CHAPTER 3

LOAD-RESOURCE ANALYSIS

3-1. Introduction.

a. General. An analysis to establish the need for a project's power output is an integral part of the hydropower feasibility study. Generally, this analysis consists of a comparison of projected supply (power resources) and demand (power loads). For small projects, a marketability statement can sometimes be substituted for a full load-resource analysis.

b. Scope. The Engineering Regulations and Circulars (ER's and EC's) contained in the Planning Guidance Notebook (49) provide general guidance on the information required to establish the need for water resources projects, as well as the format in which this material is to be presented. This chapter concentrates on the specific material to be developed for evaluating hydropower projects and covers the requirements of Principles and Guidelines (77). Subjects covered include (a) types of load forecasts, (b) sources of information on load forecasts and resource projections, (c) the guidelines for selection of a forecast, (d) marketability requirements, and (e) the type of material to be presented at various study levels.

3-2. Purpose of Analysis.

a. The purpose of the load-resource analysis is to determine the need for and the timing of proposed hydropower projects. Need refers to the existence of power deficits, which occur when the sum of the forecasted power demand and reserve requirements exceeds the planned power supply, while timing refers to the point in time when the need for additional generation occurs. Forecasts are generally made for peak loads and resources (measured in megawatts) and for average energy loads and resources (measured in either megawatt-hours or average megawatts). Generation planning in most regions is based primarily on an analysis of peak loads and resources. An analysis of energy loads and resources may also be required in regions that have a high proportion of energy-limited resources such as hydropower.

b. The above discussion applies to the determination of the need for additional generating capacity. A hydro project could also be used to displace the output of existing thermal power plants. Since the need for the project would be based primarily on economic viability of fuel displacement, a load-resource comparison would not be required. Section 3-11 provides further information on this type of analysis.

3-3. Scope of Analysis.

a. General.

(1) The scope of the forecast is prescribed in the Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies, which is referred to hereafter as simply Principles and Guidelines (77). Principles and Guidelines is also incorporated in the Planning Guidance Notebook as a part of EM 1105-2-40. Two sections of Principles and Guidelines apply to evaluating the need for hydropower: Section 2.5.4(b), which covers small hydro projects, and Section 2.5.6, which generally applies to larger projects.

(2) Section 2.5.4(b) permits an analysis of marketability to be substituted for a determination of need for future generation when evaluating single purpose, small scale hydro projects (80 MW or less) at existing Federal facilities. The marketability analysis is discussed further in Section 3-12 of this chapter.

(3) However, there are cases where load-resource analyses should be provided for small projects. Where a proposed hydro project would meet a substantial portion of a system's new generation requirements over a period of one or more years, a load-resource analysis would be appropriate regardless of the size of the project. However, the degree of detail included in the analysis should be consistent with the project size.

(4) As noted earlier, analyzing need when the hydro project's output is used for displacing generation from existing thermal plants is also a special case, which is discussed in Section 3-11. The balance of this chapter deals with the determination of need, which is described in Section 2.5.6 of Principles and Guidelines. The major steps outlined in Section 2.5.6 are as follows:

b. Major Steps.

(1) Identify System for Analysis. Generally, the system to be analyzed should be the system in which power from the proposed hydro project will be used. For small projects, the system may consist of a single utility, but for larger projects, the system may consist of several utilities or even a power pool. Definition of the system should be made in consultation with the regional Power Marketing Administration and/or the FERC Regional Office.

(2) Estimate Future Demand for Electric Power. Forecasts of electric power loads are generally made in terms of annual peak demand (capacity demand). A forecast of annual energy demand should also be made where more than one-third of a system's firm energy is met by hydropower or other energy-limited resources. Weekly system load shapes are sometimes defined in order to help determine the type of load that a hydropower project should carry. In order to describe the full range of expected conditions, weekly load shapes should be constructed for a minimum of three periods in the year (e.g., typical summer, winter and spring or fall weeks). Load forecasts should reflect the effects of all load management and conservation measures that, on the basis of present and future public and private programs, can reasonably be expected to be implemented during the forecast period. Load forecasts should be made and analyzed by sector use (residential, commercial, industrial, irrigation, etc.). Load estimates should be made at increments of 5 to 10 years (intervals shorter than 10 years are preferred to adequately define trends), from the present to a time when the proposed hydro plant will be operating in a manner representative of the majority of its project life. Loads for intermediate years can be obtained through interpolation. In the case of staged hydropower development (Section 9-10f), or where generation system resource mixes may change markedly (Section 9-6), load-resource analyses may be required for 20 years or more beyond the hydro project's initial operation date. Estimates should account for system exports and reserve requirements (Section 2-2e) as well as the system loads themselves.

(3) Define Base System Generating Resources. Identify the generating resources and imports that will be available to the system at various points in time without the proposed hydropower project in the system (the "without project" scenario). Resource estimates are normally based on the resources' peaking capability, but data on annual energy production should also be developed for systems where a high proportion of the generation is hydropower. Data is usually readily available on projected system resources for the next 10 years. Resource additions beyond that time should be based on system studies or estimates. Retirement of older plants should be accounted for, as well as the reduction in the output of some plants due to age or environmental constraints. The capacity contribution of hydro projects should generally be based on dependable capacity rather than on installed capacity (see Section 6-7).

(4) Evaluate Need for Additional Generation. Compare the loads identified in step (2) above, with the resources identified in step (3) to determine: (a) when generating resource deficits will occur, (b) the magnitude of these deficits, and (c) what portion of these deficits could be met by the hydropower project. If nonstructural measures are components of one or more of the plans being considered

TABLE 3-1. Summer Peaking Capacity, Peak Demand, Reserves, and

	1981	1982	1983	1984
Planned capacity (MW)	53,600	56,781	61,205	64,013
Net imports/exports (MW)	795	813	941	707
Peak demand (MW)	44,383	46,398	48,238	50,317
Total reserve (MW) 3/	10,012	11,196	13,908	14,403
Total reserve (%)	22.6	24.1	28.8	28.6
Scheduled maintenance (MW)	0	301	331	354
Full forced outages & unavail. cap'y (MW) 1/	4,567	4,824	5,288	5,593
Actual reserves (MW) 2/	5,445	6,071	8,289	8,456
Actual reserve (%)	12.3	13.1	17.2	16.8
Capacity needed but unscheduled (MW) 3/	0	0	0	0
Annual energy (gWh)	216,003	226,074	235,006	245,218
Annual load factor (%) 4/	55.6	55.6	55.6	55.6

1/ Full forced outages and unavailable capacity are calculated based on historical data.

2/ Reserve less scheduled maintenance and full forced outages.

Annual Energy for the Southwest Power Pool Region, 1981-1990

1985	1986	1987	1988	1989	1990
65,688	67,031	68,881	70,306	72,310	74,682
440	356	348	294	107	-28
52,302	54,382	56,342	58,535	60,728	63,069
13,826	13,005	12,887	12,065	11,688	11,585
26.4	23.9	22.9	20.6	19.2	18.4
360	363	377	383	401	413
5,707	5,800	5,996	6,120	6,371	6,572
7,759	6,842	6,514	5,562	4,917	4,600
14.8	12.6	11.7	9.5	8.1	7.3
0	590	1,198	2,568	3,494	4,182
55,389	266,543	277,729	289,760	300,414	313,362
55.7	56.0	56.3	56.5	56.5	56.7

3/ Capacity needed to insure that total reserve margin is 25 percent of peak demand and actual reserve is 15 percent of peak demand

4/ (Annual energy, gWh)/(8760 hours x peak demand, MW) and these measures will reduce system loads (see Section 3-9), the amount of such reduction will reduce system deficits correspondingly. Some hydropower sites can be developed to provide either base load, midrange or peaking service. Where these options are available, the system demand for each class of hydropower generation should be evaluated (see Section 6-3). Simple tabulation of annual peak and energy loads and resources is generally adequate for preliminary studies and for detailed analysis of base load plants. It is often desirable to use system load resource models in order to evaluate the need for mid-range and peaking plants, including pumped-storage projects. These models account for load characteristics and generating plant operating characteristics.

c. Display of Analysis. Load-resource information should be displayed year-by-year over a period starting several years prior to the hydro project on-line date and extending several years beyond the year when project output is fully usable in the system load. Table 3-1 is a sample of a typical load-resource analysis.

3-4. Authority and Responsibility of the Corps of Engineers.

a. The responsibility of the Corps is to satisfy all requirements specified by Principles and Guidelines when determining the need for future generation. As described above, this process includes a determination of (a) the time period when generating resource deficits occur, (b) the magnitude of those deficits, and (c) the portion of deficits that could be met by the proposed hydropower project.

b. Forecasts of loads and resource requirements are normally obtained from an outside source such as the Federal Energy Regulatory Commission, the regional Federal Power Marketing Administration, the local utilities or power pool, or a non-Federal government agency. The Corps normally does not perform load and resource projections, but they assume responsibility for the validity of the forecast when it is incorporated in a Corps report. Therefore, Corps staff should understand and support the forecasting methodology and assumptions used in the forecast.

c. There may be occasions when the Corps must develop the load-resource analysis. Examples would be where suitable existing data is not available, or where the entity which normally does load-resource analysis cannot develop the data in the required time frame. In these cases, Corps staff should work closely with these entities in order to develop the data. Consulting firms experienced in this type of work should also be considered.

3-5. Sources of Forecast Data.

a. General. Following is a list of the principal sources of load-resource information.

b. Regional Reliability Council Reports.

(1) The North American Electric Reliability Council (formerly the National Electric Reliablity Council) was formed in 1968 to promote the adequacy and reliability of bulk power supply in North American electric utility systems. NERC consists of nine Regional Reliability Councils which encompass essentially all of the power systems in the United States and Canada (Figure 3-1).

(2) One of the primary functions of the regional councils is to prepare annual load-resource analyses in response to the requirements of the Federal Power Act (as amended). These reports comprise the principal regularly-issued source of load-resource information generally available to the power planner, and they serve as the basis for reports prepared by a number of other entities.

(3) The key load-resource data required by the Act, as implemented by Department of Energy Form EP-411, is as follows:

- monthly energy and peak demand for the past year, the reporting year, and the following year
- annual energy and peak demand for the next eight years
- existing generating capability available at the beginning of the reporting year
- additions and retirements of generating capability for the following ten years
- peak demand and reserve margin for summer and winter seasons for the next ten years
- statement of criteria for determining reserve requirements

The data presented in some of the regional reports is further categorized by sub-region, and data is also presented for U.S. portions of those regions that include Canadian systems.

(4) The load data presented in the regional reports is compiled from the individual load forecasts prepared by member utilities. Although data is presented in a uniform manner, each utility uses its own techniques for preparing its forecasts.

(5) The Regional Reliability Council load-resource analyses have several distinct advantages: (a) they present adequate detail for most Corps studies, (b) they are updated annually, and (c) they are recognized industry-wide as a standard reference source. Disadvant-

ages are that (a) in some cases the regions or sub-regions are too large for properly evaluating a hydro project, (b) only a single load forecast is provided, rather than a range of forecasts, (c) the forecasts extend only ten years, which may be inadequate for some project analyses, and (d) in most cases it is not possible to identify assumptions regarding fuel prices, population and income growth rates, and other factors. However, because of its availability, level of detail, and general acceptance, the Regional Reliability Council forecast should be considered the basic data source in most areas.

(6) Copies of the regional reports are available from the offices of the Regional Reliability Councils (Table 3-2). However, the reports are printed in limited quantities, and availability may

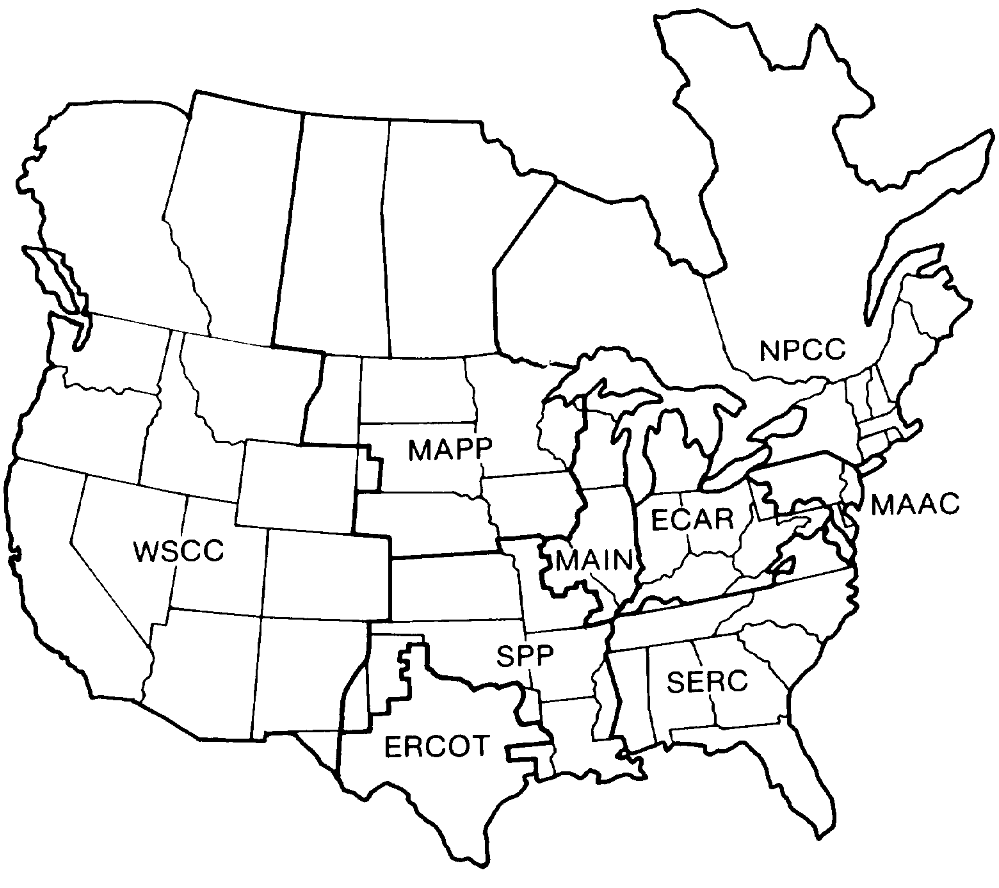

Figure 3-1. North American Electric Reliability Council

TABLE 3-2
North American Electric Reliability Council

North American Electric Reliability Council
101 College Road East
Princeton, NJ 08540-6601
Telephone: (609) 452-8060

* East Central Area Reliability
Council (ECAR)
Post Office Box 21040
Canton, OH 44701-1040
Telephone: (216) 456-2844

Electric Reliability Council
of Texas (ERCOT)
7200 MoPac Expressway, Suite 250
Austin, TX 78731
Telephone: (512) 343-7215

Mid-America Interpool
Network (MAIN)
1N301 Swift Road
Lombard, Illinois 60148
Telephone: (312) 495-3664

Northeast Power Coordinating
Council (NPCC)
1115 Avenue of the Americas,
28th Floor
New York, NY 10036
Telephone: (212) 840-1070

Southwest Power Pool (SPP)
4015 North McKinley
Plaza West, #700
Little Rock, AR 72205
Telephone: (501) 664-0145

Mid-Atlantic Area Council
(MAAC)
Valley Forge Corporate Center
Norristown, PA 19403
Telephone: (215) 666-8801

Mid-Continent Area Power Pool
(MAPP)
430 Century Plaza
1111 3rd Avenue South
Minneapolis, MN 55404
Telephone: (612) 341-4650

Southeastern Electric
Reliability Council (SERC)
TVA 5N 53A Missionary Ridge
Place
Chattanooga, TN 37402
Telephone: (615) 265-8278

Western System Coordinating
Council (WSCC)
540 Arapeen Drive, #203
Salt Lake City, UT 84108
Telephone: (801) 582-0353 *

be limited. Summary reports (28) are available from the North American Electric Reliability Council, Research Park, Terhune Road, Princeton, NJ 08540.

c. Regional Power Marketing Administrations.

(1) Five regional Power Marketing Agencies or Administrations (PMA's) have been established under the U.S. Department of Energy (DOE) to market the power generated at Federal hydroelectric projects. The Tennessee Valley Authority markets much of the power from Corps projects adjacent to its service area in cooperation with the Southeastern Power Administration. The northeastern and midwestern states are not served by a regional PMA, but assistance in evaluating a project in these areas can be provided by the DOE's Office of Power Marketing Coordination (OPMC) in Washington, DC, or by an existing PMA as designated by OPMC. Figure 3-2 shows regional boundaries for the five PMA's and Table 3-3 lists their addresses.

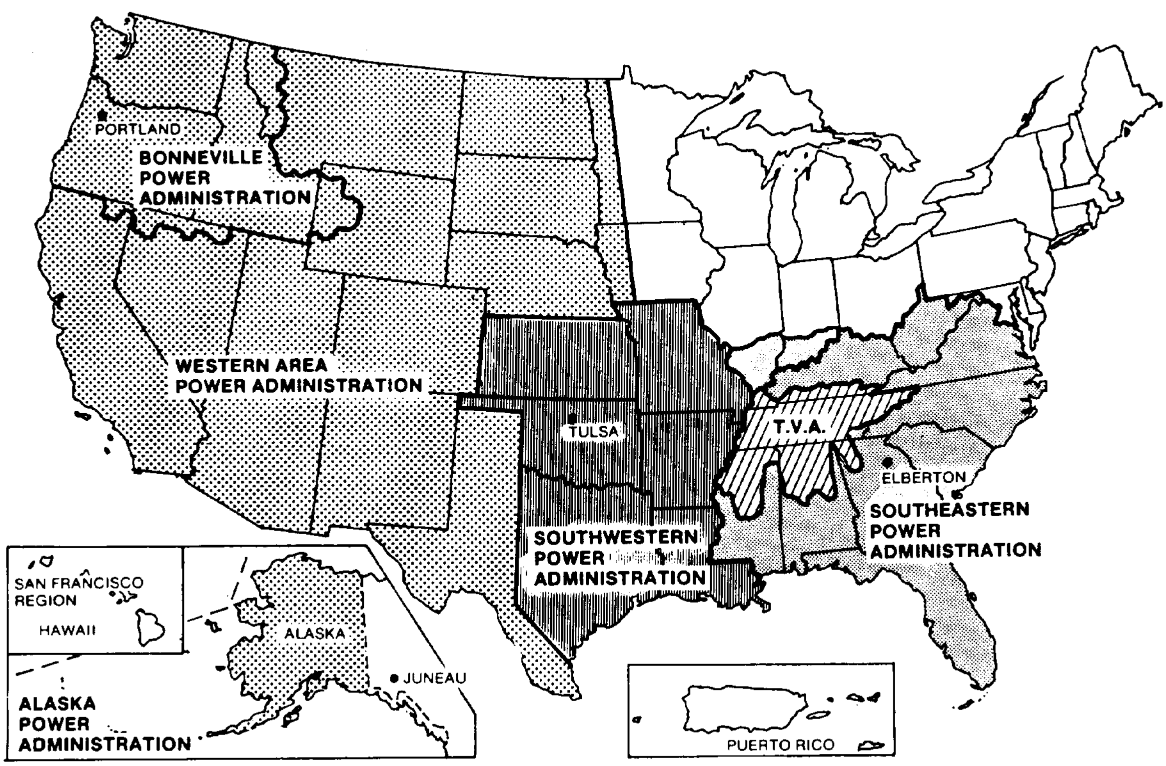

Figure 3-2. Federal Power Marketing Administration boundaries

TABLE 3-3
Federal Power Marketing Administrations

* Southeastern Power Administration Samuel Elbert Building Elberton, GA 30635 Telephone: (404) 283-9911	Alaska Power Administration P.O. Box 50 Juneau, AK 99802 Telephone: (907) 586-7405
Southwestern Power Administration P.O Drawer 1619 Tulsa, OK 74101 Telephone: (918) 581-7474	Bonneville Power Administration P.O. Box 3621 Portland, OR 97208 Telephone: (503) 230-3000
Western Area Power Administration P.O. Box 3402 Golden, CO 80401 Telephone: (303) 231-1511	

(2) The regional PMAs are required to prepare an analysis of marketability for each proposed Federal hydroelectric project (see Section 3-12). This analysis considers projected demand and resource availability. However, in most cases it does not meet the requirements of Section 2.5.6 of Principles and Guidelines, because it is restricted to a limited market (preference customers) and is based on the financial criteria unique to the individual PMAs. There are at least two exceptions. Alaska Power Administration prepares load-resource analyses for proposed Corps projects in Alaska, which is not included in a Reliability Council region. Bonneville Power Administration is required to prepare a regional load forecast pursuant to the Pacific Northwest Electric Power Planning and Conservation Act of 1980. The marketability reports are, however, adequate for establishing the need for single-purpose small-scale hydro projects at existing Federal projects (Section 2.5.4(b) of Principles and Guidelines).

(3) Those PMAs that do not provide formal load forecasts are generally available to provide assistance to Corps offices in evaluating load-resource studies prepared by Regional Reliability Councils and others. *

d. Other DOE Offices.

(1) Federal Energy Regulatory Commission regional offices are sometimes able to assist Corps offices in evaluating the need for hydro projects. Their studies are generally based on Regional Reliability Council reports, but the amount of assistance that can be provided is dependent on staff availability. Figure 3-3 shows FERC district boundaries and Table 3-4 lists their addresses.

(2) The Energy Information Administration (EIA) prepares a number of periodic reports on current electric power generation and related fuel consumption. For example, Electric Power Monthly (83), and Electric Power Quarterly (84) summarize net generation, net energy for load, peak load, and capability by state and NERC region. More detailed information is maintained in EIA's computerized data files. The "Energy Data Contacts Finder" provides a listing of the names and telephone numbers of the specialists responsible for maintaining the various data files. Copies are available from the National Energy Information Center, Energy Information Administration, Washington, DC 20585.

Figure 3-3. Federal Energy Regulatory Commission regional boundaries

TABLE 3-4
Federal Energy Regulatory Commission

* Federal Energy Regulatory Commission
825 North Capitol Street, NE
Washington, DC 20426

ATLANTA
Regional Engineer, FERC
730 Peachtree Street, NE
Room 800
Atlanta, GA 30308
Telephone: (404) 257-4134

NEW YORK
Regional Engineer, FERC
201 Varick Street, Room 664
New York, NY 10014
Telephone: (212) 264-2609

CHICAGO
Regional Engineer, FERC
Federal Building, Room 3130
230 South Dearborn Street
Chicago, IL 60604
Telephone: (312) 353-6171

SAN FRANCISCO
Regional Engineer, FERC
901 Market Street, 3rd Floor
San Francisco, CA 94103
Telephone: (415) 974-7150

PORTLAND
Regional Director, FERC
1120 SW Fifth Ave., Suite 1340
Portland, OR 97204
Telephone: (503) 326-5840

e. Utilities. Electric utilities routinely prepare load forecasts for generation planning and other purposes. These forecasts are also submitted to the Regional Reliability Councils for incorporation in their reports. The regional reports are satisfactory for most Corps studies, so it is not usually necessary to obtain data directly from utilities. However, in the case of hydro projects located in isolated areas (such as Hawaii or Puerto Rico), or projects which would be utilized in single power systems, evaluation of need on the basis of an individual utility's loads and resources would be warranted.

f. National Hydropower Study. The Corps' Institute for Water Resources prepared under contract a study on the magnitude and regional distribution of needs for hydropower, as a part of the National Hydropower Study (48c, 48d). This report was a one-time forecast of loads and resources, intended to identify by region and sub-region the potential need for hydro generation through the year 2000. Although * the study was based primarily on the 1979 Regional Reliability Council reports and is thus out-of-date, it contains useful information on load characteristics, the operation of individual regional power systems, and other related information.

g. Electric Power Research Institute (EPRI). EPRI was formed in 1973 to conduct a broad program of research and development in technologies related to electric power production, transmission, distribution and utilization. EPRI's activities are coordinated with those of the Federal government, state agencies, individual utilities, and research organizations in other countries. Numerous publications on load forecasting, rate designs, and power generation alternatives are available at cost from Electric Power Research Institute, 3412 Hillview Avenue, Palo Alto, CA 94304. A useful primer is Electric Load Forecasting: Probing the Issues with Models (13). Another helpful document is Synthetic Electric Utility Systems for Evaluating Advanced Technologies (15), which provides generalized weekly load shapes by region and by season and other related information on load characteristics.

h. States. Some states prepare load forecasts as a part of their planning and utility regulatory functions. In many cases these forecasts are based largely on utility-supplied information and are therefore comparable to the Regional Reliability Council data, except for the different geographical areas covered. In other cases, the states prepare independent forecasts, sometimes using economic modeling techniques.

i. Other Sources.

(1) Two additional categories of other load forecasts are available to the planner: (a) generalized forecasts intended to guide policy decisions, and (b) analyses prepared to evaluate the need for specific power projects. The generalized forecasts may be prepared on a national basis, but with data provided by region. An example of this type of forecast would be the quarterly Energy Review prepared by Data Resources, Inc. (4), which provides data on demand and price by region for all energy sources for the next 20 years. An econometric model is used to develop this data, and information is presented on the input assumptions underlying the forecast. Other generalized forecasts are developed for regional planning agencies, such as the Northwest Power Planning Council (29). Some of these forecasts may be published on a regular basis, but others may be one-time studies prepared for specific purposes.

(2) The second category refers to special studies intended for evaluating the need for large (and usually controversial) proposed power projects. For some projects, several forecasts may be avail-

able, each prepared by an entity with a different viewpoint. Forecasts may be developed by the sponsoring utilities, regulatory agencies, and special interest groups. These forecasts are generally one-time only studies, and sometimes are prepared by universities or consultants. State utility regulatory agencies can often help to identify the forecasts available for a given area.

3-6. Load Forecasting Methods. Three basic methods or models are used for load forecasting:

- trend analysis
- end-use analysis
- econometric analysis

Trend analysis is based on extending historical trends and modifying the resulting projections to reflect expected changes. End-use analysis involves constructing demand forecasts based on expected use of the electricity. For example, residential end use forecasts are compiled from estimates of electricity demand by appliance, saturation rates for each appliance, and projections of number of households. Econometric analysis is based on the relationships between electricity demand and the various factors that influence demand. At the present time, many forecasts are based on two or more of these methods. Appendix B describes the three forecasting methods in more detail.

3-7. Guidelines for Selecting a Forecast.

a. The forecast should be responsive to the requirements of Section 2.5.6 of Principles and Guidelines. The analysis should show forecasted resource and required reserve margins as well as loads so that it will be possible to identify a projected shortfall which can be met by the proposed hydro project.

b. The period of analysis should be appropriate to the planning period for the project being studied. The lead time required for planning, authorization, design, and construction of Federal hydro projects generally exceeds 10 years, so a 15 to 20 year analysis is usually required. This is especially true for large plants that require several years to be absorbed in the system load. Where projects are small compared to system load growth, shorter lead times are possible, and a 10-year forecast may be adequate.

c. A simple comparison of annual loads and resources is adequate to establish the need for most base load hydro projects. A more detailed analysis, including examination of daily load shapes, may be necessary in order to identify the need for peaking projects, including pumped-storage plants. It is also necessary to document the availability of off-peak pumping energy when evaluating pumped-storage projects.

d. The load forecast should be responsive to the price of electricity. If the price of electricity is rising due to the addition of high-cost generating resources, the forecast should reflect the resultant conservation measures, and the shift of some load to other energy sources.

e. For the sake of consistency, it is desirable to use the same forecasting source throughout all study stages. It is also desirable to use the same forecasting source that has been used historically on other hydropower studies performed within the district or division, providing that the forecast is current and meets the other criteria outlined in this section.

f. When the regional Federal PMA prepares a load-resource analysis that meets the criteria outlined in this section, it should normally be used as the base case forecast. In other areas, the Regional Reliability Council forecasts generally provide the best starting point. The PMA and Regional Reliability Council forecasts are generally summations of load and resource forecasts provided by individual utilities within the power marketing area, and they tend to represent the regional consensus among utilities and power planners on the need for power. These forecasts are generally updated and published annually, and they provide useful information on peak loads, scheduled resource additions, power imports and exports, and reserves. They are also useful for evaluating the accuracy of past forecasts and trends in forecast growth rates because they have been made for a number of years. In some cases, the PMA or regional power planning organization will also have an econometric load forecast that can be used to test the reasonableness of the load forecast prepared by summing individual utility forecasts. The econometric forecast will also provide information on input assumptions and load growth by residential, commercial and industrial sectors that can be used in intermediate and detailed studies.

g. Forecasts prepared by research groups, ad hoc task forces, special study commissions, non-Federal energy offices, and private consultants are best utilized in sensitivity analyses and in comparison with the selected forecast.

3-8. Variations in Load Forecasts.

a. Several forecasts, often prepared by different entities, may be available for a given area. These forecasts may vary widely, particularly if they are prepared by entities with opposing objectives. The Corps planner must determine why the forecasts differ and, if they vary significantly, how to treat this variation.

b. There are two basic reasons why forecasts give different results. In some uses, different forecasting methods are used. In other instances, different basic assumptions are used in the forecasts. These assumptions may be stated explicity as demand-influencing factors or implicitly as subjective factors which prompted the forecasters to modify historical growth rates or patterns. Even if the forecasting models were perfectly formulated and the associated statistical methodologies and data bases were absolutely correct (and they are not), the accuracy of the forecasts themselves would still depend upon the underlying assumptions. Future demand for a particular energy fuel, for example, is dependent on a variety of interactive changing factors. These include price of the fuel and its alternatives, population growth and lifestyle, employment, per capita income, the number and size of households, the rate at which existing housing and other buildings are replaced, appliance saturation and the rate at which appliances are replaced, industrial technology, and a host of other so-called independent intangibles.

c. In a sophisticated econometric demand model, several hundred different mathematical relationships between independent variables and demand for various energy fuels are statistically estimated for different areas and consumer classes. Not one of these demand influencing factors can be predicted with complete assurance. Accordingly, alternative forecasts should be interpreted as rough indications of the reasonable range of possible outcomes of energy growth, rather than precise computations of future energy consumption.

d. The most important demand-influencing factors (independent variables) are: population, number of households or customers (and type of customers), per capita real income, total personal income, and prices of electricity, natural gas, and oil. When comparing alternative load forecasts, it is sometimes helpful to prepare a table listing these key variables, 10-year historical growth rates for each variable, the present "base" value used for each variable, and the projected growth rate for each variable as assumed in each forecast. Unless there are major discrepancies in the structure of the models or the estimated coefficients or elasticities used in the models, comparing the assumed growth rate of these variables will normally account for most of the differences in the alternative load forecasts.

e. If several varying forecasts are available and they all meet the general requirements of Section 3-7, all should be considered for use in defining the need and timing for a proposed hydro project. As noted in Sections 3-5b and 3-7, the forecast prepared by the PMA or the Regional Reliability Council could serve as the base forecast, and alternative forecasts would be used as sensitivity tests. If the alternative forecasts would have an impact on the timing or need for the project, the planner should watch load growth closely as planning and design progresses, so that necessary adjustments can be made to the design and construction schedule. This periodic review of timing and need should be undertaken for any hydro project, but becomes particularly important when a wide range of load growth projections exist or when load growth is in a state of change.

f. Often forecasting entities will develop a range of load growth projections which reflect the uncertainty associated with many of the factors that influence load growth. In these cases, it is common to utilize the mid-range forecast as the basis for planning and utilize the high and low growth scenarios for sensitivity studies.

3-9. Level of Conservation in the Forecast.

a. Historically, load forecasts were developed on the basis of an implicit assumption that the real cost of elecricity would not rise. This led to another implicit assumption, that the cost of electricity would not induce consumers to reduce their consumption. As a result, electricity demand forecasts did not include adjustments to account for load reductions due to price or institutionally induced conservation measures. The rapidly rising energy and electricty prices beginning in the 1970's revealed the fallacy of these assumptions. The effect of price on the demand for electricity was dramatically demonstrated as forecasts were lowered year after year, and orders for new generating plants were canceled.

b. Since the 1970's, rising electricity prices, combined with government and utility sponsored conservation programs, have produced measurable energy savings. Electricity demand forecasting models have been developed that more accurately account for price-induced conservation and institutionally mandated conservation measures (see Appendix B). As a result, planners can now be reasonably confident that conservation effects are accounted for in most forecasts, at least those that are generated with input-output models. However, Corps planners must review forecast assumptions to assure themselves that price-induced and institutionally mandated conservation have in fact been included. The results of this review should be summarized in the text which documents the load forecast in the project feasibility report.

c. There may be some situations where the feasibility of or need for the proposed hydro project hinges on the load growth forecast, and there is some question as to whether or not conservation is adequately reflected in the forecast. In these cases, studies could be made to determine the load growth rates with prices based on the expected increases in the long-run average cost (LRAC) of electricity and on the long-run incremental cost (LRIC) of electricity. The forecast based on LRAC pricing would represent the most likely growth rate, while that based on LRIC pricing would represent the probable maximum attainable level of conservation. If the growth rate in the forecast being used in the study approximates the growth rate resulting from the LRAC study, it can be assumed that conservation is properly accounted for. LRAC and LRIC studies would have to be made using econometric models, and this would be justified only in the case of large projects.

d. The above discussion applies to conservation actions that would be taken and conservation measures which would be implemented in the absence of any new specific actions or measures. It addresses the without-project condition as it relates to non-structural means of reducing the need for additional generation resources. The analysis of conservation measures as an alternative to a proposed hydropower project (or as a part of a plan including the hydropower project) is discussed in Chapter 9.

3-10. Level of Detail Required in Reports.

a. General. The level of detail included in load and resource forecasts depends on the study type and stage. As described in Sections 3-11 and 3-12, load-resource analyses are not required in order to establish need for (a) hydro projects which displace generation from existing thermal plants, and (b) most small scale (80 MW or less) hydropower projects. Load-resource analyses of appropriate scope and detail are required for studies of all major hydropower projects not being analyzed as a fuel displacement project and those small scale projects not exempted as described in Section 3-12c.

b. Reconnaissance Phase Studies. A reconnaissance study must provide a preliminary finding of need, economic feasibility, and Federal interest within rigorous funding and time constraints. In order to satisfy these requirements, existing studies should be used as much as possible, and a complete load-resource analysis is not necessary if it is not readily available. In most cases, a simple statement of need from the regional Federal PMA, the regional office of FERC, or the local power pool or generation planning entity will be sufficient if more detailed data is not readily available.

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c. Detailed Study Phase. Detailed feasibility studies of major hydropower projects could entail one or more iterations of load-resource analysis. Requirements for iterative refinements of the needs analysis will evolve from the overall plan formulation process (i.e., scope, complexity, and possible controversy associated with alternative plans), so the level of necessary effort will vary from study to study and may not be totally predictable at the outset of the detailed study phase. Within this typical planning environment, it is essential that the load-resource analysis made during the initial stage of the Detailed Study Phase be of adequate scope and detail to provide (a) for timely completion of reports on major projects which are not unduly complex or controversial, and (b) a solid foundation for the iterative refinements necessary to complete detailed studies of complex and controversial projects.

d. Basic Steps. The steps involved in an initial or base load-resource analysis are as described in the next section.

(1) Select the Study Area. For larger projects, this will be a power pool area, Regional Reliability Council area, or a subregion of a Regional Reliability Council area. For smaller projects or projects located in isolated service areas, it could be a smaller geographical area (see Section 3-3b(1)).

(2) Select the Forecast Period. See Section 3-7b.

(3) Select the Required Type of Analysis. In most areas, a peak load-resource analysis is sufficient. For those systems where hydro or other energy-limited generation carries a substantial portion of the load (33 percent or more), an energy load-resource analysis is also required.

(4) Identify the Peak Load Months. Alaska, New England, and the Pacific Northwest have their peak loads in the winter months. The southern portion of the country and a portion of the midwest (MAIN Reliability Council area) have summer peaks. Summer and winter peak load periods are comparable in the remainder of the country. For those areas with a single load season, the load-resource analysis need be done only for that season. Where there are two seasonal peaks, it may be desirable to analyze both seasons.

(6) Estimate Generation Requirements. This should also be done by year for the same period. Peak load requirements should include reserve requirements (Section 2-2e).

(7) Tabulate by Year the Peaking Capability of Existing and Planned Generation. Adjustments should be made for retirements and scheduled outages. Hydro capability should reflect only that capacity which is considered to be dependable in the peak demand months. Data on scheduled new generation can be obtained from Regional Reliability Council reports (Section 3-5b).

(8) Compute the Generation Surplus or Deficit Year by Year. This is done by deducting generation requirements (step 6) from peaking capability (step 7).

(9) Determine if the Proposed Project is Needed. By analyzing the dates and magnitudes of the projected deficits, it is possible to determine if the proposed hydro plant can be utilized in the system and, if so, the earliest date that it would be needed. This analysis would include the development of a resource schedule including the proposed hydro project (the "with-project" scenario) and a resource schedule without the hydro project (the "without-project" scenario). The latter information will serve as the basis for the economic evaluation (see Section 9-4). Tables 3-5 and 3-6 illustrate a load-resource analysis for a small power system in Alaska presented in a with- and without-project format, while Table 3-1 shows a generalized analysis for an entire power pool.

e. Peak Load vs. Energy Load Analysis. The above procedure describes a peak load-resource analysis. If an energy analysis is also required, the steps would be similar except that the analysis would be based on energy demand and the estimated energy output of generating resources. Hydro energy capability would be based on output in an adverse water year unless regional practice specifies otherwise. In energy analyses, it is sometimes necessary also to compare the seasonal demand pattern with the seasonal output of the hydro project, in order to determine if the hydro project's output is compatable with the demand pattern.

f. Additional Information. In addition to the load-resource analysis itself, the following information should be presented in the feasibility report:

TABLE 3-5. Load-Resource Analysis, Kenai

		1988	1989
Capacity Required, MW			
1.	Utility peak load	122.3	128.7
2.	Industrial peak load	28.8	29.6
3.	Total peak load	151.1	158.3
4.	Reserves required	40.0	70.0
5.	Total capacity required	191.1	228.3
Capacity Resources, MW			
6.	Bernice Lake C.T.	52.1	52.1
7.	Cooper Lake hydro	15.0	15.0
8.	Seward diesel	5.5	2.5
9.	Seldovia diesel	2.3	0.0
10.	Industrial generation	30.4	30.4
11.	115 KV Anchorage line	40.0	40.0
12.	Total existing capacity	145.3	140.0
13.	Net surplus or deficit	-45.8	-88.3
14.	Combustion turbine	36.0	36.0
15.	Bradley Lake	0.0	90.0
16.	135 KV Anchorage line	0.0	0.0
17.	Total capacity	181.3	266.0
18.	Adjusted surplus/deficit	-9.8	+37.7

Peninsula Subsystem with Bradley Lake

1990	1991	1992	1993	1994	1995
135.5	141.0	146.7	152.7	158.9	165.4
30.4	31.1	31.9	32.6	33.4	34.2
165.9	172.1	178.6	185.3	192.3	199.6
70.0	70.0	70.0	70.0	70.0	70.0
235.9	242.1	248.6	255.3	262.3	269.6
52.1	52.1	52.1	43.9	43.9	35.7
15.0	15.0	15.0	15.0	15.0	15.0
2.5	2.5	2.5	2.5	2.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0
30.4	30.4	30.4	30.4	30.4	30.4
40.0	40.0	40.0	40.0	40.0	40.0
140.0	140.0	140.0	131.8	131.8	121.1
-95.9	-102.1	-108.6	-123.5	-130.5	-148.5
36.0	36.0	36.0	36.0	36.0	36.0
135.0	135.0	135.0	135.0	135.0	135.0
0.0	0.0	0.0	0.0	0.0	0.0
311.0	311.0	311.0	302.8	302.8	292.1
+75.1	+68.9	+62.4	+47.5	+40.5	+22.5

TABLE 3-6. Load-Resource Analysis, Kenai

		1985	1986	1987	1988
Capacity Required, MW					
1.	Utility peak load	104.7	110.2	116.5	122.3
2.	Industrial peak load	26.6	27.3	28.1	28.8
3.	Total peak load	131.3	137.5	144.6	151.1
4.	Reserves required	40.0	40.0	40.0	40.0
5.	Total capacity req'd	171.3	177.5	184.6	191.1
Capacity Resources, MW					
6.	Bernice Lake C.T.	52.1	52.1	52.1	52.1
7.	Cooper Lake hydro	15.0	15.0	15.0	15.0
8.	Seward diesel	5.5	5.5	5.5	5.5
9.	Seldovia diesel	2.3	2.3	2.3	2.3
10.	Industrial generation	30.4	30.4	30.4	30.4
11.	115 KV Anchorage line	40.0	40.0	40.0	40.0
12.	Total existing cap'y	145.3	145.3	145.3	145.3
13.	Net surplus or deficit	-26.0	-37.7	-39.3	-45.8
14.	Combustion turbine	18.0	36.0	36.0	54.0
15.	Bradley Lake	0.0	0.0	0.0	0.0
16.	135 KV Anchorage line	0.0	0.0	0.0	0.0
17.	Total capacity	163.3	181.3	181.3	199.3
18.	Adjusted Surplus/Deficit	-8.0	+3.8	-3.3	+8.2

Peninsula Subsystem without Bradley Lake

1989	1990	1991	1992	1993	1994	1995
128.7	135.5	141.0	146.7	152.7	158.9	165.4
29.6	30.4	31.1	31.9	32.6	33.4	34.2
158.3	165.9	172.1	178.6	185.3	192.3	199.6
40.0	40.0	40.0	40.0	40.0	40.0	60.0
198.3	205.9	212.1	218.6	225.3	232.3	259.6
52.1	52.1	52.1	52.1	52.1	52.1	35.7
15.0	15.0	15.0	15.0	15.0	15.0	15.0
2.5	2.5	2.5	2.5	2.5	2.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.4	30.4	30.4	30.4	30.4	30.4	30.4
40.0	40.0	40.0	40.0	40.0	40.0	40.0
140.0	140.1	140.1	140.1	140.1	140.0	121.1
-58.3	-65.9	-72.1	-78.6	-85.3	-92.3	-138.5
54.0	72.0	72.0	90.0	90.0	90.0	90.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
194.0	212.0	212.0	230.0	230.0	230.0	211.1
-4.3	+6.1	-0.1	+11.4	+4.7	-2.3	-48.5

- map of market area
- source of selected forecast
- type of forecast (e.g., single agency forecast or aggregation of multiple utility forecasts)
- forecast methodology and underlying assumptions (if available)
- a tabulation of actual loads for each of the past 10 years. The average annual growth should be computed and compared with the growth rate in the forecast
- a comparison of the growth rate for the selected load forecast with previous years' growth rates (i.e., are 10-year or 20-year growth rates rising or falling compared with forecasts made in the past 5 years). Explain upward or downward trends in terms of conservation, higher energy prices, economic growth or decline, etc.
- an evaluation of the accuracy of historic load forecasts. For example, compare actual load in a recent year with the load that was forecast for that year in forecasts dating back at least 5 years
- a listing of the major power plants under construction or proposed for construction that are included in the resource forecast, including information on type, installed capacity, average energy output (where an energy analysis is being made), and scheduled on-line date.

This evaluation process and information display should satisfy plan formulation and reporting requirements for major projects which are not unduly complex or controversial.

g. Load Forecast Requirements. Plan formulation and public involvement activities will generally identify necessary refinements of needs analysis for complex and controversial projects. Typical refinements include (a) separation of forecasted loads into residential, commercial, and industrial sectors to more clearly define source and projected growth of further demands, (b) more detailed definition of weekly/daily load shapes for representative periods of future demand years to more clearly display the type of load that the hydro project could serve, (c) the development of alternative load growth scenarios to determine the impact of load growth on timing and need for the project, and (d) comparison with other published load forecasts.

3-11. Analysis of Energy Displacement Projects. The output of some hydroelectric projects can best be used to displace generation from existing high-cost thermal plants. This could be the case in areas like California, Alaska and New England, where much of the energy demand is met by oil-fired steam generation. In these cases, the proposed hydro plant would not defer or displace an increment of new thermal capacity, and thus a load-resource study would not be required to establish need. The need would be tied instead to the analysis of economic feasibility. Studies that show that the cost of constructing and operating the proposed hydro plant is less than the cost of the existing generation displaced would be sufficient to establish need. The report, however, must include a description of the existing and expected future power system, with an explanation of how the hydro project would be used to displace thermal generation and what types of plants would be backed off. The energy displacement method for evaluation of hydro projects is discussed further in Section 9-6.

3-12. Marketability Analysis.

a. Flood Control Act of 1944. Under the provisions of Section 5 of the Flood Control Act of 1944 (Public Law 534, 78th Congress) and other acts, power developed at multiple-use reservoirs under the jurisdiction of the Chief of Engineers and Bureau of Reclamation is turned over to the Secretary of Energy for marketing. The Act requires that the Secretary shall transmit and dispose of power and energy so as to encourage the most widespread use at the lowest possible rates to consumers, consistent with sound business principles. It also provides that preference in the sale of power be given to public bodies and cooperatives. Rates for sale of power to recover allocated costs are established by DOE's regional Power Marketing Administrations (PMA's), and approved by the FERC. Figure 3-2 shows the location of the regional PMAs. As noted earlier, DOE's Office of Power Marketing Coordination will designate an adjacent PMA to handle the marketing function where a hydro project is located outside of the service areas of the established PMA's.

b. Marketability Reports. All feasibility reports for hydroelectric projects must contain a statement by the regional PMA that the power from the proposed project is marketable and that project costs allocated to power can be repaid with interest within fifty years (see Section 9-9). The marketability analysis in many cases is limited to the needs of preference customers, and the revenue rates upon which the analysis is based are frequently average costs, which include the costs of substantial amounts of older, low-cost generation. This type of analysis is consistent with the requirements of the Flood Control Act of 1944 which govern the PMA's, but does not meet the requirements of Principles and Guidelines (P&G) for a determination of need for an economic analysis.

c. Treatment of Small Projects. To insure efficiency in the use of planning resources, P&G encourages simplified procedures for small scale hydro projects. One area where simplifications are suggested is in establishment of the need for power. Section 2.5.4 of P&G states that ". . . an analysis of marketability may be substituted for determination of need for future generation for hydropower projects up to 80 MW at existing Federal facilities." The PMA marketability analysis described above would serve this purpose. Such a substitution would be particularly appropriate for large power systems where the annual load growth is so large that the small hydro project would have little or no effect on the scheduling of other new generating resources. However, where the proposed hydro project is large with respect to system loads, such as in small, isolated systems in Alaska, a full load-resource analysis would still be required.