

computer models used are IBM 30-33N and IBM 370/155

Attachment 1



WISCONSIN POWER & LIGHT COMPANY

MADISON GAS & ELECTRIC COMPANY

WISCONSIN PUBLIC SERVICE CORPORATION

WISCONSIN ELECTRIC POWER COMPANY

Service areas are approximate and do not reflect the service areas of smaller utilities located within the above areas.

EASTERN WISCONSIN UTILITIES' SERVICE AREAS

Attachment 2

Classes/Categories of Spatial Data Utilized by Wisconsin Electric

1. Base Map
2. Glacial geology
3. Topography
4. Soil suitability rating - on site sewage disposal
5. Soil suitability rating - erodibility estimate
6. Soil suitability rating - urban development
7. Soil productivity rating - field crops
8. Soil productivity rating - canning crops
9. Soil productivity rating - truck crops
10. Soil productivity rating - livestock
11. Soil productivity rating - conifers
12. Soil productivity rating - hardwoods
13. Soil associations
14. Water resources & wetlands
15. a. vegetative cover
    b. wildlife habitat
16. Existing land use (generalized)
    a. existing residential land use
    b. existing commercial land use
    c. existing industrial land use
    d. existing agricultural land use
    e. existing recreational land use
17. Proposed land use
18. Public ownership
19. Population density
20. Existing corridor (existing transmission system)
21. Active mines & quarries
22. Radio and T.V. towers, vortacs, and airports
23. Historical sites
24. Valuable natural areas
25. Residential concentrations
26. wild rivers, scenic rivers, scenic roads
27. woodlands
28. floodlands - floodplains
29. Special wildlife habitats
20. Environmental corridors
31. Prime agricultural lands
32. Zoning

Attachment 3

Forecasting Methods Used by Wisconsin Electric Power Company

Demand Forecast

Annually, Wisconsin Electric Power Company formulates a long range (20 year) projection of future peak demands for electricity that it must meet on an annual, seasonal or monthly basis. The peak demand forecast integrates an econometric forecast based on local and national economic conditions with adjustments for anticipated influences not taken into account by the Econometric Model. These adjustments include the impact on peak demand due to the unavailability of alternative fuels, improved appliance efficiency, residential load management, rate structure reform and solar energy.

Energy Forecast

The energy forecast is derived directly from the demand forecast. Monthly unadjusted demand is transformed into energy by deriving hourly demand forecasts based on hourly load distributions which occurred during the period October 1976 through September 1979. This process is called Phase I.

Adjustments in energy, quantifying effects not reflected in the historical data nor taken into account by the econometric assumptions, are calculated from corresponding demand adjustments using hourly distributions appropriate to each adjustment. Adjustments include the increase in load due to unavailability of alternative fuels and the decrease in load due to improved efficiency, rate structure reform and alternative energy sources. These adjustments are added to the Phase I energy forecasts to obtain final (Phase II) hourly energy forecasts. Hourly forecasts are summed to obtain monthly and annual energy forecasts.

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Portland General Electric

2. Respondent's Name Keith White

Title Power Planning Analyst

Address 121 SW Salmon Ave.
Portland, Oregon 97204

Contact Telephone (503) 226-7447

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 3,350 sq. miles

Location (include sketch map if available) Oregon

Number of customers:
Residential 423,389

Commercial 54,029

Gov't/Institutional —

Industrial 184

Other (Street lighting) 1,367

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
(X) Allow public agencies access to data for planning
( ) Other:

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
(✓) Electrical load/unit	✓ JOINT	✓	MAPPING SERVICES
(✓) Electrical load/area	✓ "	✓	" "
( ) Census			
( ) Economic			
( ) Land Use			
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography		✓	MAPPING SERVICES
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)	✓	✓	ENVIRONMENTAL SERVICES
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   ( ) if no -- please describe

   WITHIN MAPPING SERVICES - YES, COMPANY - NO

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

1) WHEN OPERATIONAL, MAPPING FILES WILL BE UPDATED AS REQUIRED. REQUIREMENT IS TO UPDATE WITHIN 3 WEEKS OF RECEIVING INPUTS FROM FIELD

2) YES

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   ( ) Accurate enough for small-area analysis and demand projections
   ( ) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial data acquisition?

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
    - ( ) No experience
    - ( ) Remotely sensed data considered, not evaluated
    - (✓) Remotely sensed data considered, rejected- please state reasons: ACCURACY OF INTERPOLATION & RESOLUTION. ALSO NO REAL NEED
    - ( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

    Small Area Analysis:

    System-wide Analysis:
    [illegible]
    [illegible]

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

    - ( ) Availability of source data
    - ( ) Data at appropriate scale
    - ( ) Base map precision
    - ( ) Data not kept current
    - ( ) Hardware availability
    - ( ) Software availability
    - ( ) Technical staff expertise
    - ( ) Limited mandate
    - (3) Time
    - (1) Budget
    - (2) REAL NEED OR REQUIREMENTS

14. Check the items which apply to your use of automated geographic information.

- (✓) Spatial data automated in-house.
  Number of persons required STILL IN DEVELOPMENTAL STAGE
- (✓) Data files are referenced to x,y coordinate system
- (✓) Stored data planes can be overlaid using an automated technique
- ( ) Image processing and classification capabilities are being used.
  Describe specific functions________________
- ( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems 3
Data Files THOUSANDS

16. Describe your current hardware/software configuration. Specify model of computer.

IBM 3032 w/ MVS, VSPC, CICS, TSO & MODEL 204 DATA BASE

M&S COMPUTING PDP 11/70 w/ IGDS, DMRS
- 4 INTERACTIVE GRAPHIC WORKSTATIONS
- 600 MB DISC STORAGE

HP 1000
- 250 MB DISC STORAGE

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Pacific Power & Light Company

2. Respondent's Name Scott Hannigan

Title Manager, Load Forecasting and Analysis Dept.

Address 920 S.W. Sixth Ave., Portland, OR 97204

Contact Telephone (503) 243-7009

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 63,000 sq. miles

Location (include sketch map if available) see attached

Number of customers:
Residential 535238

Commercial 88162

Gov't/Institutional 497

Industrial 2966

Other 15

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
( ) Allow public utilities access to data for planning
( ) Other: ______

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
( ) Electrical load/unit			
( ) Electrical load/area			
( ) Census			
( ) Economic			
( ) Land Use		NONE IN THE FORECASTING AREA	
( ) Land Cover			
( ) Zoning			
( ) Proposed Land Use			
( ) Legal Property Descriptions			
( ) Topography			
( ) Land Resources (soils, geology)			
( ) Environmental Data (air, water, etc.)			
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5.

7. Are the automated data types uniform throughout the entire service area?
   ( ) yes
   ( ) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

9. How accurate are the land use/land cover spatial data elements?
   ( ) Accurate enough for site-specific analysis
   ( ) Accurate enough for small-area analysis and demand projections
   ( ) Accurate enough for regional analysis and demand projections
   ( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial acquisition?

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery).

(X) No experience
( ) Remotely sensed data considered, not evaluated
( ) Remotely sensed data considered, rejected- please state reasons: ______
( ) Remotely sensed data used regularly - please describe:

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis:

System-wide Analysis:

(see attached flow charts)

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

( ) Availability of source data
( ) Data at appropriate scale
( ) Hardware availability
( ) Software availability
( ) Technical staff expertise
( ) Limited mandate
( ) Time
( ) Budget
( ) Base map precision
( ) Data not kept current

FORECASTING PROCESS NOT ORIENTED TO LAND USE APPROACH

14. Check the items which apply to your use of automated geographic information.

( ) Spatial data automated in-house. NONE.
Number of persons required ______
( ) Data files are referenced to x,y coordinate system
( ) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions______
( ) Being investigated. Describe needs______

15. How many data processing systems and files are currently maintained by your utility?

Systems______
Data Files______

NONE FOR GEOGRAPHIC DATA

16. Describe your current hardware/software configuration. Specify model of computer.

All analysis for forecasting purposes is done on an outside time sharing system.

INTRODUCTION

Pacific Power and Light Company prepares an annual econometric electricity sales forecast for the residential, commercial, industrial, street lighting and irrigation customer classes. This forecast is derived from a set of economic, demographic and price projections specific to each of the parts of the six states which are within the Company's service territory. These states are Oregon, Washington, Idaho, Montana, California and Wyoming. The load forecasting and analysis department used two forecasting methods to predict demand; a combined econometric/end-use analysis of the residential sector, and an econometric forecast of non-residential demand.

Residential demand was projected on the basis of ten "end-uses." These uses are space heat, water heat, electric ranges, electric dryers, refrigerators, televisions, lighting, air conditioning, freezers and residual uses. The percentage of the total number of households expected to choose a particular heating type or appliance in the future was estimated with an econometric equation containing such variables as prices, income and housing type. Average consumption for each end use was predicted primarily on the basis of institutional factors. Some of these influences are climate, persons per household, tastes and expected government actions such as increased insulation or appliance efficiency standards. In addition, the residential sector contains a conservation assessment submodel which analyzes the anticipated effect of both Company and non-Company sponsored conservation measures including insulation retrofits, water heater wraps and solar assisted space heat.

Within the non-residential sector the commercial, street and highway lighting, irrigation, and sales for resale segments are forecast with single aggregate econometric equations. The industrial sector, however, has been subject to a significant amount of disaggregation in both the manufacturing and mining components. Future demand is forecast for the food processing, lumber and wood products, paper and allied products, petroleum refining, primary metals and residual categories in manufacturing. Mining projections are made for the metal, uranium, coal, trona, and bentonite industries as well as for oil and gas exploration.

In addition to the sales forecasting methodology described above, Pacific also prepares monthly net system input and peak projections for each of the major operating systems in the service territory. The systems are Oregon-Washington-California (OWC), Idaho, Montana and Wyoming. The net system input forecast is obtained by adding estimates of system losses to the sales forecast results. The peak forecast is based upon statistical relationships between past system peaks and corresponding temperature levels. Peak is forecast monthly, and annual energy is broken into monthly totals on the basis of historic seasonal patterns.

The variables used to "drive" the energy equations were obtained from the application of a concept known as "Regional Export Base Theory." This construct allows for the development of a set of internally consistent economic and demographic projections. These are tied to future national output levels and correspond to the same general geographic areas as the Company's service territory. Specific forecasts have been completed for population, total and per capita income, employment and industrial output.

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT
ECONOMIC FORECASTING MODEL

EXHIBIT R

DEMOGRAPHIC EMPLOYMENT INCOME AND REAL VALUE ADDED SUBMODEL STRUCTURE

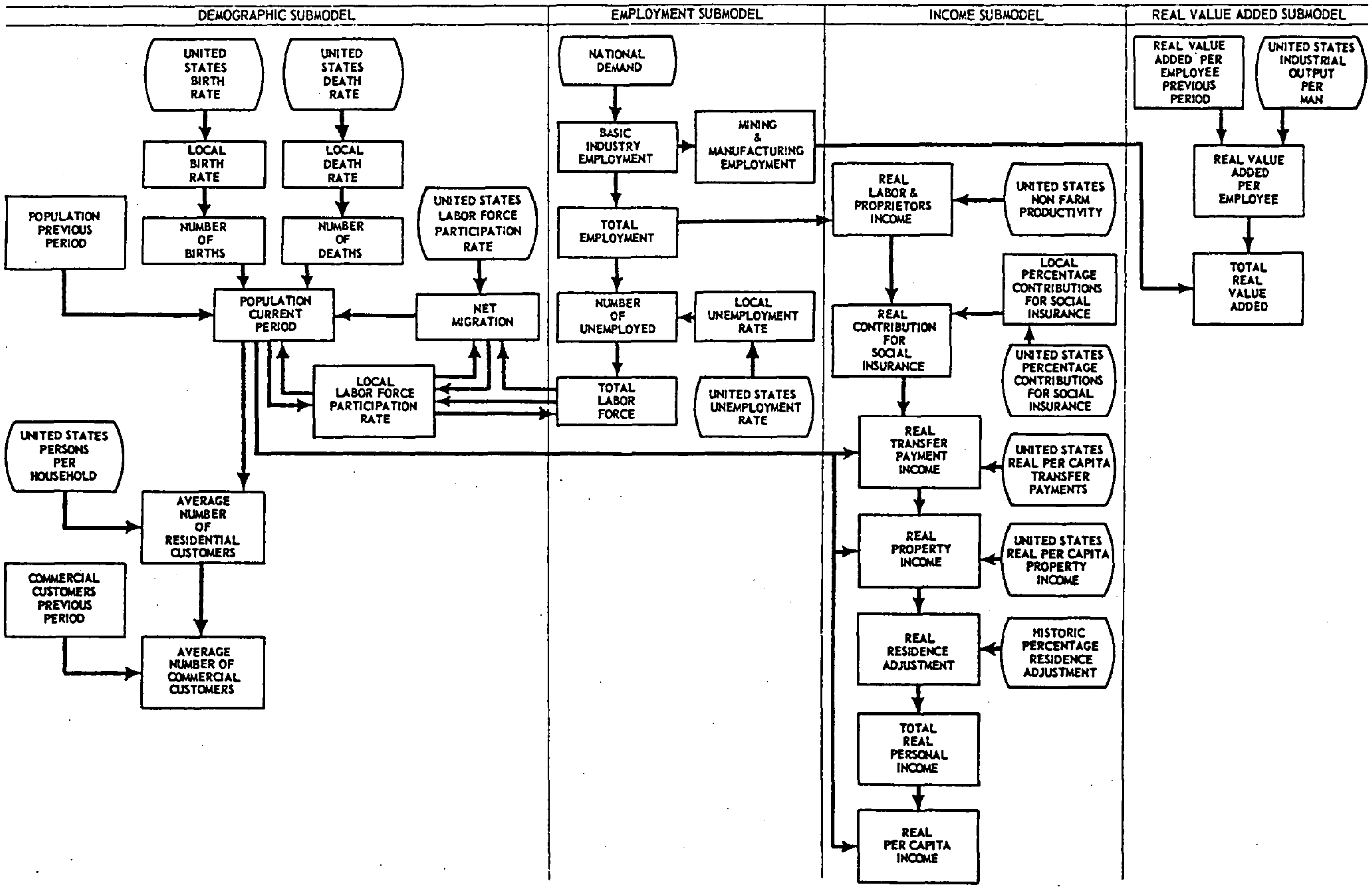


EXHIBIT A

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT

RESIDENTIAL SECTOR ELECTRICITY FORECASTING MODEL

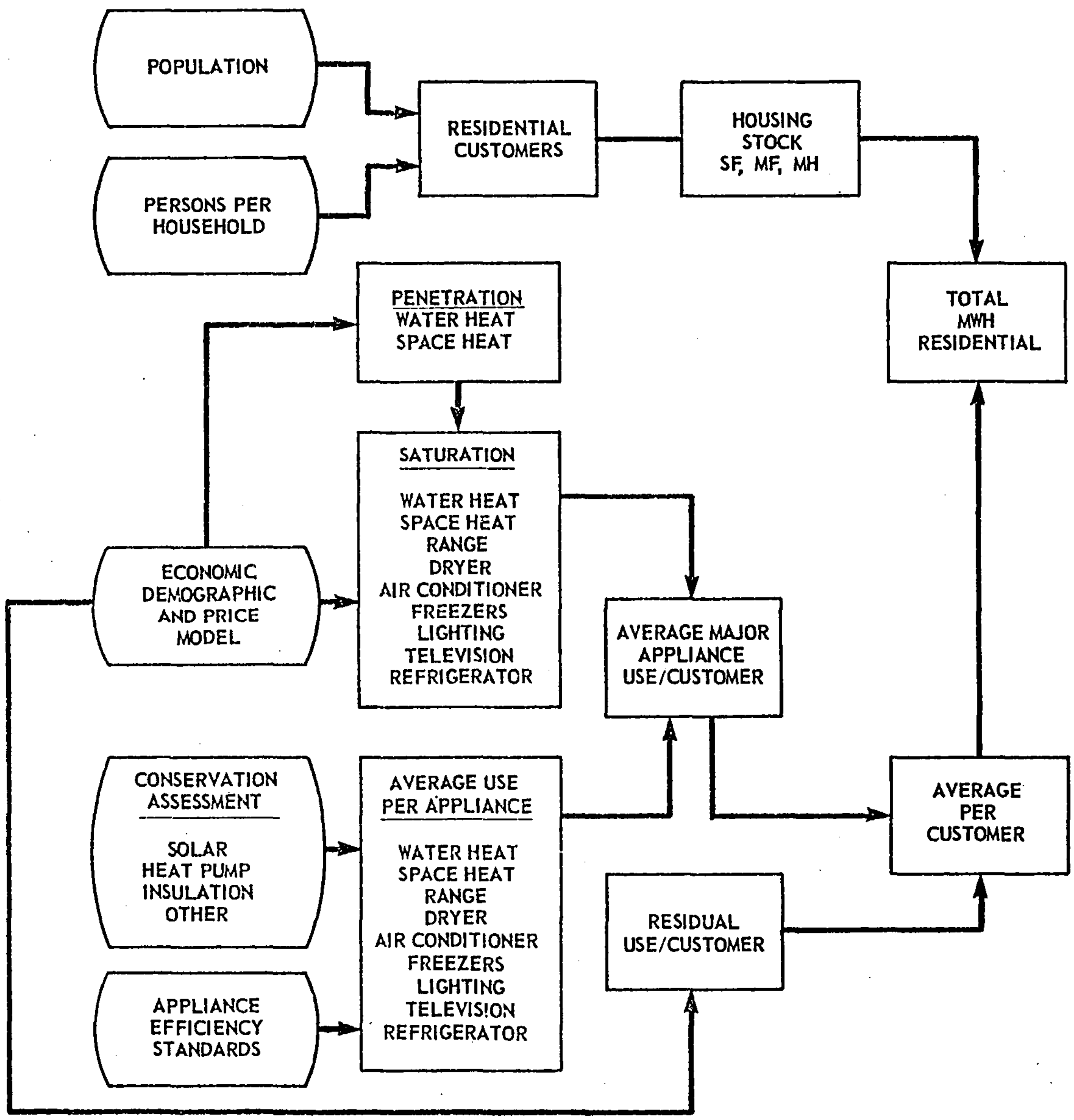


EXHIBIT L

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT

COMMERCIAL SECTOR ELECTRICITY FORECASTING MODEL

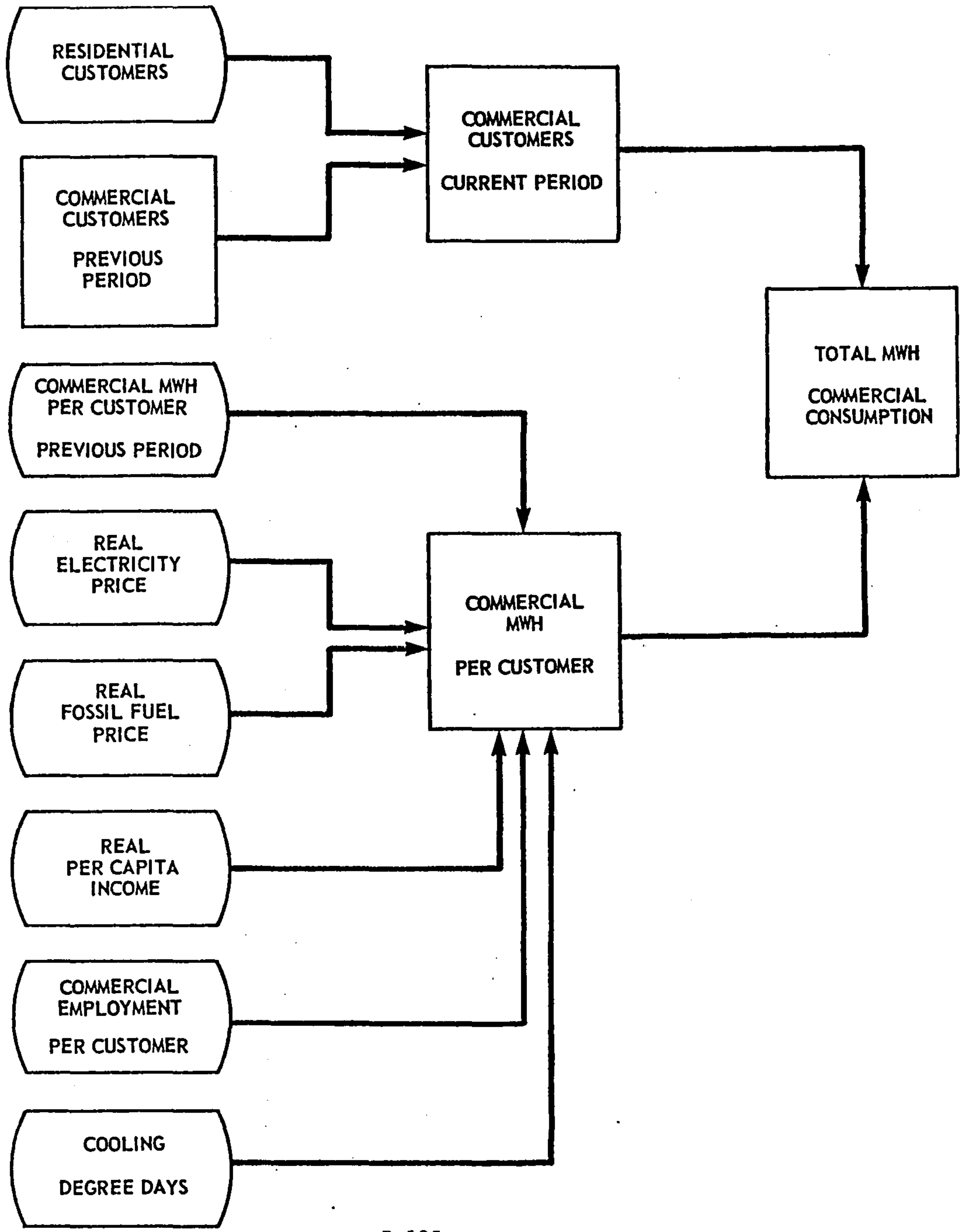


EXHIBIT M

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT

INDUSTRIAL ELECTRICITY FORECASTING MODEL

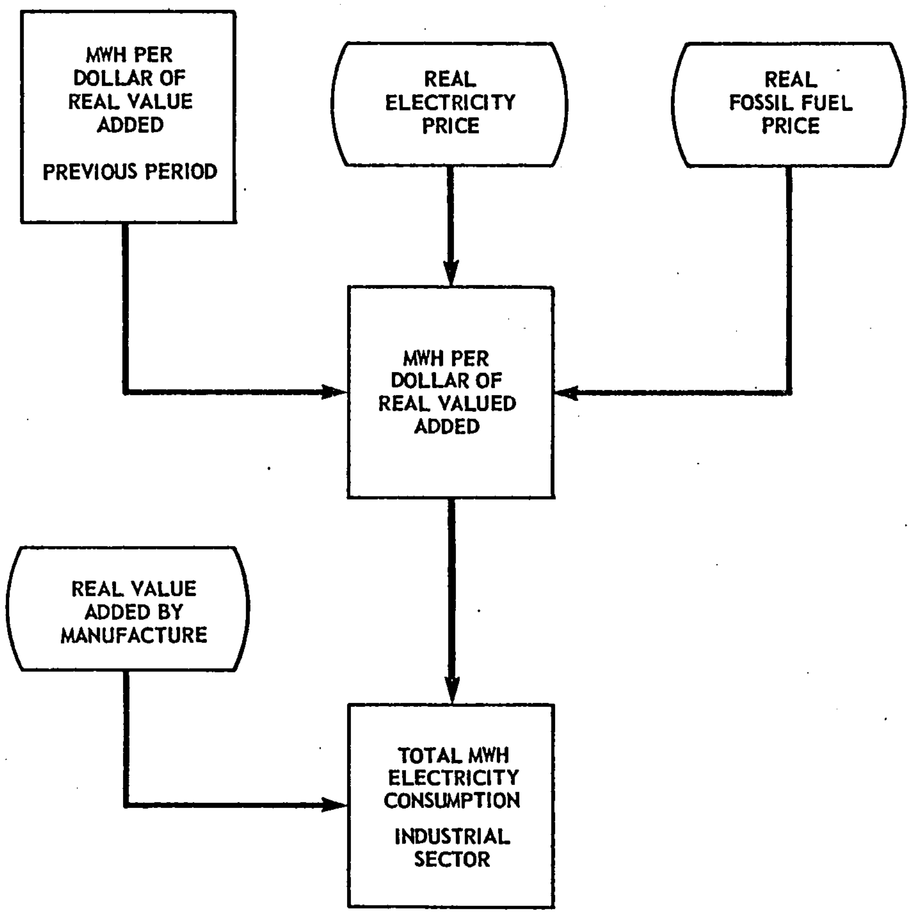


EXHIBIT N

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT

STREET AND HIGHWAY LIGHTING ELECTRICITY FORECASTING MODEL

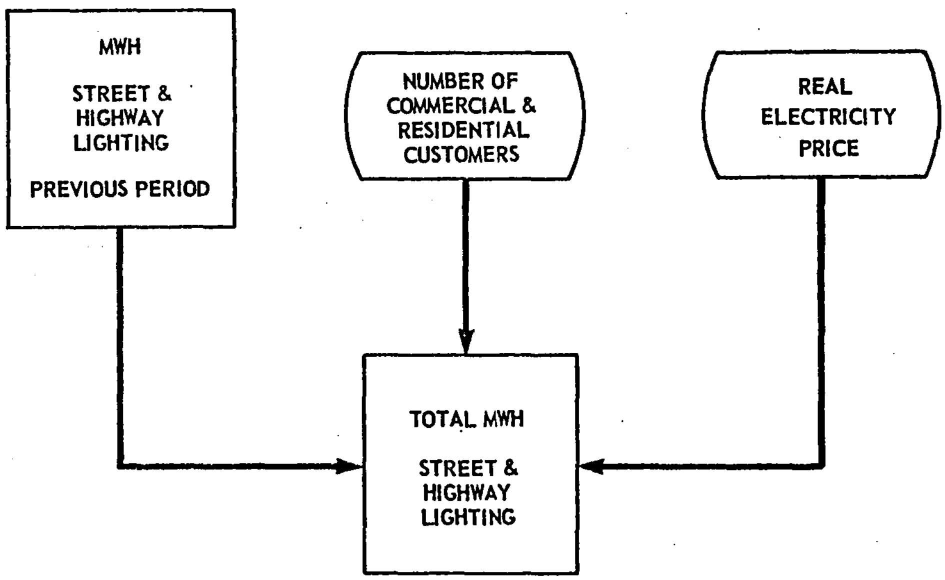


EXHIBIT O

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT

IRRIGATION ELECTRICITY FORECASTING MODEL

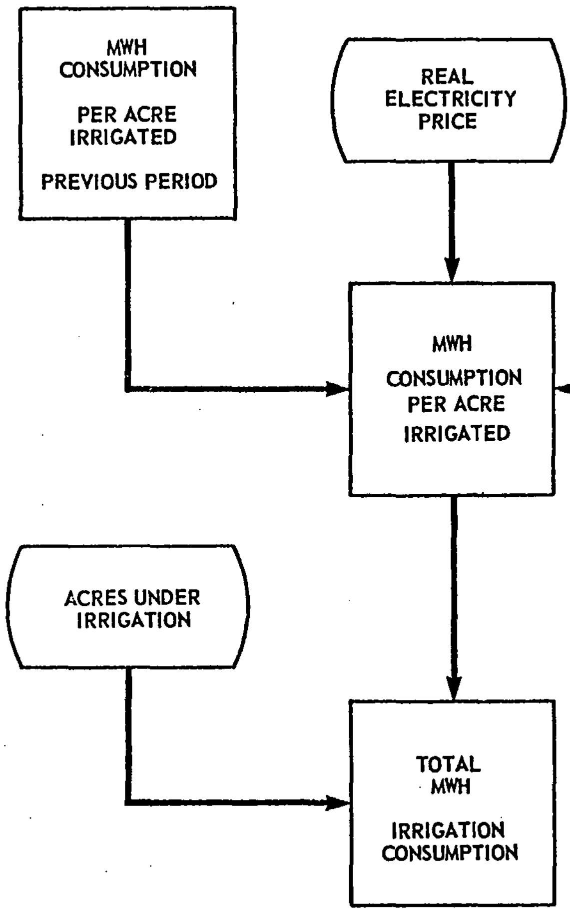
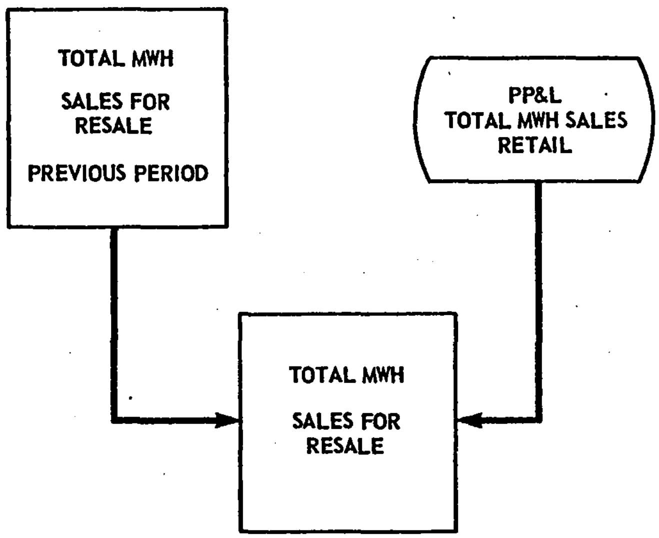


EXHIBIT P

PACIFIC POWER & LIGHT COMPANY
LOAD FORECASTING AND ANALYSIS DEPARTMENT

SALES FOR RESALE ELECTRICITY FORECASTING MODEL



P. O. BOX 33189

DUKE POWER COMPANY
GENERAL OFFICES
422 SOUTH CHURCH STREET
CHARLOTTE, N. C. 28242

TELEPHONE: AREA 704
373 ~~XXXX~~ 8199

January 30, 1981

Dr. Bill Hodson
Environmental System Research Institute
380 New York Street
Redlands, California 92382

Dear Sir:

Enclosed is the Duke Power Company response to your survey of the utility industry data needs and land use forecasting methods.

I'm sorry the response is quite late. I contacted several departments in our company, which led to the delay in compiling the answers.

If you have additional questions, please feel free to call me.

Very truly yours,

William H. Gray

William H. Gray
Senior Planning Engineer
System Planning Department

WHG:lm

Enclosure

ELECTRIC UTILITY QUESTIONNAIRE

NASA Energy Utility Data Needs Survey

Return completed form to:

Environmental Systems Research Institute
380 New York Street
Redlands, California 92373

1. Name of Company Duke Power Company

2. Respondent's Name William H. Gray

Title Senior Planning Engineer

Address P. O. Box 33189
Charlotte, N. C. 28242

Contact Telephone 704 373-8199

3. Describe the service area of the company:
Size (sq. miles/acres, etc.) 20,000 Sq. Miles

Location (include sketch map if available)__________

Number of customers:
Residential 1 106 421

Commercial 164 811

Gov't/Institutional 55

Industrial 7 580

Other 6 000

4. Indicate (X) which of the following responsibilities are required of this company.

(X) Provide adequate power for existing users
(X) Provide adequate power for projected future users
(X) Promote efficient power use
(X) Minimize adverse impacts to environment
( ) Allow public agencies access to data for planning
( ) Other:__________

5. Check the type of spatial data (maps, photographs, satellite imagery, etc.) which you use to fulfill the responsibilities of the utility. Indicate which items are placed in automated data files by in-house personnel, and which items are acquired in automated form from outside sources. Also indicate which departments utilize these data types.

Data Type	Automated In-House	Automated File Purchased	Used by Which Department
(X) Electrical load/unit	X		Distribution
(X) Electrical load/area	X		Distribution
(X) Census	No		Design Eng.
(X) Economic	No		Design Eng.
(X) Land Use	No	Real Estate, Design, Transmission	
(X) Land Cover	No		"
(X) Zoning	No	Real Estate, Transmission	
(X) Proposed Land Use	No	"	
(X) Legal Property Descriptions	No	"	
(X) Topography	No	Real Estate, Design, Transm.	
(X) Land Resources (soils, geology)	No		"
(X) Environmental Data (air, water, etc.)	No		Design Eng.
( ) Other (please specify)			

6. Attach a list of the classes/categories which are used to subdivide spatial data identified in #5. N/A

7. Are the automated data types uniform throughout the entire service area?
(X) yes
( ) if no -- please describe

8. How often are the spatial data types reviewed and updated with new information. Is this frequency and timing adequate for the departments using the data?

Daily -- Elect. systems, only.
As needed -- for others.

9. How accurate are the land use/land cover spatial data elements?
(X) Accurate enough for site-specific analysis
(X) Accurate enough for small-area analysis and demand projections
( ) Accurate enough for regional analysis and demand projections
( ) Accuracy limited to system-wide analysis and demand projections

10. What is the approximate annual cost to the utility of spatial data acquisition? $550,000

11. Indicate the utility's experience with remotely sensed data (aircraft and satellite imagery). (See attached description of LANDSAT data.)
( ) No experience
( ) Remotely sensed data considered, not evaluated
(X) Remotely sensed data considered, rejected- please state reasons: Inadequate Scale
(X) Remotely sensed data used regularly - please describe: Balck and white panchromatic aerial photographs.

12. Describe the types of trend analysis and forecasting methods that are currently used to project future energy demands in your service area. Use flow diagrams and formulae to describe.

Small Area Analysis: $Y = A + BX$

Y = Peak load
A = Base load
BX = Temperature sensitive component

System-wide Analysis: SAME

13. What factors limit the use of land use/land cover and automated geographic data by your department and by other departments? Please check all that apply, indicating the most important factor(s) with a "1".

(1) Availability of source data
(1) Data at appropriate scale
(1) Base map precision
( ) Data not kept current
(5) Hardware availability
(4) Software availability
(1) Technical staff expertise
( ) Limited mandate
(2) Time
(3) Budget

14. Check the items which apply to your use of automated geographic information.

(X) Spatial data automated in-house.
Number of persons required ___4___
(X) Data files are referenced to x,y coordinate system
(X) Stored data planes can be overlaid using an automated technique
( ) Image processing and classification capabilities are being used.
Describe specific functions________________

( ) Being investigated. Describe needs________________

15. How many data processing systems and files are currently maintained by your utility?

Systems________________
Data Files______________

16. Describe your current hardware/software configuration. Specify model of computer.

<u>Computer Aided Drafting:</u>

(1) DEC 11/70 - 256 K

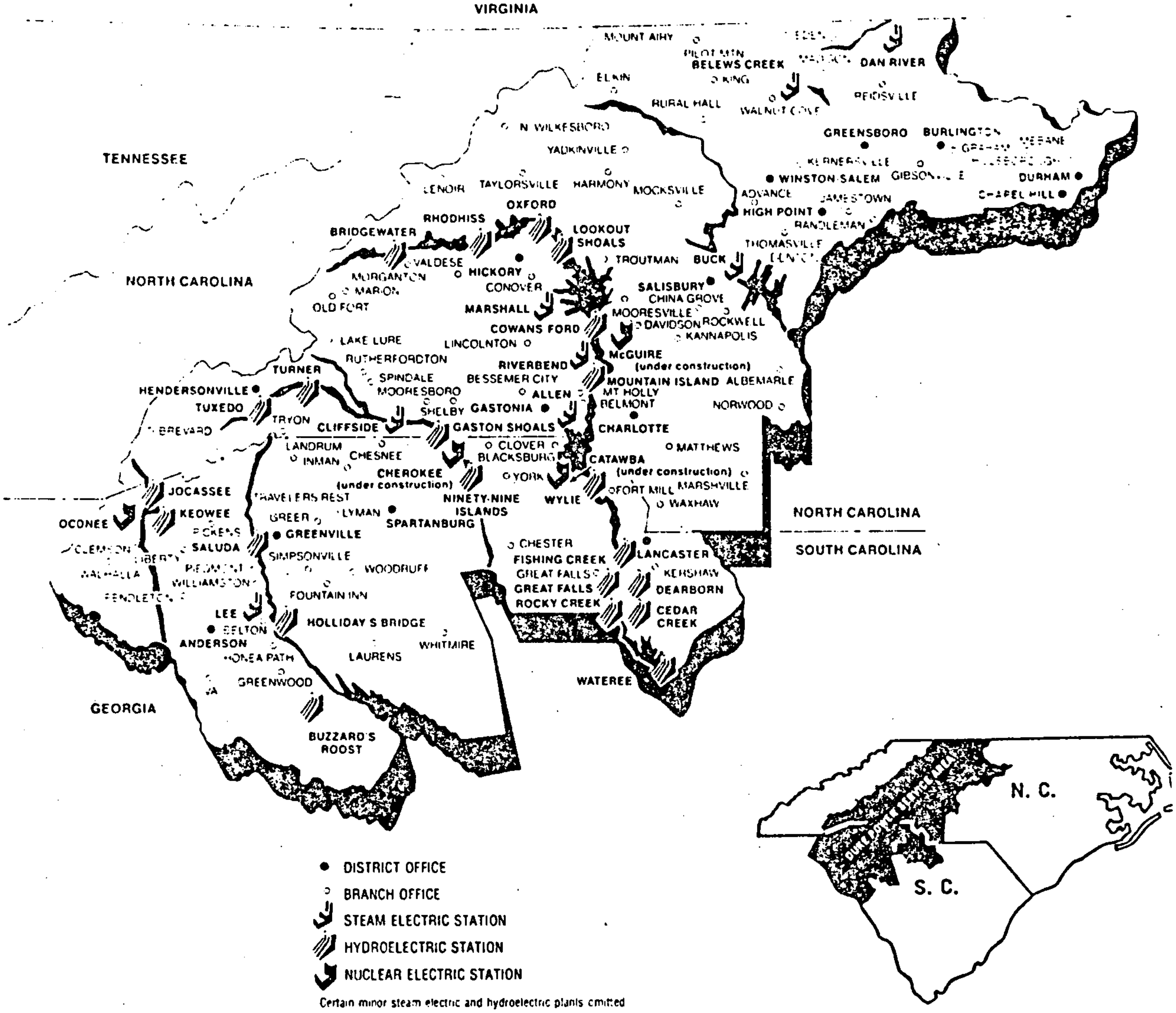
(2) RSX - 11M

(3) Intergraph System - (formerly M & S computing)

(4) 2 - Digitizing work stations

(5) 3 - Shift operation

Duke Power Service Area



About your company

Duke Power Company is an investor-owned electric utility serving approximately 1.3 million customers in North Carolina and South Carolina. The company's service area encompasses about 20,000 square miles through the Piedmont sections of the two states. Retail customers are served locally through 96 district and branch offices.

In addition to selling electricity directly to its own retail customers, the company sells bulk electricity to 55 major wholesale customers, primarily municipal electric systems and rural electric cooperative systems.

During the 12 months ended December 31, 1979, Duke's electric revenues were $1.5 billion, of which approximately 70 percent was derived from sales in North Carolina and 30 percent from sales in South Carolina.

Duke Power has five active subsidiaries—Crescent Land & Timber Corp., land management; Mill-Power Supply Company, wholesale distributor of electrical equipment and purchasing agent for Duke; Eastover Land Company, coal property management; Eastover Mining Company, coal mining, and Western Fuel, Inc., exploration and development of uranium ore deposits.

APPENDIX C

Examples of Geographic Data Bases in the Utility Industry

1. PG & E
2. SCE
3. HL & P
4. PP & L

PG & E

Variable Classification (Sacramento Valley Project)

Specific Data Variables

I. Course Lines
   1.0 Intermittent (8 orders)
   2.0 Perennial (8 orders)

II. Ridge Lines (2 classes)

III. Terrain Units
   1.0 Waterbody (presence or absence)
   2.0 Vegetation (14 classes)
   3.0 General Soil Association
   4.0 Slope
   5.0 Geology
   6.0 Hydrology (flood prone)

IV. Land Use
   1.0 Agriculture (10 classes)
   2.0 Industrial (2 classes)
   3.0 Residential (4 classes)
   4.0 General Urban
   5.0 Dedicated Reserves (3 classes)
   6.0 Intensive Recreation (3 classes)
   7.0 Conservation Recreation (7 classes)
   8.0 Mineral Exploration/Extraction (4 classes)
   9.0 Waterbodies
   10.0 Unused Lands

V. Infrastructure
   1.0 Transmission Lines
   2.0 Railways
   3.0 Pipelines
   4.0 Waterways
   5.0 Proposed Waterways
   6.0 Scenic Roads

VI. County Boundaries (22 counties)

VII. Special Features
   1.0 Landscape Preservation Areas and Vortac Stations
   2.0 Rare, Endangered and/or Threatened Animal Species
   3.0 Significant Animal Habitat Areas
   4.0 Animal Reproductive Unit Locations
   5.0 Historic Sites
   6.0 Designated Natural Areas
   7.0 Rare and Endangered Plants
   8.0 Hiking, Riding and Bicycle Trails
   9.0 Anadromous Fish Spawning Grounds and Important Riparian Habitat

VIII. Land Ownership (12 classes)

ATTACHMENT II

LAND USE CLASSIFICATION

Major Class	Class	1980 Codes	Plot Codes
Residential			110
	Residential, RS <½ acre	RS/110	111
	Residential, RS >½ acre	RSL/111	111
	Residential, MF	RM/112	112
	Mobile Homes	RT/113	113
	Rural Residential (2.5 acres)	RR/114	114
Commercial			120
	Regional and General Commercial	CRG/121	121
	Commercial Strip	CS/122	122
	Neighborhood Strip	CC/123	123
Industrial/Extractive			130
	Light Industry	IL/131	131
	Heavy Industry	IH/132	132
	Extractive	E/133	133
Public/Institutional			160
	Public/Institutional	PI/161	161
	Schools	PS/162	162
Open Space/Recreational			170
	Greenspace-Irrigated	GG/171	171
	Recreation-Non-Irrigated	GR/172	172
Other Committed Uses			150
	Transportation/Communication	TC/151	151
	Utilities	TU/152	152
	Military	M/153	153
	Water	W/154	154/220
Vacant			230
	Vacant with <24% slope	U1/231	231,235
	Vacant with >24% slope	U2/232	232,235
	Vacant with Improvements	UE/233	233
Agriculture			210
	Pasture, Field Crops-Irrigated	AG/213	213
	Row and Truck Crops, Grain and Seed Irrigated	AC/211	211
	Orchards - Irrigated	AO/212	212
	Vineyards - Irrigated and Non-Irrigated	AV/210	21~~0~~2
	Dairies and Feedlots	AD/214	214
	Poultry Operations	AP/215	215
	Other Agriculture	AX/216	216

SCE

ENVIRONMENTAL INVENTORY PILOT STUDY

3200 square miles of the Colorado Desert
primarily in eastern Riverside County.

MAPPING SCALE 1:62,500 or 1 inch=1 mile or a 15 minute U.S.G.S. topographic quad (may be a composite of 7.5 minute quads)

POLYGON TERRAIN UNITS (Grid also)

Catalogued by a unique polygon number

1) Slope*
2) Surface Form*
3) Landform*
4) Geology*
5) Soil Association*
6) Soil Series
7) Minimum Elevation
8) Maximum Elevation
9) Hydrology*
10) Vegetative Community*
11) Floral Association
12) Perennial Plant Species Richness
13) Annual Plant Species Richness
14) Vegetation Data Source
15) Oases

MAPPING SCALE 1:125,000 or 1 inch=2 miles or a composite of 7.5 and 15 minute U.S.G.S. topographic quads

POLYGONS, LINES, POINTS (Grid also)

Existing Land Use (Polygons)***
Existing Land Use (Point)***

Consolidated Land Use**

Projected Land Use - 1995*

Ownership**

Infrastructure**

1) Electrical Transmission Lines and Substations
2) Highways
3) Railroads
4) Aqueducts, Canals, Pipelines and Communication Lines
5) Airports and Navigation Facilities

Scenic Resources**

Cultural Resources*

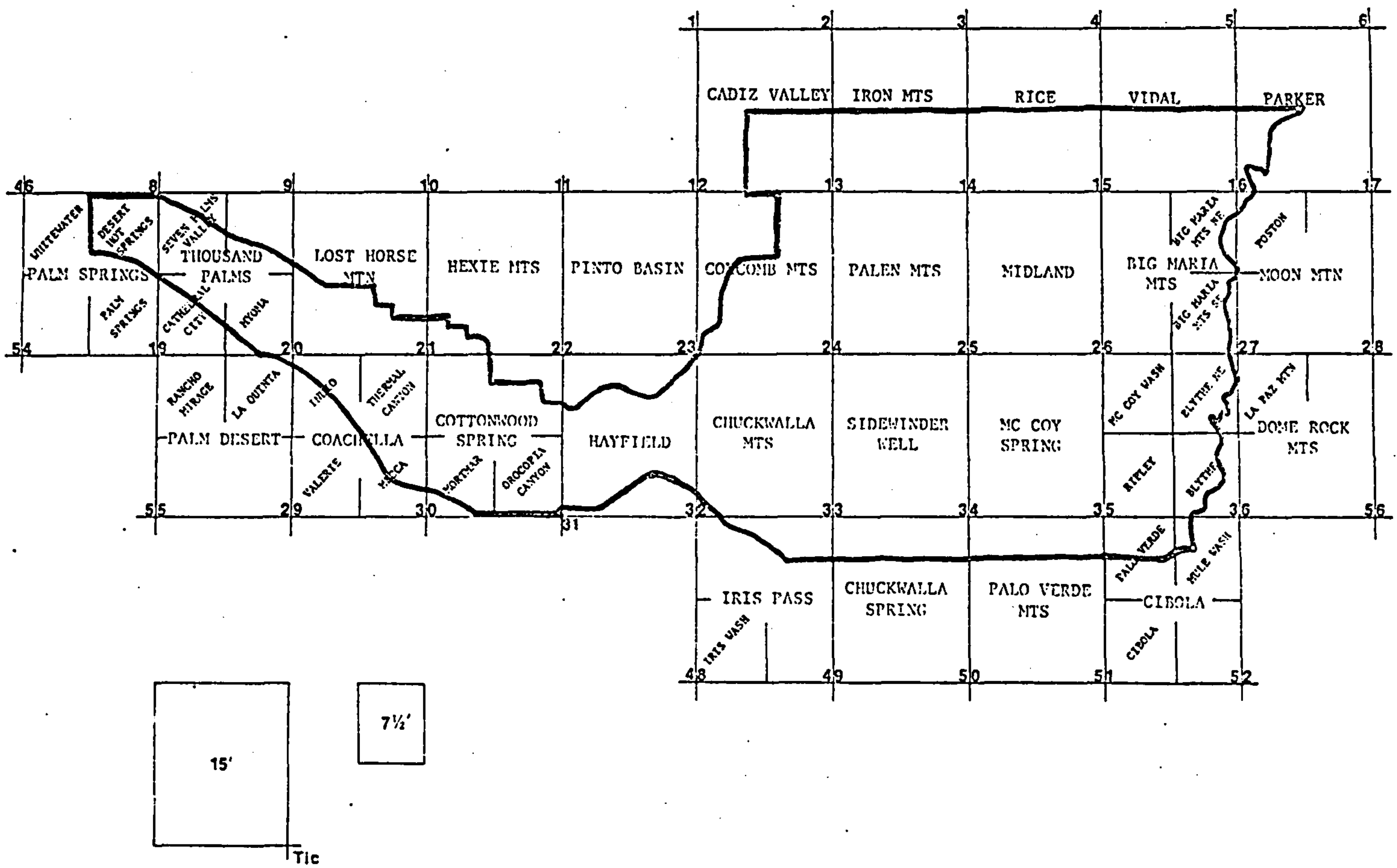
Rare, Endangered, Threatened and Protected Animals**

Rare, Endangered, Threatened and Protected Plants**

Transmission Corridor Alternatives

County and Corporate Boundaries**

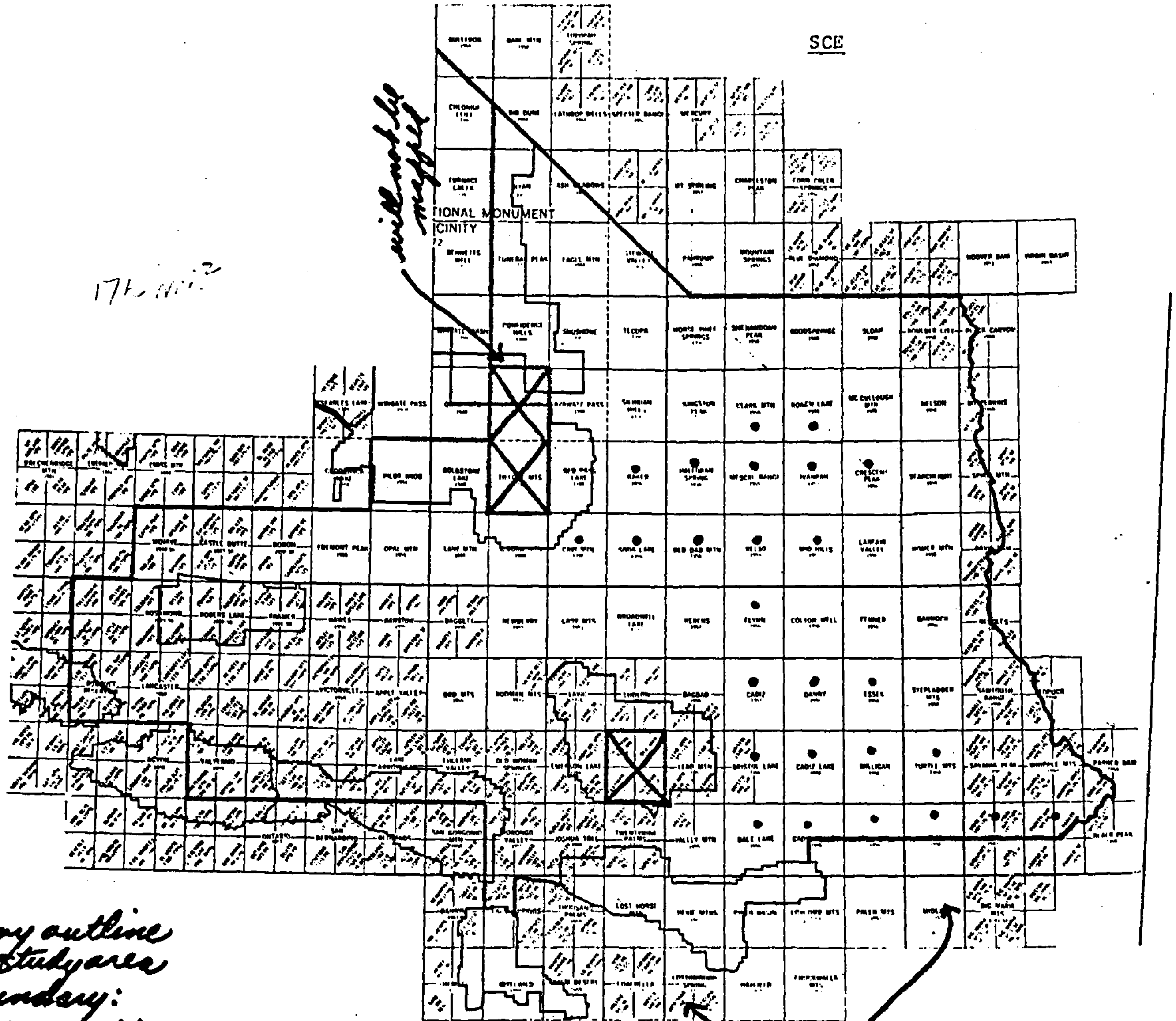
SCE



ENVIRONMENTAL INVENTORY PILOT STUDY AREA

10/29/80

SCE



176 mi²

will not be mapped

heavy outline is study area boundary; lighter outlines are areas to be excluded

[illegible]. X = modules will not be mapped

mapped as part of the Environmental Inventory Pilot Study

SCE

COASTAL RESOURCES INVENTORY

MAPPING SCALE 1:24,000 or 1 inch=2000 feet or a 7.5 minute U.S.G.S. topographic quad

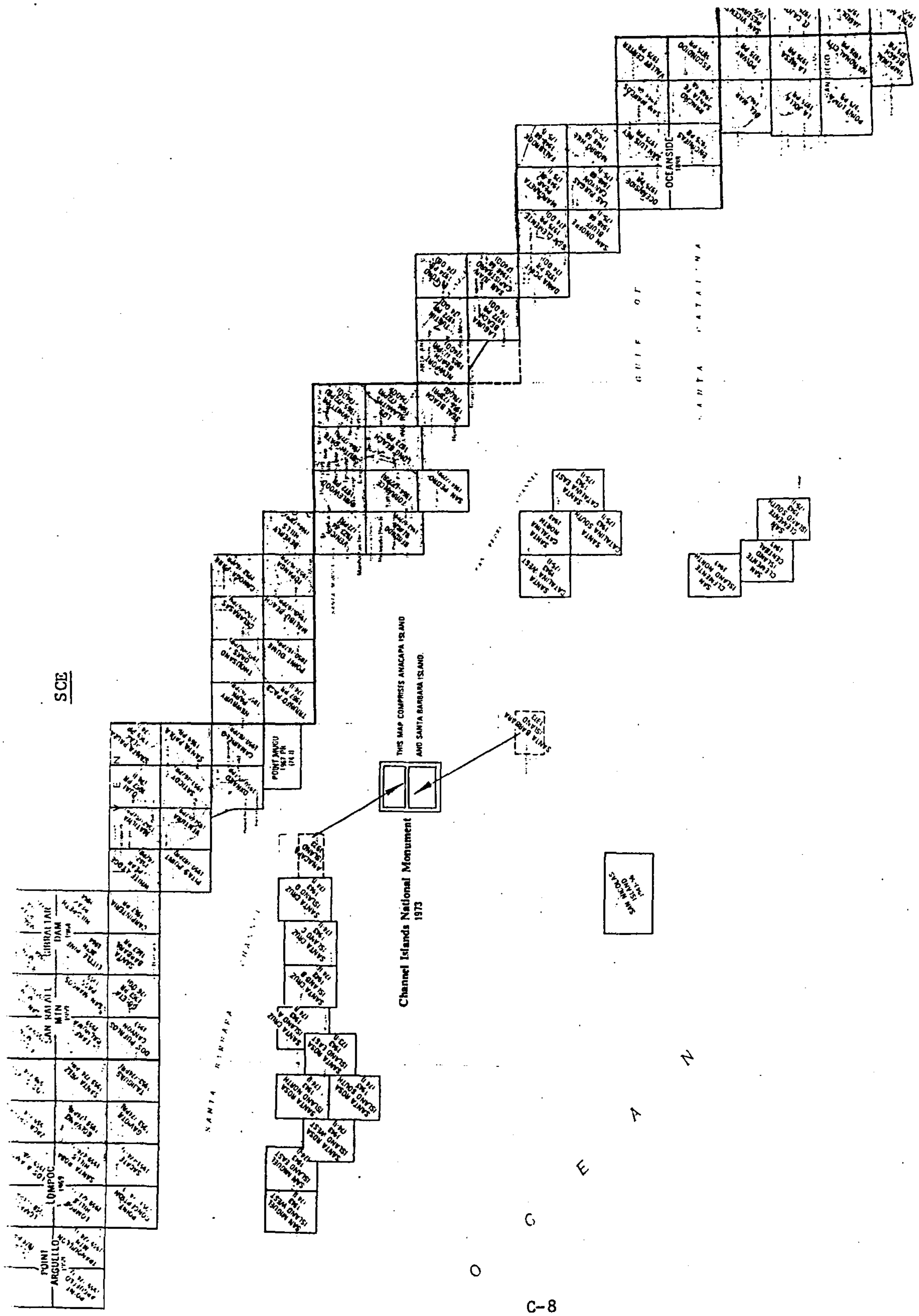
POLYGON TERRAIN UNITS	1) Slope
	2) Surface Form
	3) Landform
Catalogued by a unique	4) Geology
polygon number	5) Soils
	6) Vegetation
	7) Land Use
	8) Disturbance History

GRID INFORMATION — Elevation (center of every 250 foot square, appears as a .125 inch grid square registered to UTM's)

POLYGONS, LINES, POINTS

- United States Census Tracts, 1970
- Administrative Units
  - Counties
  - Cities
  - Regional Governments
  - Water Districts
  - Sanitation Districts
  - Air Quality Districts
  - Air Quality Receptors (points)
  - Electric Utility Districts
- Infrastructure, Transportation
  - Highways
  - Railroads
  - Airports
  - Lighthouses (points)
- Infrastructure, Energy
  - Transmission Lines
  - Transmission Substations
  - Generating Stations
- Special Reserve Areas
  - Parks
  - Sanctuaries
  - Military Reservations
- Special Cultural Features
  - Historical Sites
  - Campgrounds
  - Bicycle Trails
  - Vista Points
- Special Natural Features, Biological
  - Rare or Endangered Plants (CNPS)
  - Natural Areas (CNACC)
- Special Natural Features, Fault Seismic
  - Earthquake Fault-line traces
- Hydrology (lines)
  - Stream Course lines
- Hydrology
  - Floodprone Areas
  - Watershed Boundaries
- California Coastal Commission Boundaries and Designations

Each of the 50 U.S.G.S. topographic quadrangles which make up the study area modules will not have all of the above mentioned categories.


SCE
Channel Islands National Monument
1973
THIS MAP COMPRISES ANACAPA ISLAND
AND SANTA BARBARA ISLAND
OCEANSIDE
LOMPOC
POINT ARGUELLO

HOUSTON LIGHTING & POWER

FIGURE 1

DATA ELEMENTS ON THE AUTOMATED MAPPING BASE MAP

1. X,y coordinates tied to state plane mapping system.
2. Roads
3. Lots and blocks
4. Easement information
5. Control survey if available
6. Rail lines
7. Name of subdivision
8. Transmission lines and towers
9. Major landscape features, such as streams or floodways
10. Large building (in downtown areas)

TABLE 2

LAND USE CLASSES OF INTEREST

1.	Residential	1.1
2.	Multiple	1.2
3.	Single Family	2
4.	Commercial	3
5.	Industrial	3.1
6.	Light Industry	3.2
7.	Heavy Industrial	4
8.	High-rise Office Bldg.	5
9.	Transportation	
10.	Highways	5.1
11.	Rail Lines	5.2
12.	Water	6
13.	Parks & Open Space	7
14.	Undeveloped Area	8
15.	Environmental Factors Constraining Land use (i.e., floodplains, tidal areas, hurricane prone areas, and bad air quality areas)	9
16.	Institutional	~~11~~

TABLE 1

INPUTS TO THE LAND USE FORECASTING METHODOLOGY:

1. Land Use (12 - 15 Land Use Categories)
2. Environmental Constraints
   a. Flooding
   b. Air Quality
   c. Hurricane Threats
   d. Related Problems, physical in nature
3. Socio-Economic Data (Various statistics displaying where geographically problem areas exist which may limit future growth and expansion of the urban land uses.
4. Transportation Accessibility
   a. Shipping Accessibility
   b. Rail Accessibility
   c. Road Accessibility (particularly accessibility to limited access highway interchanges.
   d. Access to Downtown (Including subcenters scattered throughout the metropolitan area)
5. Restricted Land (Various governmental ownership such as parks, reserves, wetland, etc.)

PP & L

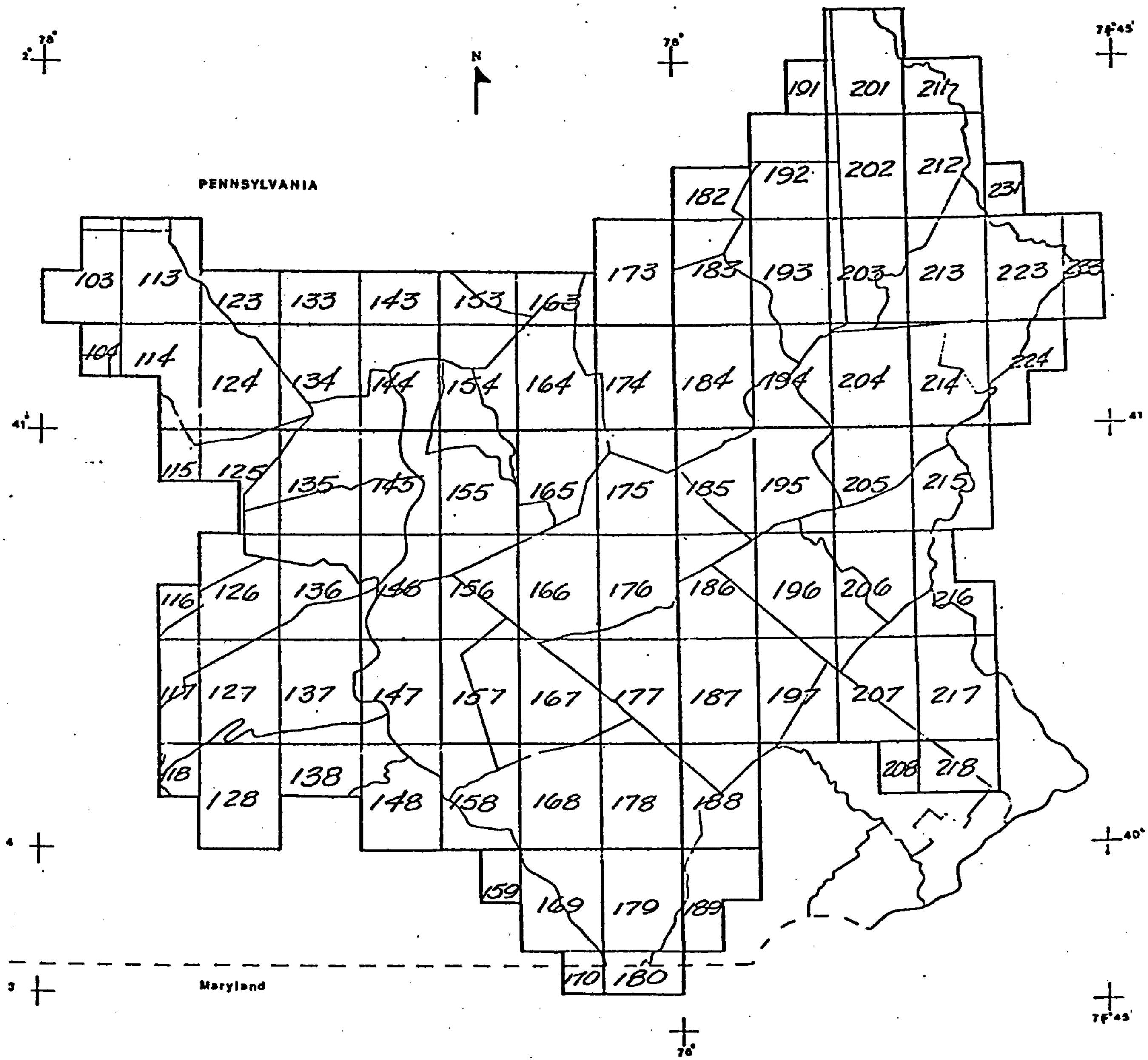
PP&L MULTI-VARIABLE FILE

CATEGORY	LAYER	VARIABLE
LOCATION	1	Row
	2	Column
	3	Map Module
SERVICE AREAS	4	Service Areas
PP&L FACILITIES	5	PP&L Facilities - Point Data
INFRASTRUCTURE	6	Highways
	7	Railroads
	8	Transmission Lines
	9	General (Pipelines, Vortac Stations, etc.)
	10	Scenic Roads/Canals/Trails
PUBLIC LANDS (POINT DATA)	11	Historic Sites/Natural Areas(WPC)County Prefix
	12	Historic Sites
	13	Natural Areas(WPC)
	14	Other
PUBLIC LANDS (POLYGON DATA)	15	Public Lands (Polygon Data)
COURSE LINES	16	Course Lines
FUTURE LAND USE TRENDS	17	Future Land Use Trends
LUDA	18	Land Use and Land Cover
	19	Political Units
	20	Hydrologic Units
	21	Census County Subdivisions
	22	Federal Land Ownership (to be added)
	23	State Land Ownership (to be added)
TERRAIN UNIT	24	Terrain Unit Polygon Number
	25	Vegetation/Land Cover
	26	Landform
	27	Slope
	28	Soils
	29	Agricultural Potential
	30	Soil Depth
	31	Soil Permeability
	32	Seasonally High Water Table
	33	Geologic Code Number
	34	Rock Type
	35	Bedding
	36	Surface Drainage
	37	Groundwater
	38	Porosity
	39	Ease of Excavation
	40	Cut Slope Stability
	41	Foundation Stability
	42	Mineral Resources
	43	Flood Prone

<u>PP & L</u>

1. Row Number
2. Column Number
3. Map Module Number

Map modules were assigned numbers as follows:



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15. Supplementary Notes

Technical Monitor: David Lozier
NASA Ames Research Center TE: 415-965-5912
Moffett Field, CA 94035 FTS 448-5912

16. Abstract

A representative sample of the electric utility industry in the United States was surveyed to determine industry need for spatial data (specifically Landsat and other Remotely Sensed data) and the methods used by the industry to forecast land use changes and future energy demand. Information was acquired through interviews, written questionnaires, and reports (both published and internal). Interviews were conducted with personnel at Houston Lighting and Power, Pacific Gas and Electric Company, Pennsylvania Power and Light, and Southern California Edison Company. Questionnaires were sent to 33 additional companies across the United States. Use of spatial data was found to be limited though several potential uses for spatial data were identified.

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