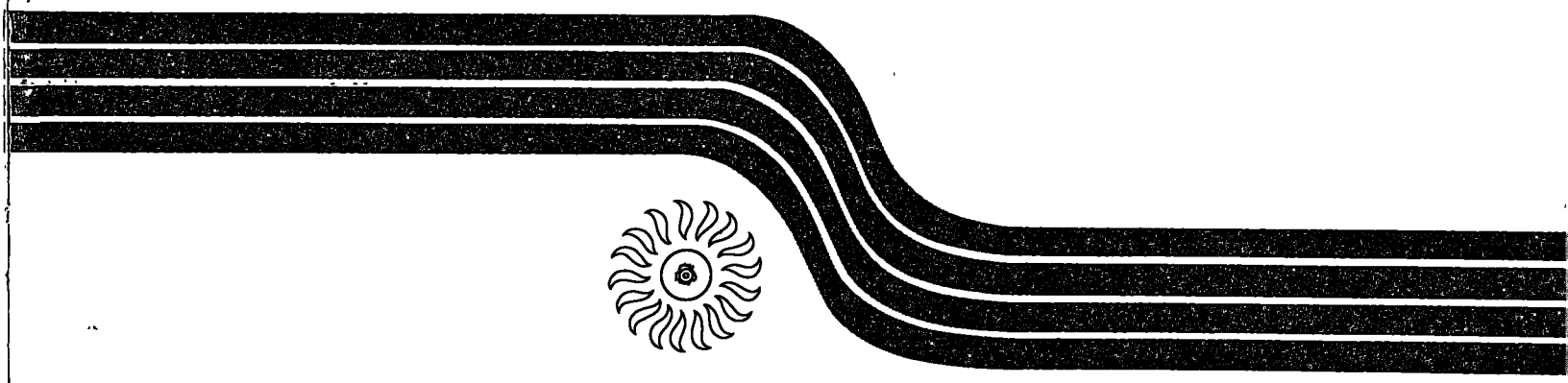
US Army Corps
of Engineers

National Hydroelectric Power Resources Study

Volume I
May 1983



Executive Summary

Unclassified

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This volume contains an overview of the findings and conclusions of the National Hydroelectric Power Resources Study. It presents summary data on the findings of the NHS, including information on Hydroelectric Power potential by National Electric Reliability Council Region, and by ownership.

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United States Army Corps of Engineers

National Hydroelectric Power Resources Study

Executive Summary

Institute for Water Resources
Casey Building
Fort Belvoir, Virginia 22060

May 1983

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CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

THE STUDY AND REPORT

The Corps of Engineers has completed the National Hydroelectric Power Resources Study (NHS) and has prepared a plan that identifies a set of best candidate sites for future study of hydroelectric power potential. The plan includes both Federal and non-Federal sites. The NHS final report consists of 23 volumes. Volume I, the Executive Summary, summarizes the major findings of the NHS.

PURPOSE AND AUTHORITY

Congress authorized the Corps of Engineers to conduct the NHS in the Water Resources Development Act of 1976 (PL 94-587), to evaluate the potential for additional hydroelectric power and to prepare a plan for future development of sites under the jurisdiction of the Secretary of the Army. This report is a synthesis of the results of the study. The full citation authorizing the study is shown in Table 1.

The task was assigned to the Secretary of the Army, to be accomplished by the Chief of Engineers. Management of the study was assigned to the U.S. Army Engineer Institute for Water Resources, now part of the Corps' Water Resources Support Center. All U.S. Army Engineer division and district offices participated in the data compilation and evaluation.

TABLE 1

PL 94-587, SECTION 167 AUTHORIZATION FOR NHS

(a) The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to conduct a study of the most efficient methods of utilizing the hydroelectric power resources at water resource development projects under the jurisdiction of the Secretary of the Army and to prepare a plan based upon the findings of such study. Such study shall include, but not be limited to, an analysis of:

(1) the physical potential for hydroelectric development, giving consideration to the economic, social, environmental and institutional factors which will affect the realization of physical potential;

(2) the magnitude and regional distribution of needs of hydroelectric power;

(3) the integration of hydroelectric power generation with generation from other types of generating facilities;

(4) measures necessary to assure that generation from hydroelectric projects will efficiently contribute to meeting the national electric energy demands;

(5) the timing of hydroelectric development to properly coincide with changes in the demand for electric energy;

(6) conventional hydroelectric potential, both high head and low head projects utilizing run-of-rivers and possible advances in mechanical technology, and pumped storage hydroelectric potential at sites which evidence such potential;

(7) the feasibility of adding or reallocating storage and modifying operation rules to increase power production at Corps projects with existing hydroelectric installations;

(8) measures deemed necessary or desirable to insure that the potential contribution of hydroelectric resources to the overall electric energy supply are realized to the maximum extent possible; and

(9) any other pertinent factors necessary to evaluate the development and the operation of hydroelectric projects of the Corps of Engineers.

(b) Within three years after the date of the first appropriation of funds for the purpose of carrying out this section, the Secretary of the Army, acting through the Chief of Engineers, shall transmit the plan prepared pursuant to subsection (a) with supporting studies and documentation, together with the recommendations of the Secretary and the Chief of Engineers on such plan, to the Committee on Public Works of the Senate and the Committe on Public Works and Transportation of the House of Representatives.

(c) There is authorized to be appropriated to carry out subsections (a)and (b) of this section not to exceed $7,000,000.

OBJECTIVES

The following specific objectives were established for the study:

1. To analyze and define the nation's need for hydroelectric power.
2. To assess the physical potential for increasing hydroelectric power capacity and generation.
3. To analyze the current institutional and policy setting for hydroelectric power planning, development, marketing, and utilization.
4. To determine the feasibility of increasing hydroelectric generation capacity by developing new sites, by adding generation facilities to existing water resources projects, and by increasing the efficiency and reliability of existing hydroelectric power plants and systems.
5. To assess the general environmental and socio-economic impacts of additional hydroelectric power development.
6. To recommend to Congress a national hydroelectric power development plan and any institutional and policy modifications which would increase the effectiveness of existing and future hydroelectric power development.

SCOPE

Time Frame

Actual electric demand figures were compiled for 1978. Forecasts of future electric demands were made for the years 1985, 1990, 1995, and 2000. The recommended plan for future hydroelectric development is for 1982-2000.

Geographic Area

The NHS is national in scope and includes all 50 states and Puerto Rico. The data collection and site inventory portions of the study, however, were subdivided into electric reliability council regions as defined by the National

Electric Reliability Council. The map inserted in the back pocket of this report shows the regions.

Areas of Investigation

The NHS examined conventional hydroelectric power potential. Run-of-river, storage, and diversion projects were included in the inventory. All sites, both Federal and non-Federal, were assessed. Potential sites include those at existing dams and at undeveloped dam sites which had been studied by the Corps of Engineers or other Federal and state agencies. An assessment of regional pumped storage potential was undertaken as a separate study.

Several projections of future demand for electricity were used to prepare a range of possible rates of growth. Also, projection of possible supplies of energy were compiled. These demand and supply estimates were used to determine the need for additional hydroelectric power.

Several studies were initiated to investigate the legal/institutional, economic, and environmental factors that will affect the future of hydroelectric power. These studies were used to help choose a plan to guide the selection of potential hydroelectric power sites and to uncover policy issues that would affect the future development of hydroelectric power facilities. The NHS plan designates a selected number of sites for more detailed feasibility studies to determine if development is warranted.

PLAN OF STUDY

The Institute for Water Resources, in cooperation with Corps divisions, prepared a detailed study execution plan which divided the work into two major

elements. In the first element, potential hydroelectric power sites throughout the United States were identified and evaluated by engineering, economic, and environmental screening criteria. Electric power supply and demand were also investigated here. The second element focused on the important policy issues which affect the development and use of hydroelectric power resources. Information and data from these two elements were used to select the best candidate potential sites for future hydroelectric power development.

PUBLIC INVOLVEMENT

Public involvement was an integral part of the NHS. Public meetings were held in each electric reliability council region to provide a forum for full discussion of proposed sites. Three national public meetings were held to seek comment on the preliminary results of all parts of the NHS, including the policy studies.

FINAL REPORT VOLUMES

The NHS report consists of 23 volumes. Volumes I and II are the Executive Summary and the National Report, respectively. These volumes are a synthesis of the results of the entire NHS. This document is the Executive Summary.

Existing and future electric demand are covered in Volumes III and IV. Specifically, Volume III is a base line (1978) study of the electric power supply system for each of the electric reliability council regions of the United States. Volume IV describes projections of electric power load growth in each region through the year 2000, in five-year increments.

Five policy studies were conducted. Volume V covers the legal and institutional aspects of hydroelectric power development and operation. Volume VI is a review of economic evaluation criteria for Federal hydroelectric power projects. Volume VII covers aspects of the marketing and transmission of Federal hydroelectric power. Volume VIII is a generic environmental assessment

of hydroelectric power. Volume XI is a technology assessment of national hydroelectric power development.

Two technical overview studies dealt with the efficiency of existing hydroelectric power facilities and pumped storage. Volume IX explores the potential for increasing the output of existing hydroelectric plants. Volume X is an assessment of the future demand and potential supply of hydroelectric pumped storage.

The next two volumes deal with the development and results contained in the computerized inventory of potential hydroelectric power sites. Volume XII addresses the sequential process used to develop the site-specific inventory, including the methods used to collect and analyze raw data, the major problems encountered in screening candidate sites, and how these problems were resolved. The resulting inventory of hydroelectric power sites is listed in Volume XII. Volume XIII includes descriptions and results of the support studies that were necessary to develop the inventory data base.

Volumes XIV through XXIII contain regional assessments of hydroelectric power potential. Each volume covers one of the nine electric reliability council regions. Volume XXIII covers the states of Alaska and Hawaii. Puerto Rico is included in Volume XVI, Southeastern Electric Reliability Council. Each regional assessment report contains information on best candidate sites for future hydroelectric power studies and a map showing the location of each site.

All of the reports are available for purchase through the Government Printing Office. Table 2 lists the GPO ordering number and the price for each report volume.

National Hydroelectric Power Resources Study Final Report

Volume	Title	GPO Number	Price
I	Executive Summary	008-022-00212-0	$3.75
II	National Report	008-022-00213-8	$6.00
	POLICY AND TECHNICAL STUDIES		
III	1978 Electric Power Demand and Supply	008-022-00198-1	$9.50
IV	Future Electric Power Demand and Supply	008-022-00199-9	$9.50
V	Legal and Institutional Aspects of Hydroelectric Power Development and Operation	008-022-00190-5	$7.50
VI	A Review of Economic Criteria for Federal Hydroelectric Power Projects	008-022-00193-0	$5.50
VII	Marketing and Transmission of Hydroelectric Power	008-022-00208-1	$8.00
VIII	Environmental Assessment	008-022-00209-0	$9.50
IX	Potential for Increasing the Output of Existing Hydroelectric Plants	008-022-00191-3	$8.00
X	An Assessment of Hydroelectric Pumped Storage	008-022-00194-8	$13.00
XI	Technology Assessment of Hydroelectric Power Development	008-022-00195-6	$9.00
XII	Data Base Inventory	008-022-00196-4	$28.00
XIII	Data Base Inventory Support Studies	008-022-00197-2	$15.00
	REGIONAL ASSESSMENTS		
XIV	Northeast Power Coordinating Council	008-022-00171-9	$8.50
XV	Mid-Atlantic Area Electric Reliability Coordination Agreement	008-022-00172-7	$6.00
XVI	Southeastern Electric Reliability Council & Puerto Rico	008-022-00173-5	$8.00
XVII	East Central Area Reliability Coordination Agreement	008-022-00177-8	$6.50
XVIII	Mid-American Interpool Network	008-022-00179-4	$6.00
XIX	Mid-Continent Area Reliability Coordination Agreement	008-022-00174-3	$7.00
XX	Southwest Power Pool	008-022-00175-1	$8.00
XXI	Electric Reliability Council of Texas	008-022-00176-0	$5.50
XXII	Western Systems Coordinating Council	008-022-00180-8	$11.00
XXIII	Alaska and Hawaii	008-022-00178-6	$7.50

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HYDROELECTRIC POWER SUPPLY AND DEMAND

SUPPLY

About 30 percent of the nation's total energy production is in the form of electricity. Coal is used to generate 44 percent of the annual electric output; petroleum, 17 percent; gas, 14 percent; nuclear power, 12 percent; and hydroelectric power, 13 percent. In addition, hydroelectric power provides 14 percent of the total electric generating capability (Figure 1). The aggregate capacity of all existing hydroelectric facilities is about 76,000 megawatts (MW), including 13,000 MW of pumped storage. These facilities produce about 280 billion kilowatt hours (KWh) per year. Figure 2 shows the existing hydroelectric power capacity by National Electric Reliability Council (NERC) region. Hydroelectric power dominates the energy mix in the Western Systems Coordinating Council (WSCC) with about 40 percent of the total capacity. Elsewhere, hydroelectric power plays a minor role, contributing 12 percent of the capacity in the Southeastern Electric Reliability Council (SERC), about 10 percent in the Northeast Power Coordinating Council (NPCC) and less than 10 percent in the rest of the regions. Hydroelectric power plants are an integral part of U.S. electric utility systems, and the characteristics of this energy source make new additions highly desirable. For example, hydroelectric power facilities consume no fuel, are extremely durable and reliable, are part of an established technology, are renewable sources of energy, and emit no air pollution or solid waste. In addition, projects with storage can release water to produce electricity during peak demands. Hydroelectric power turbines and generators can more easily match fluctuating demand than most thermal-electric plants and can be called on quickly for added power even if the unit has been turned off. The flexibility is a major advantage of hydroelectric power in electric generating systems.

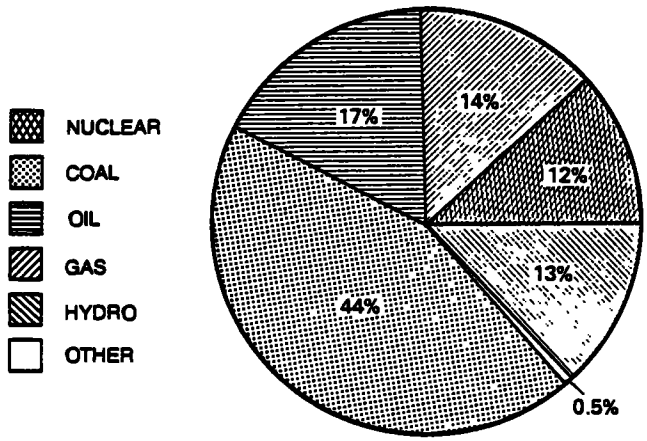


Figure 1 EXISTING ELECTRIC POWER CAPABILITY—1982

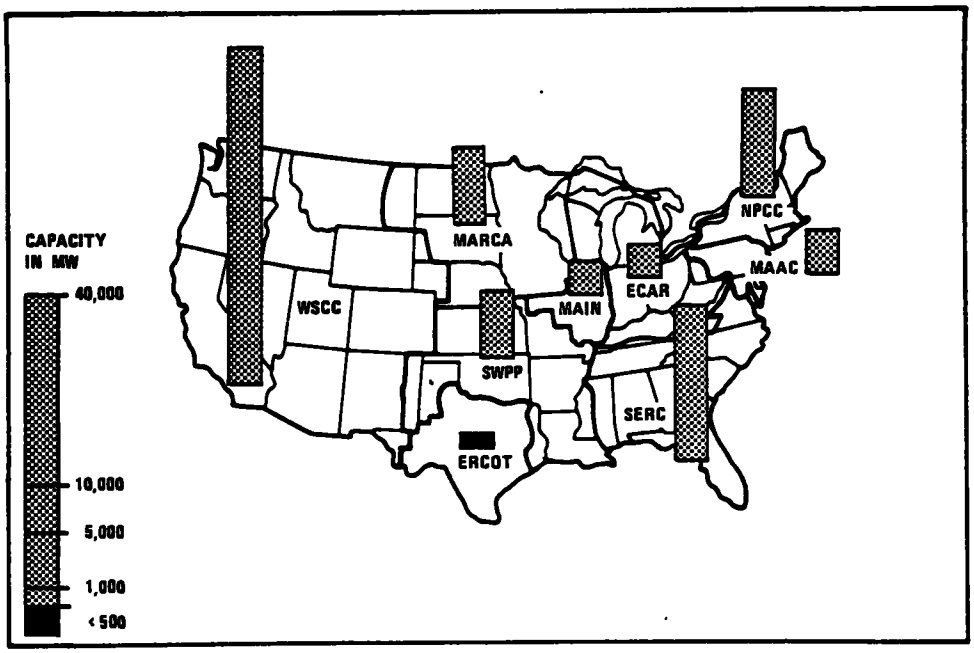


Figure 2 EXISTING HYDROELECTRIC POWER CAPACITY BY NERC REGION

DEMAND

Future levels of electricity demand depend on economic, social, environmental, and political factors, both domestic and international, which can have profound effects that may not be readily foreseen. Consider that projections of electricity demand growth rates are now projected at about one to three percent per year rather than seven to nine percent as in the early 1970s. The NHS analyzed a range of recent forecasts to derive these projections of future electricity demand. Another forecast was added during the pumped storage assessment. The range of the NHS projections indicated annual growth rates in peak demand from 2.6 to 4.9 percent.

Using the demand projections and estimates of the likely sources of energy to be developed during the planning period, the NHS estimated the range of probable demand for hydroelectric power. The ranges of demand for hydroelectric power indicate that all best candidate potential sites identified in the NHS could be readily absorbed into future electric utility systems.

PUMPED STORAGE

There are currently 31 pumped storage projects in the United States with an installed capacity of 13,406 MW. These plants are used to store energy generated during off-peak periods for use during peak demand periods. Although other storage devices are being developed, pumped storage is the only large-scale means of storing electrical energy that is used today by electric utilities.

The NHS examined the potential for additional pumped storage potential using a range of assumed future economic conditions and electricity demand growth. Under the combination of most likely conditions, pumped storage capacity is expected to grow to about 60,000 MW by the year 2000. However, if electricity demand does not increase as expected, the growth of pumped storage could be nil. The NHS pumped storage study was a preliminary investigation and should be followed up by detailed regional studies.

HYDROELECTRIC POWER RESOURCE ASSESSMENT

The NHS screened some 60,000 sites in the initial inventory. These sites included some 50,000 existing dams or structures, with or without hydroelectric power, and some 10,000 undeveloped sites where a dam or other water control facility had been investigated by a Federal or state agency. Specialized computer routines were designed to analyze these sites further.

The specialized computer routines were designed to screen the sites in four separate stages. All sites that met standards set for a stage were investigated at the next stage. Sites that failed to meet standards set for a stage were withdrawn from consideration.

The first stage identified about 17,000 sites that had minimum physical potential for hydroelectric power development. Additional data were collected on these sites, and they were screened for economic feasibility in Stage 2. About 8,000 sites remained after Stage 2. Stage 3 analyzed sites for economic feasibility and environmental compatibility. The Stage 3 screening included not only computer routines but also Federal, state, and local input received at public meetings regarding environmental compatibility. Nearly 2,000 sites survived Stage 3. In Stage 4 the remaining sites were separated according to near term (to 1990) and long term (2000 and beyond) potential. These sites, identified as the best available candidates for future feasibility studies, are presented by region in the NHS regional assessments, Volumes XIV through XXIII. Table 3 presents a summary of those sites by region.

The NHS conducted a special study of the efficiency of existing hydroelectric power projects (NHS Volume IX). The study examined 1,288 individual plants, totaling about 3,000 individual generating units with installed capacities totaling 63,375 MW and generating an average of 272,552 GWh of electrical energy per year. The study found that the energy output from these plants could be increased by a maximum of 11 percent with virtually all of the increase due to capturing spill. This potential for more energy from existing plants has been accounted for in the NHS resource assessment.

TABLE 3

NUMBER OF PROJECTS REMAINING AFTER STAGE 4 EVALUATION
AS RECORDED IN REGIONAL REPORTS 1/

REGION	EXISTING			UNDEVELOPED			TOTAL		
	No.	Capacity (MW)	Energy (GWh)	No.	Capacity (MW)	Energy (GWh)	No.	Capacity (MW)	Energy (GWh)
ECAR	178	2,900	10,620	16	1,540	2,540	194	4,440	13,160
ERCOT	19	137	292	33	466	950	52	603	1,242
MAAC	46	465	1,024	1	424	521	47	889	1,545
MAIN 2/	58	1,244	3,483	0	0	0	58	1,244	3,483
MARCA	46	1,022	1,573	2	24	81	48	1,046	1,654
NPCC	553	2,432	8,367	102	2,394	8,336	655	4,826	16,703
SERC	100	1,513	2,416	83	5,234	11,103	183	6,747	13,519
SWPP	62	1,027	3,602	40	1,217	3,747	102	2,244	7,349
WSCC	315	8,730	16,416	204	11,682	33,392	519	20,412	49,808
Alaska	10	17	162	49	3,510	15,380	59	3,527	15,542
Hawaii	7	9	28	7	29	84	14	38	112
Puerto Rico	13	35	109	4	24	71	17	59	180
TOTAL	1,407	19,531	48,092	541	26,544	76,205	1,948	46,075	124,297

1/ Excludes mutually exclusive alternative projects.

2/ Data on the number of projects and capacity and energy potentials in the MAIN reliability council are estimates based on data in the current data base because these data were not included in the regional report.

NATIONAL HYDROELECTRIC POWER DEVELOPMENT PLAN

The NHS plan divides the best candidate sites for future studies into four categories defined by ownership. Sites in each category are described in terms of capacity, energy, and geographic distribution.

CATEGORIES OF SITES BY OWNERSHIP

Table 4 displays the NHS best candidate sites included in the national hydroelectric power development plan. The sites are separated into four categories: Corps of Engineers dams with existing hydroelectric power facilities, Corps of Engineers dams without existing hydroelectric power facilities, all non-Corps dams either with or without existing hydroelectric power facilities, and undeveloped sites. All sites contained in the table have the potential for additional hydroelectric power facilities. These sites are the same ones summarized in Table 3 and described in the NHS regional reports. For more detailed information on any individual site, consult the regional reports.

The first category includes all Corps dams with existing hydroelectric power facilities where there is a potential for additional hydroelectric power. There are 30 sites in this category with a potential capacity increase of 2204 MW and average annual energy generation of 4027 GWh. The capacity and energy figures are in addition to that already being produced at these sites. The second category includes all Corps dams without existing hydroelectric power facilities but with feasible hydroelectric power potential. These dams were built for purposes other than hydroelectric power but were identified during the NHS as best candidates for future hydroelectric power studies. There are 249 Corps dams in this category with a potential capacity of 4296 MW and average annual energy production of 15,106 GWh. The third category contains all non-Corps dams either with or without existing hydroelectric power facilities. This category contains sites operated by other Federal agencies as well as non-Federal developers. There are 1128 non-Corps dams in this category with a potential capacity of 13,031 MW and average annual energy potential of 28,959 GWh. The fourth and final category includes all

	Corps Dams with Hydroelectric Power			Corps Dams without Hydroelectric Power			All Non-Corps Dams with Additional Power Potential			Undeveloped Sites			Total		
	Number	Capacity (MW)	Energy (GWh)	Number (GWh)	Capacity (MW)	Energy (GWh)	Number (GWh)	Capacity (MW)	Energy (GWh)	Number (GWh)	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)
ECAR	2	23	76	107	1960	7538	69	917	3006	16	1540	2540	194	4440	13160
ERCOT	0	0	0	9	37	75	10	100	217	33	466	950	52	603	1242
MAAC	0	0	0	12	84	275	34	381	749	1	424	521	47	889	1545
MAIN	10	129	560	20	500	2442	28	615	481	0	0	0	58	1244	3483
MARCA	4	575	-20	6	110	328	36	337	1265	2	24	81	48	1046	1654
NPCC	0	0	0	15	15	74	538	2417	8293	102	2394	8336	655	4826	16703
SERC	2	84	187	18	223	722	80	1206	1507	83	5234	11103	183	6747	13519
SWPP	4	117	161	40	572	2278	18	338	1163	40	1217	3747	102	2244	7349
WSCC	8	1276	3063	22	795	1374	285	6659	11979	204	11682	33392	519	20412	49808
Alaska	0	0	0	0	0	0	10	17	162	49	3510	15380	59	3527	15542
Hawaii	0	0	0	0	0	0	7	9	28	7	29	84	14	38	112
Puerto Rico	0	0	0	0	0	0	13	35	109	4	24	71	17	59	180
Total	30	2204	4027	249	4296	15106	1128	13031	28959	541	26544	76205	1948	46075	124297

Table 4 Summary of NHS Best Candidate Sites Categorized by Ownership

undeveloped sites identified in the NHS regional reports as best candidate sites. No dam or other structure exists at these sites; thus; a new dam would be required to capture the hydroelectric power potential. There are 541 sites in this category with a potential capacity of 26,544 MW and average annual energy potential of 76,205 GWh. In all four categories, there are a total of 1948 sites with an aggregate capacity of 46,075 MW and average annual energy potential of 124,297 GWh.

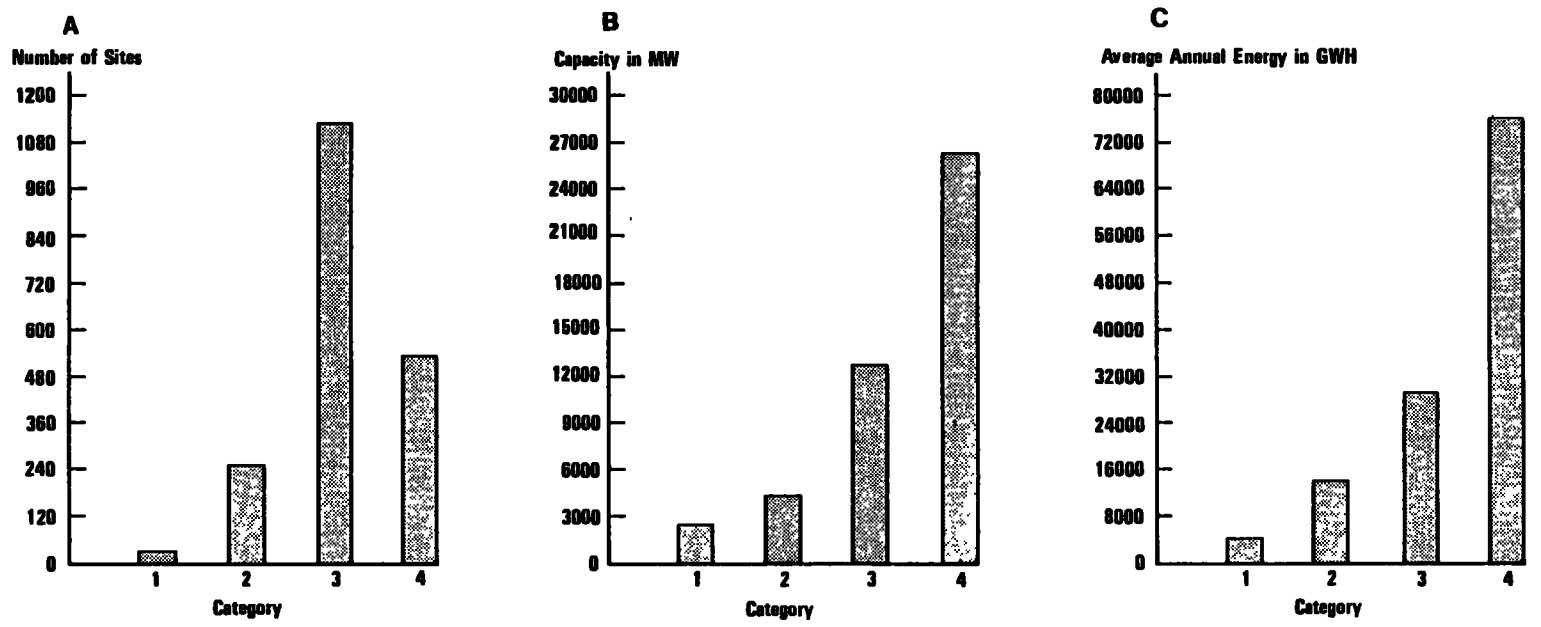
As shown in Figure 3, the majority of potential sites is at non-Corps existing dams. However, most of the additional capacity and energy is at undeveloped sites. Corps dams, although relatively few in number, account for about one-third of the additional potential capacity and energy available at all existing dams.

DISCUSSION OF SITES BY CATEGORY

Corps Dams with Existing Hydroelectric Power Facilities

Figure 4 depicts the distribution of existing Corps hydroelectric power dams that have additional potential for capacity and/or energy. Only six of the NERC regions contain sites in this category with over one-half of the sites in the WSCC, MAIN, and SWPP regions. Alaska, Hawaii, and Puerto Rico have no existing Corps hydroelectric power projects. WSCC contains over one-half of the additional capacity and energy to be gained at these sites.

The primary means of increasing the capacity and energy output at the 30 Corps dams in this category are to add new generating units, rehabilitate or replace existing units, modify water handling facilities, and alter existing operating policies (reallocation of existing storage and/or change of annual and seasonal operating schedules). Most of the additional capacity and energy to be gained at these sites would be gained by adding new generating units to capture excess flow or spill. Small amounts of capacity and energy would be gained by increasing the efficiency of converting fluid energy to electricity through uprating turbines and generators. Additional study of each site is



CATEGORY 1 = Existing Corps Hydroelectric Power Dams with Additional Capacity Available.

CATEGORY 2 = Existing Corps Dams with Hydroelectric Power Potential.

CATEGORY 3 = Existing Non-Corps Dams with New or Additional Hydroelectric Power Potential.

CATEGORY 4 = Undeveloped Sites which have Feasible Hydroelectric Power Potential.

Figure 3 - NHS Best Candidate Sites Categorized by Ownership

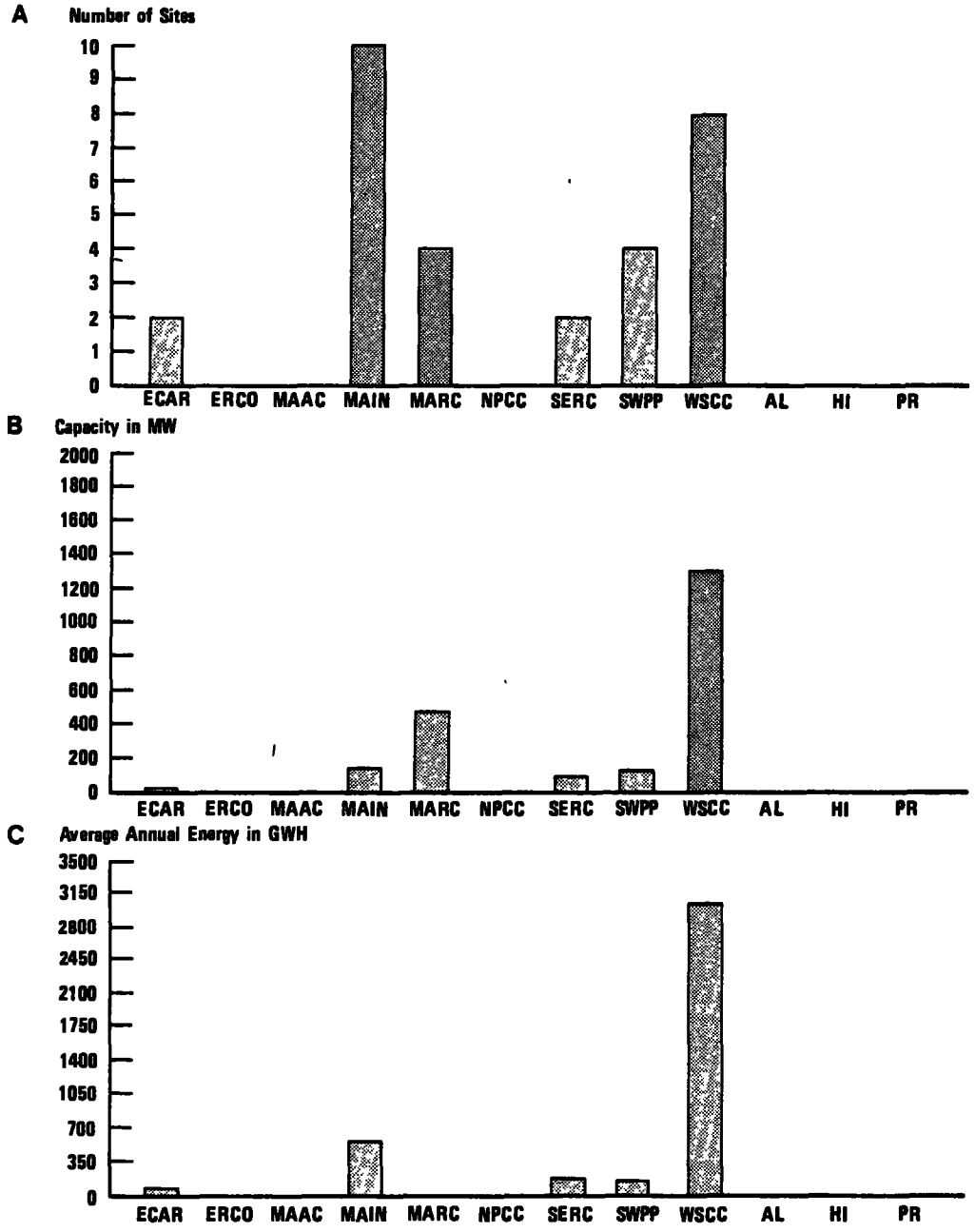


Figure 4 : Corps Existing Hydroelectric Power Sites with Additional Potential by NERC Region.

needed to determine which means of increasing capacity and/or energy is warranted. Particular attention must be given to the existing purposes of a dam in addition to providing hydroelectric power. The economic, social, and environmental impacts of any proposed changes in operation must also be evaluated.

The addition of power at these Corps sites could be accomplished by non-Federal developers under a FERC license as well as by the Corps. However, it may be more practical for the Corps to develop this potential because of the efficiency of administration and operation of the facilities under one rather than two distinct entities.

Corps Dams Without Existing Hydroelectric Power Facilities

The potential sites in this category, existing Corps dams that were built for purposes other than hydroelectric power, are highly attractive candidates for near-term development. Many of these sites had penstocks built into the dams and other provisions that anticipated eventual hydroelectric power development. All of the dams are in good physical condition and streamflow data are available for accurate power analyses.

The distribution of these sites is shown in Figure 5. Just over 40 percent are in the ECAR region. Most of these sites are lock and dam structures built for navigation on the Ohio River and its tributaries. Many of these sites, if developed, would operate as run-of-river hydroelectric power projects. The sites in the ECAR region would supply almost one-half of the total additional capacity and energy to be gained from all sites in this category.

Although the total capacity available from sites in this category is only about 95 percent higher than the previous category (2204 MW vs 4296 MW), the amount of energy to be gained is nearly four times as much (4027 GWh vs 15,106 GWh). The addition of capacity at existing hydroelectric power projects is usually attained by routing more streamflow through the turbines in a shorter time period. There are diminished returns of energy by gaining this additional increment of capacity. New facilities, especially run-of-river projects, can

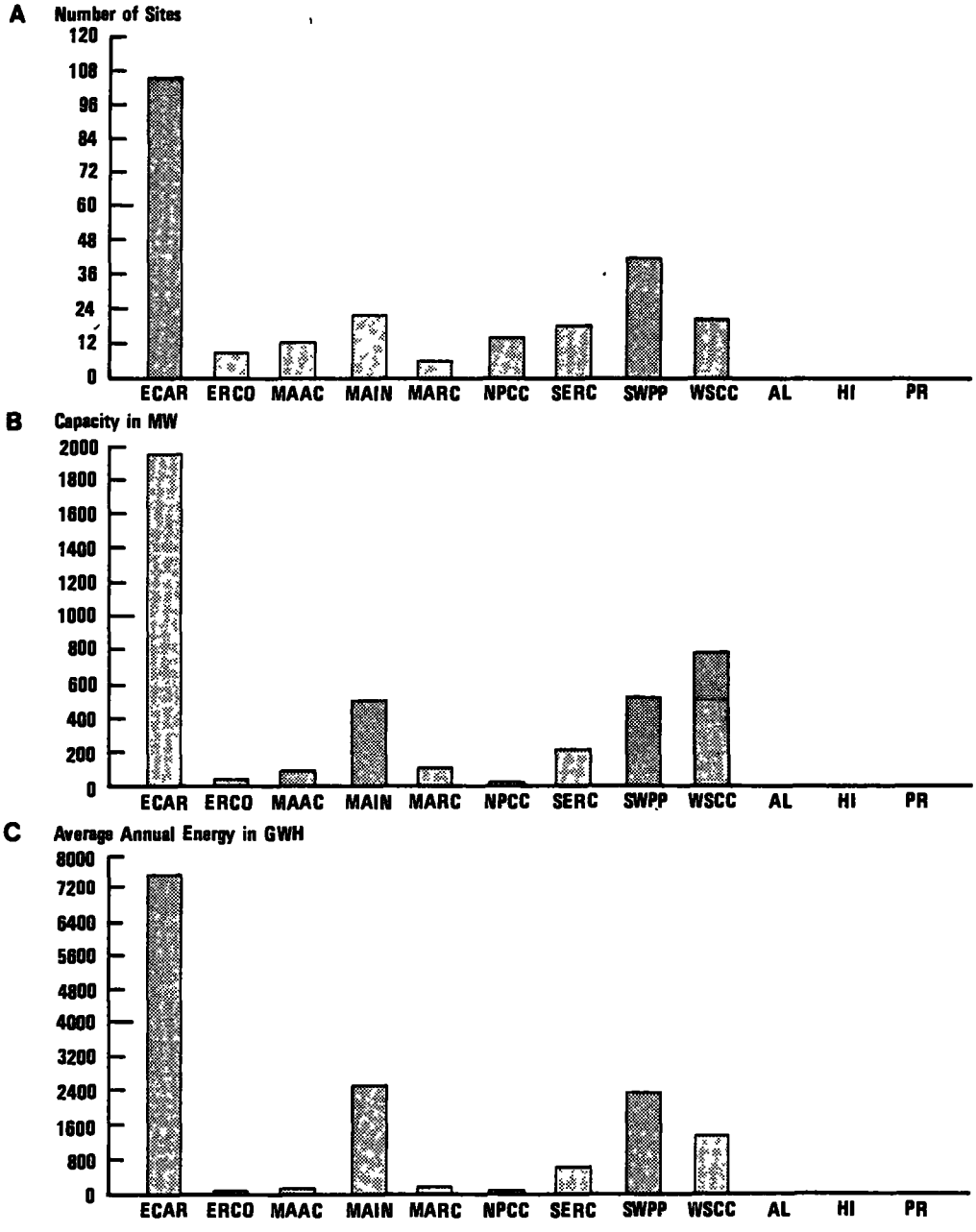


Figure 5: Corps Existing Dams with Hydroelectric Power Potential by NERC Region

capture more energy because they operate continuously. For two sites of the same capacity, more energy is gained by operating for longer periods each day.

To capture the hydroelectric power potential at these Corps dams, it will be necessary to equip the dams with water conveyance facilities, turbines, and generators. As noted above, provisions for the eventual addition of hydroelectric power have been made at many of the Corps dams, making them particularly attractive for development. The addition of power facilities at Corps dams must take into account the existing project purposes. Dams constructed for such purposes as navigation and/or flood control must preserve authorized project purposes with the addition of hydroelectric power facilities. In addition, the Corps must insure the structural integrity of the dam. Feasibility studies must take these factors into account.

There is no procedure to predetermine whether these sites should be developed by Federal or non-Federal developers. Congress authorizes the Corps to study a potential site, and, if Federal construction is determined to be in the public interest, a construction authority is given to the Corps by Congress. Non-Federal developers must comply with Corps guidelines and FERC rules to obtain a license to construct any project. The issue of Federal vs non-Federal development at Corps dams is discussed in the subsequent section on legal/institutional issues affecting development.

Non-Corps Dams With Hydroelectric Power Potential

This category contains existing dam sites that may or may not have existing hydroelectric power facilities. This includes dams operated by the Bureau of Reclamation, Tennessee Valley Authority, and other Federal agencies, as well as states, municipalities, and individuals. All sites in this category have the potential for new or additional capacity and/or energy.

Figure 6 shows the distribution of these sites. Most of the sites in this category are in the NPCC and and WSCC regions. The NPCC region contains almost one-half of the sites. However, most of those sites are small dams and are

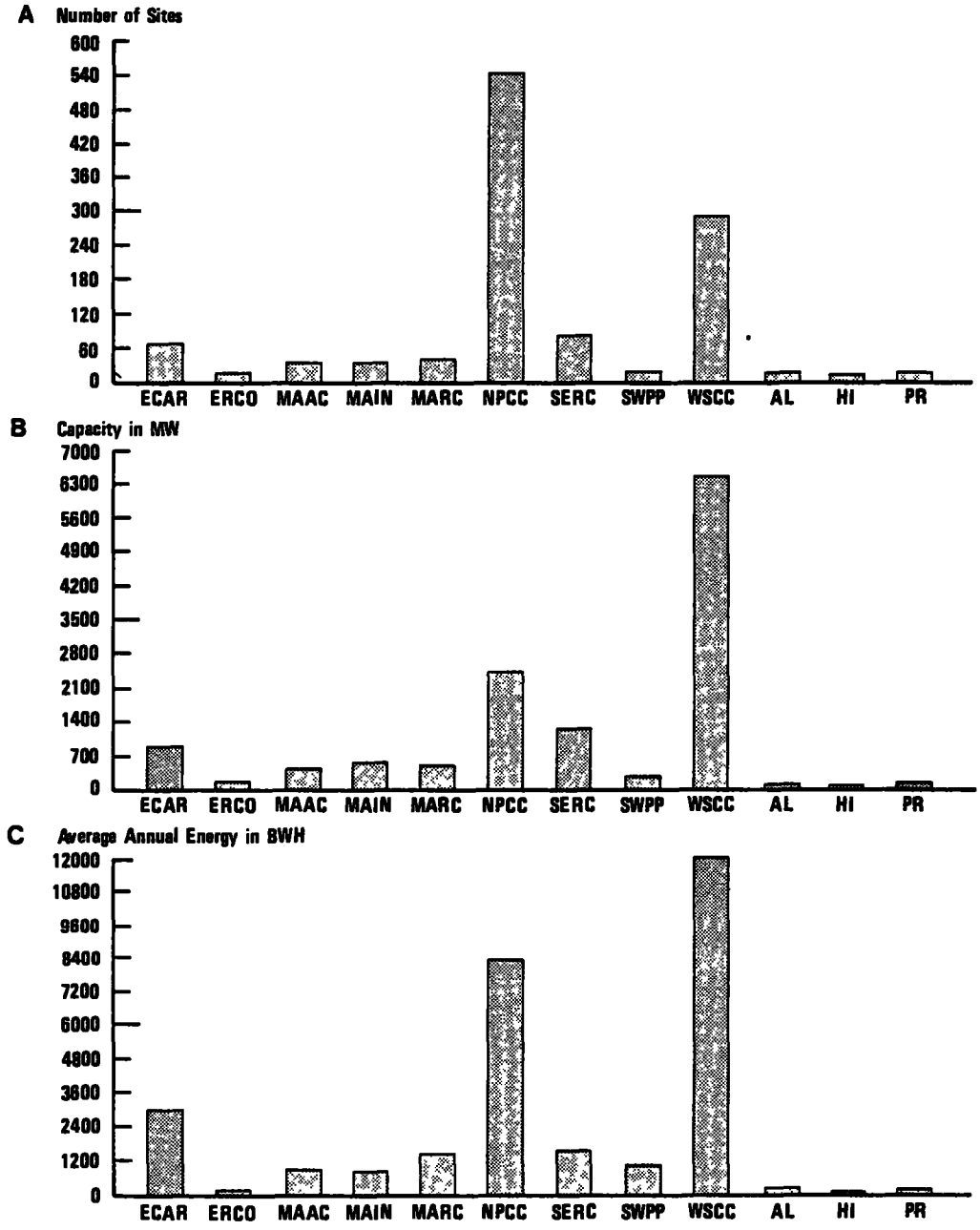


Figure 6 : Non-Corps Dams with Additional Hydroelectric Power Potential

generally classified as small-scale hydroelectric power sites (less than 15 MW). On the other hand, the potential sites in the WSCC region include some larger sites that have been built to store water. The capacity and energy to be gained from the sites in the WSCC region are greater than in the NPCC region for that reason. Together these two regions account for slightly above two-thirds of the total capacity in this category. All of the sites in this category will be developed by other Federal agencies and/or non-Federal developers.

Undeveloped Sites

The final category contains the largest amount of additional capacity and energy although it contains less than 25 percent of the total sites. These sites are different from those in the previous categories in that to capture the potential at undeveloped sites, a new dam must be built.

Figure 7 shows the distribution of potential undeveloped sites. By far the largest potential for new site hydroelectric power projects is in the WSCC. This region possesses the topography and the abundant streamflows necessary for large projects. Alaska has immense physical potential for hydroelectric power, but note that only 49 sites were deemed suitable for further evaluation by the NHS. A combination of low projected electric demand and the availability of other energy sources makes many new hydroelectric power dams unnecessary in Alaska. A large number of potential sites are also within the NPCC and SERC regions.

These sites will most likely be built as multiple-purpose sites that accommodate other project purposes besides hydroelectric power. Multiple-purpose development is necessary for full utilization of water resources. The primary developers of large, multiple-purpose dams have historically been the Federal government and the states. This is likely to continue, with states

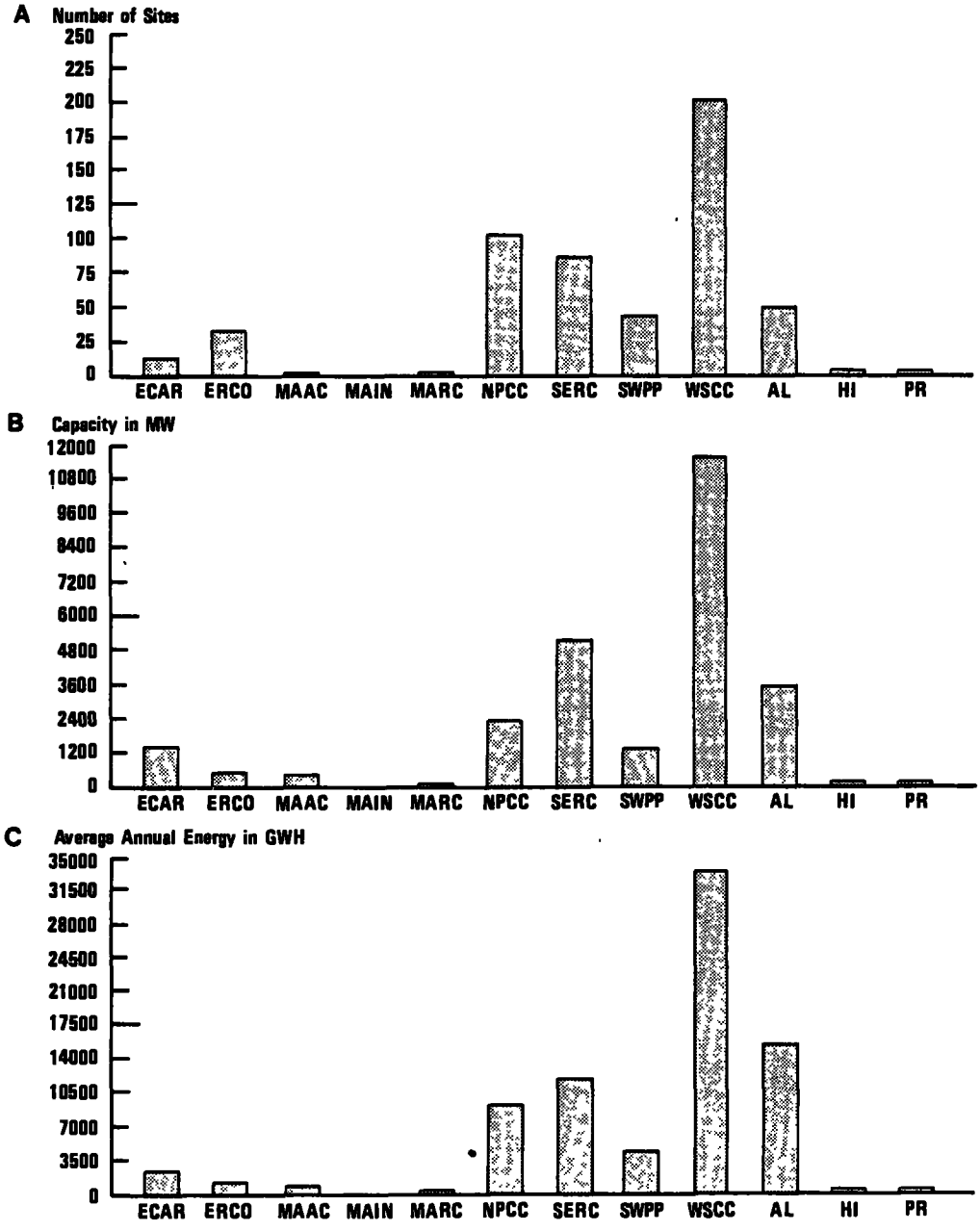


Figure 7 : Best Candidate Undeveloped Sites with Hydroelectric Power Potential by NERC Region

beginning to increase their share of development. The Federal government is pursuing new cost-sharing and financing arrangements which will shift project cost from the Federal government to non-Federal project sponsors.

ISSUES AFFECTING HYDROELECTRIC POWER DEVELOPMENT

Table 5 lists the significant issues affecting hydroelectric power development. These issues are discussed at length in the National Report (Volume II) and several of the supporting volumes of the NHS final report. A brief summary of the issues is included here.

PLANNING ISSUES

Recent post oil embargo forecasts of future electric power demands vary widely, reflecting a high degree of uncertainty. The revolution in oil prices, the availability of fuels, and emerging concern about the long-term environmental effects of all types of electric generation are examples of recent changes that increase uncertainty about the future growth of electric energy production.

The construction of individual small hydroelectric power projects--even dozens of them in a single power supply area--will not be materially affected by any difference between forecasted and realized demands, but larger projects could be. In the latter case, a substantial portion of the economic rationale for hydroelectric projects is often based upon the need for additional peaking capacity, and if that need does not materialize, the justification could be somewhat tainted.

LEGAL/INSTITUTIONAL ISSUES

The major legal/institutional issues arise from the choice of whether Federal agencies or non-Federal groups develop hydroelectric power sites, the current hydroelectric power regulating system, and Indian rights.

The potential for conflict over who develops hydroelectric power is an issue at existing Federal dams and undeveloped sites. There is no procedure to

TABLE 5

ISSUES AFFECTING THE DEVELOPMENT OF HYDROELECTRIC POWER

PLANNING ISSUES

- Electric power demand uncertainty

LEGAL/INSTITUTIONAL ISSUES

- Choice of developers
- Regulatory system
- Indian rights

ECONOMIC ISSUES

- Federal evaluation procedures
- Cost of capital
- Marketing

ENVIRONMENTAL ISSUES

- Hydroelectric power
- Alternative source impacts

RESOURCE ISSUES

- Competing water use
- Competing land use

predetermine whether a site should be developed by a Federal agency or a non-Federal developer. This situation has led to confusion for non-Federal developers interested in developing Federal dams. Often, concurrent study efforts on the same project have been conducted by both Federal agencies and potential non-Federal developers. Present Corps policy has eliminated some of the confusion. The Corps encourages non-Federal developers to pursue development at existing Corps dams as long as they meet general requirements such as preserving existing authorized project purposes and incurring the structural integrity of the dam. It is likely that additions of hydroelectric power at Federal dams will be accomplished by a mixture of Federal and non-Federal developers.

Development of undeveloped sites will likely be accomplished by Federal and state agencies. Some single-purpose sites may be developed by other non-Federal developers, but the bulk of new dams will likely be built for multiple water purposes. Federal and state agencies have traditionally built multiple-purpose projects and are in a better position to manage the multiple-purpose aspects, especially non-vendible outputs such as flood control benefits.

The regulatory system is cumbersome for both Federal and non-Federal developers. One way to resolve this issue is to continue to reduce the procedural requirements of regulation, but retain substantive portions, especially where environmental regulations are concerned. The FERC has made substantial progress in reforming its procedures regulating non-Federal hydroelectric power development. The reform of Federal construction regulations and procedures would expedite Federal development.

Indian rights will be an issue in development primarily in the Pacific northwest. These rights include reserved development rights, reserved fishing rights, and reserved water rights. Hydroelectric development will be constrained in the Pacific northwest unless these rights are accounted for in plans for development.

ECONOMIC ISSUES

The major economic issues relate to Federal evaluation procedures, financing, and marketing of hydroelectric power.

The Water Resource Council's Principles and Standards and Procedures have been replaced by new Principles and Guidelines, under the direction of the Cabinet Council on Natural Resources and the Environment. The Principles and Guidelines are more flexible for hydroelectric power planning and evaluation. Two major problems addressed in the guidelines are methods for determining the value of hydroelectric power and the price escalation of fuels.

The best method to determine the economic value of hydroelectric power is to perform system studies to examine the economic costs of hydroelectric power on a with and without basis. System costs are calculated with the addition of a hydroelectric power plant and then with the most likely alternative to that plant. The difference in cost to the utility system is the value of the hydroelectric power plant. This method will result in more realistic value estimates of potential hydroelectric power projects.

The cost of fuels for alternative sources of power has at times increased faster than general inflation. Therefore, the real increases in the cost of fuels should be accounted for in the evaluation of hydroelectric power.

Financing of hydroelectric power is more difficult during periods of high interest rates because of high initial investment costs. A major concern is to determine if assistance levels are adequate to motivate non-Federal developers. Current tax incentives have created strong support for hydroelectric power in the private sector. If the current incentives are removed, interest will likely drop off, although the magnitude of this impact is uncertain. Federal water resource agencies, including the Corps, would need substantial new funding to develop additional Federal hydroelectric power projects.

The main marketing issue is the price of hydroelectric power. Federal hydroelectric power is priced at the lowest price consistent with sound business practices as established by the 1944 flood control Act. The price is set to repay Federal costs; however, there is some question as to whether all costs are recovered. Federally produced hydroelectric power may be underpriced given current market conditions.

Non-Federal developers need to market their hydroelectric power within the existing electric utility system. The Public Utility Regulatory Policies Act (PURPA) established access to transmission lines and purchasing requirements for power produced by non-Federal developers. PURPA is currently under litigation. If PURPA is revoked, small hydroelectric power producers will have to rely on state public utility commissions to set adequate rates. If power purchase rates are inadequate to offset development costs, interest in small scale hydroelectric power development will wane.

ENVIRONMENTAL ISSUES

Hydroelectric power development can have adverse environmental effects. At the same time, hydroelectric power projects avoid many of the potential adverse health and economic system effects that result from burning fossil and nuclear fuels to produce electricity. Thus, the major issue is whether the environmental impacts of hydroelectric power development can be economically mitigated, managed, or avoided. At most potential sites, good design and operation practices along with mitigation measures can offset these impacts.

Different types of hydroelectric power projects have more or less severe environmental impacts. Generally, those sites at existing dams, especially run-of-river projects, have relatively minor environmental impacts; those sites that require new dams, especially storage projects, have greater adverse impacts.

A comprehensive environmental evaluation must consider the relative environmental impacts of hydroelectric power versus other energy sources. The

substitution of hydroelectric power for nuclear power or coal will result in a trade-off among non-comparable effects. While hydroelectric power will impact riverine systems, nuclear or coal power plants emit residuals into the air or water. Some mechanism should be formulated to compare the environmental effects of different energy resources. The NHS environmental assessment describes hydroelectric power technology in terms of its environmental impacts, discusses the generic impacts of hydroelectric power projects, and assesses the potential regional impact of developing the sites selected as best candidates in the NHS.

RESOURCE ISSUES

These issues are related to the competition among alternative uses of water and land.

The development of additional hydroelectric power, although it is a nonconsumptive use, may conflict with other uses of water. Both instream flow requirements and withdrawals of water can affect the operation of hydroelectric power plants. Often, hydroelectric power operations can be conducted without conflict. When there is a potential conflict, the resolution will depend on the allocation of water rights and the transfer of these rights based on the value of water in alternative uses.

In a similar vein, there may be conflict over the use of land for hydroelectric power storage. Decisions will no doubt be based on the value of the land, in alternative uses. However, another factor, when natural lands are involved, is the value society places on preserving these lands.

FUTURE ACTION

The NHS screening process was designed to seleot the best candidate sites for possible development from many thousands of existing dams and undeveloped sites. While appropriate for this level of analysis, a more detailed feasibility study of each site will be required before a determination can be made to oonstruct any hydroelectric power facility. All sites selected as best oandidates for future development by the NHS will have to undergo feasibility studies. The information provided on eaoh site in the NHS regional reports can serve as a starting point for these studies.

The NHS has developed preliminary information about the physical potential, the economic feasibility, and the environmental aooeptability of the NHS best oandidate sites for hydroelectric power development. The emphasis on the feasibility studies to follow should verify the preliminary NHS information and develop detailed physical, economic, and environmental data on a site to support a decision about adding hydroelectric power facilities to an existing dam or building a new dam with hydroelectric power, as the case warrants. When completed, the feasibility study should leave no doubt as to the advisability of developing power at a site.

The construction of a hydroelectric power facility at an existing dam can affect other water resources purposes of the dam and, at times, can affect the operation of other water projects in the basin. Also, the installation of a hydroelectric power facility can affect the quality and quantity of water in the river and can alter natural features in the river basin. It is important to account for these possible effects during the initial planning of projects so that modifications can be made to accommodate all water and related land resource users. Any significant increase in the number of hydroelectric power projects being constructed may bring about unintended system impacts. At undeveloped sites, it is also important to consider other possible purposes for the proposed new dam. There may be opportunities to meet other water needs through the construction of a multiple-purpose project. Thus, any large program designed to develop this nation's hydroelectric power resources should

contain comprehensive river basin assessments that evaluate opportunities for the development of other water resource projects as well as hydroelectric power.

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