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BY THE COMPTROLLER GENERAL

# Report To The Congress

OF THE UNITED STATES

## Hydropower -- An Energy Source Whose Time Has Come Again

Recent price increases in imported oil demonstrate the urgency for the U.S. to rapidly develop its renewable resources. One such renewable resource for which technology is available now is hydropower.

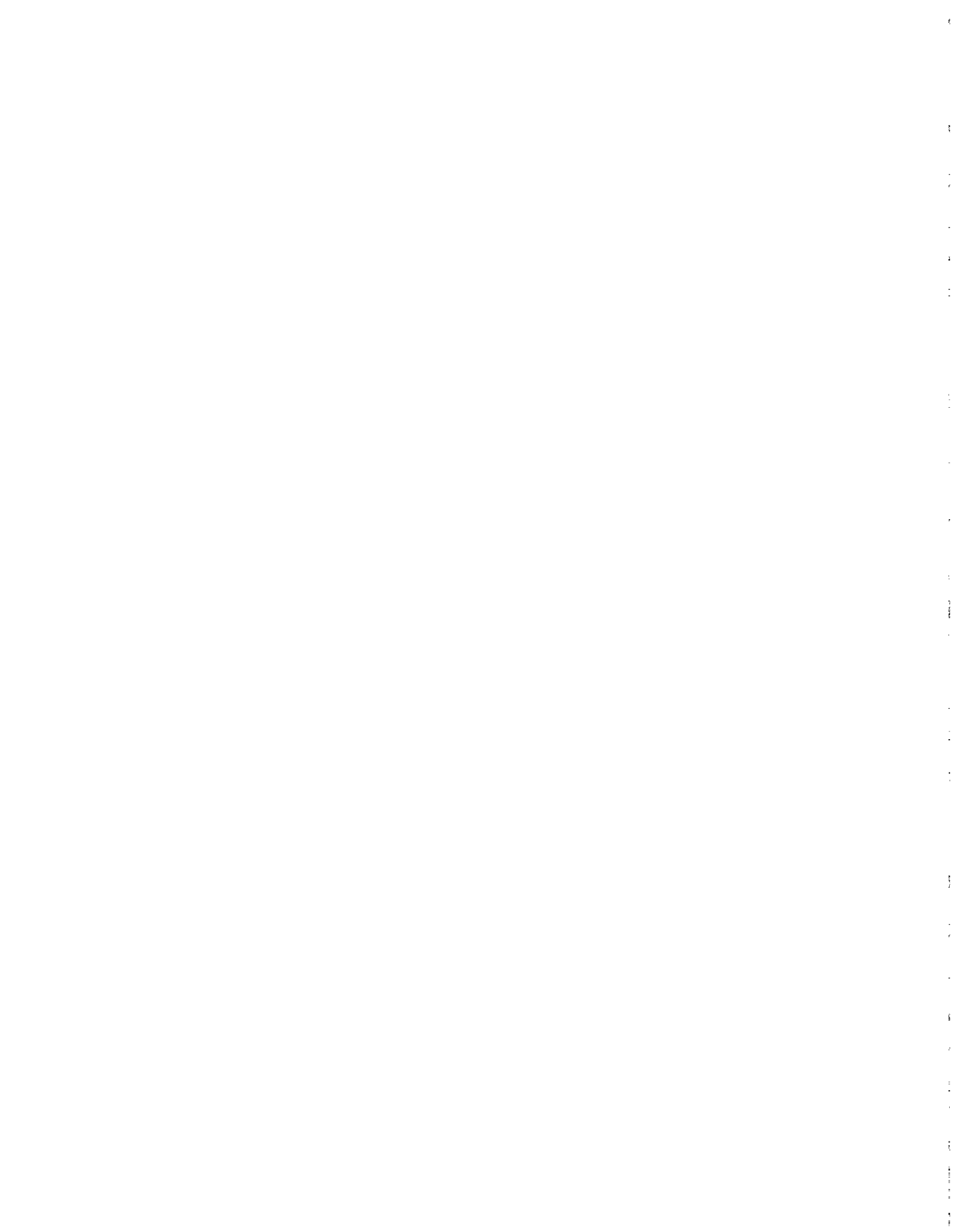
Studies indicate that hydropower potential, particularly at existing dam sites, can save the country hundreds of thousands of barrels of oil per day. But problems and constraints--economic, environmental, institutional, and operational--limit its full potential.

Federal programs have had little impact on helping to bring hydro projects on line. Specifically, the Department of Energy's Small Hydro Program could do more to overcome hydro constraints and problems through an effective outreach program and more emphasis on demonstration projects.



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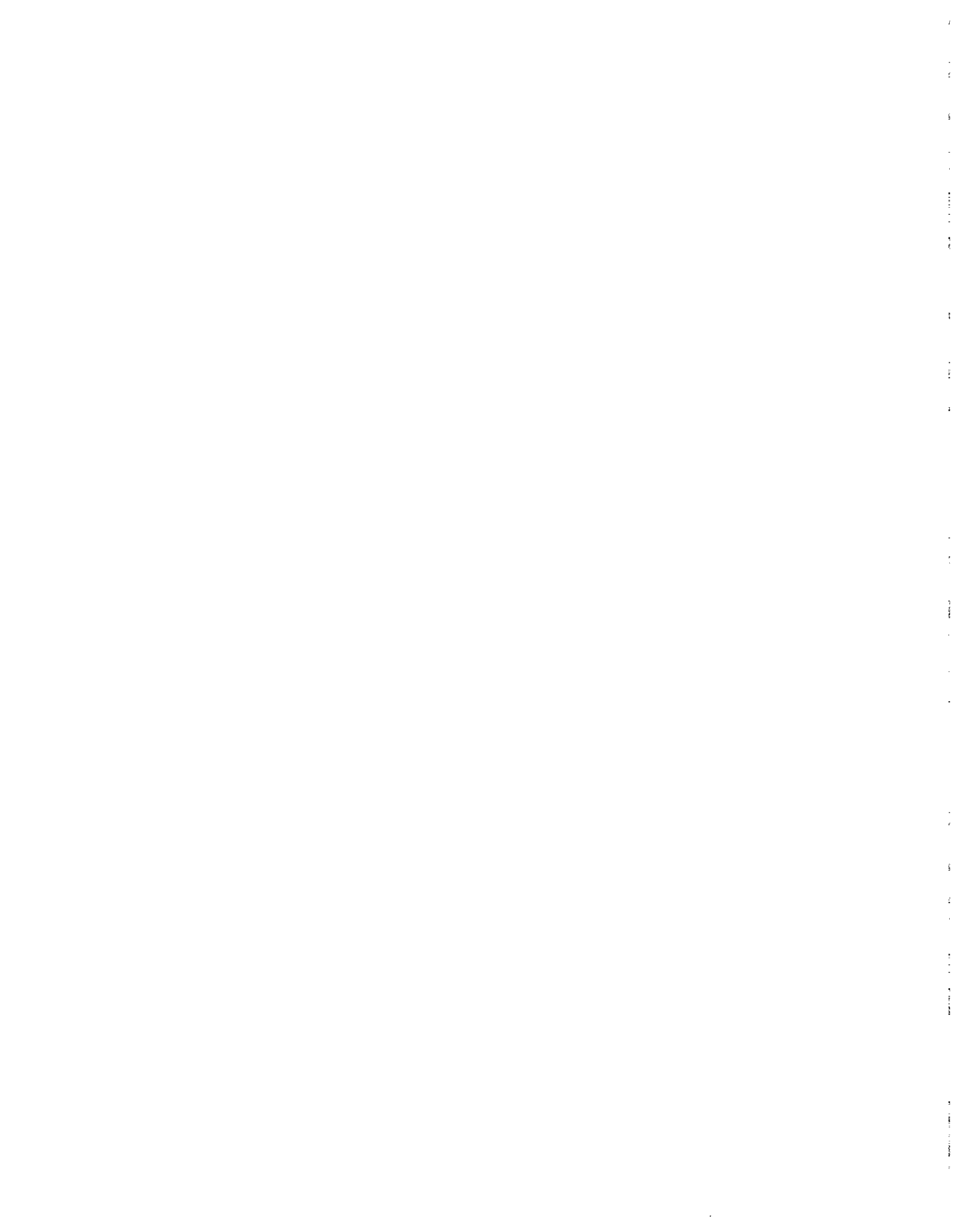
To the President of the Senate and the  
Speaker of the House of Representatives

This report analyzes the country's remaining hydro-  
power potential and what constraints stand in the way of  
its development. In addition, it considers various actions  
the Federal Government can take to spur the development of  
this renewable resource.

We are sending copies of this report to the Secretaries  
of the Interior, Energy, Army and Defense; Chairmen, Federal  
Energy Regulatory Commission and Tennessee Valley Authority;  
Directors, Office of Management and Budget and U.S. Water  
Resources Council; and the House and Senate committees and  
subcommittees having oversight responsibilities for the  
matters discussed in the report.

A handwritten signature in black ink, reading "James A. Stacks".

Comptroller General  
of the United States



D I G E S T

Recent price increases in imported oil demonstrate the urgency for the U.S. to rapidly develop its renewable resources. One such resource for which technology is available now is hydropower. The U.S. has additional hydropower potential, which if developed, could help reduce our dependence on imported oil.

The best prospects for additional development are at existing hydro sites--including many small ones--where dam structures are already built and where environmental impacts are few. But many constraints and problems must be overcome before hydro's optimal potential can be realized by Federal and non-Federal developers.

Despite the administration's stated interest in small-hydro development, its actions have not matched its talk. Small hydro was specifically cited in both energy messages by the President, included as part of the National Energy Act (P.L. 95-617), and designated by the Department of Energy as one of the eight areas to "key in on" for commercialization. But if the Congress had not taken the initiative in appropriating funds, there would have been no small-hydro program in fiscal year 1978, the first year of the program.

Since then, the program has moved slowly. More than 2 years passed before any demonstration grants were awarded, although demonstrations were needed to measure constraints and show hydro viability. Also, lack of staff and clear direction of the program resulted in little assistance being provided to potential hydro developers. Most potential developers need assistance, for they are not experienced in hydro development or in the bureaucratic processes involved. Thus, aggressive outreach could give important impetus to the program.

*ACC 00 9/12*

Year Sheet. Upon removal, the report cover date should be noted hereon.

The Department of Energy's failure to aggressively foster demonstrations and provide guidance will result, GAO believes, in the program falling short of its 1985 goal of 1,000 megawatts of capacity. More recent actions which could have a negative impact on attaining these goals are the administration's contradictory efforts in trying to clearly define how it plans to foster small-hydro development.

Although the administration did not oppose the \$300 million construction loan program authorized by the National Energy Act, which was signed into law in November 1978, its fiscal year 1980 budget proposal did not request such funds because the Office of Management and Budget believes (1) small-hydro technology is already available and (2) small-hydro sites will be developed regardless of whether the loans are made. Economic and other constraints were not considered overriding restrictions. But recently, the administration announced its rural energy development initiative which redirects almost \$300 million for grants, loans, and loan guarantees to encourage small hydro development. Actions not to implement one incentive program because the administration believed it was unnecessary and then to provide money through non-energy agencies offer no clear understanding of the administration's policy on fostering hydro-power development. *ACCOUNT*

Positive efforts have been made by the Federal Energy Regulatory Commission through its streamlining of the licensing procedures for non-Federal dams. However, no similar actions are being taken to improve the approval process for adding power at existing Federal dams. In addition, the Water Resources Council's principles and standards for assessing Federal projects do not at the moment consider life cycle benefits and costs of such projects-- and thus fail to recognize the favorable economics of a renewable resource such as hydro when compared to nonrenewable supply sources. But recent proposed changes to the principles and standards could correct this *ACCOUNT*

situation. Additional factors which GAO believes either do or could hinder hydro's development include:

- Uncertainties caused by the Federal Energy Regulatory Commission's delays and indecisiveness in ruling on who has preference to dam sites--public or non public entities--when competing relicensing applications are submitted.
- Possible bottlenecks at the Commission in handling the increasing volume of applications for hydro licenses and permits.
- Inabilities of potential hydro developers to find a market for their power.
- Limiting the legal size of a small-hydro project to 15 MW.

#### RECOMMENDATIONS

GAO recommends the Secretary of Energy:

- Increase efforts to provide assistance, information, and guidance to prospective hydro developers through an outreach program--using regional staff, as appropriate.
- Expedite the Department's grant program for demonstration projects to provide the earliest possible assessment of constraints to and potential for small hydro development.
- Reassess the Department's goals for hydro development. (GAO believes the 1985 goal is worth striving for, but that it should be based on a realistic assessment of current programs.)

GAO recommends the Chairman, Federal Energy Regulatory Commission:

- Expediently rule on who has preference for competing relicensing applications. (An early decision could mean earlier capacity expansions at some sites).
- Closely monitor applications for hydro licenses and, if the volume continues to increase, request and assign additional staff so backlogs will not occur.

--Seek statutory authority in dealing with interconnections, similar to that in the Public Utility Regulatory Policies Act for TVA, to require that the Federal power marketing agencies and Rural Electric Cooperatives purchase the hydropower output when no other markets are available.

GAO recommends the Director, Office of Management and Budget, assess its position on the need for incentives to encourage small hydro development in light of its decisions not to fund one incentive program in the Department of Energy because it was not believed necessary and then to introduce a similar type incentive program in non-energy agencies.

GAO recommends the Director, Water Resources Council, adopt the provisions in the Water Resources Council's updated draft of its principles and standards as enclosed in the May 24, 1979 Federal Register. These changes would require Federal hydro benefit-cost studies be done on a life cycle costing basis, thus putting renewable resource projects such as hydro in proper economic perspective in relation to non-renewable resources. — REC 00620

REC 00305

GAO recommends the Secretaries of the Interior and the Army direct the Bureau of Reclamation and Corps of Engineers, respectively, to streamline their procedures for adding power at existing dams when such additions require no major structural changes and result in minimal environmental impact. — 40 000 78

GAO recommends the Congress amend the National Energy Act (P.L. 95-617) by redefining a small-hydro project as one that could have up to 100--rather than 15--megawatts of capacity, thereby including several good sites that now exceed the limitation set in the present law.

#### AGENCY COMMENTS

The Departments of the Interior, Energy, Defense, and the Army; Federal Energy Regulatory Commission; Tennessee Valley Authority; Water Resources Council; and the Office of Management and Budget



were given the opportunity to comment on a draft of this report. Comments received are included in appendixes III through IX. The report was revised in several sections to reflect technical comments. The overall thrust of the agency comments is discussed in chapter 6 along with GAO's response to them. In general, the agencies were in agreement with GAO's recommendations.



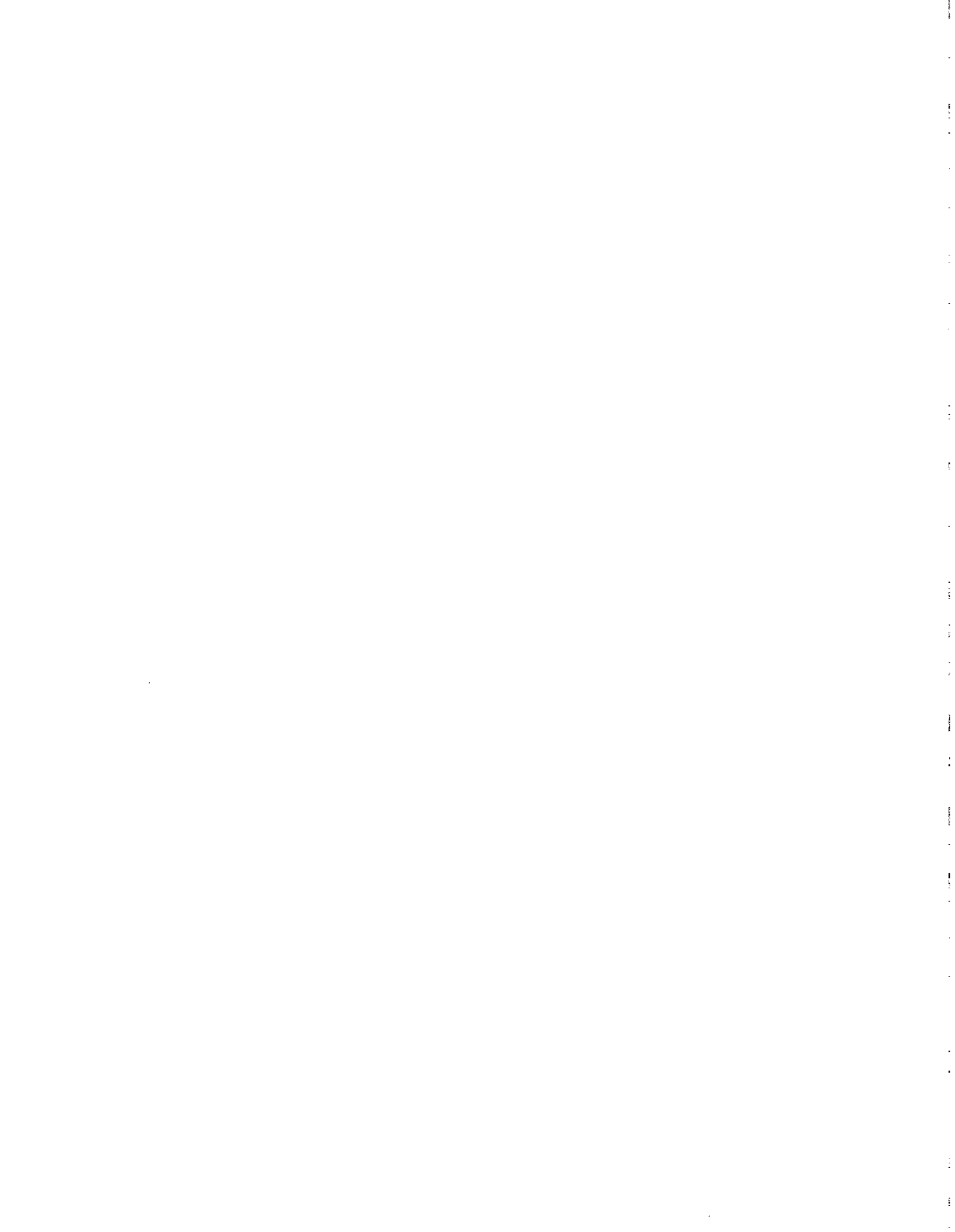
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## ABBREVIATIONS

BUREAU	Bureau of Reclamation
CORPS	U.S. Army Corps of Engineers
DOE	Department of Energy
ERDA	Energy Research and Development Administration
FERC	Federal Energy Regulatory Administration
GAO	General Accounting Office
kW	kilowatt
kWh	kilowatt-hours
MW	megawatts
OMB	Office of Management and Budget
TVA	Tennessee Valley Authority
WRC	Water Resources Council



## CHAPTER 1

### INTRODUCTION

Water power--how much is left? This question has the attention of Federal and non-Federal electricity planners. In past years hydropower has played an important role in meeting the electricity demand of this Nation and many feel it can play an important role in helping solve current energy problems. Recent studies indicate that hydropower potential exists which could save the country hundreds of thousands of barrels of oil per day. But problems and constraints--economic, environmental, institutional, and operational--limit its full potential.

Use of water to produce electricity is not new, but is receiving much interest as the country's attention turns to development of its renewable resources in the face of increased fossil fuel costs. The administration's National Energy Plan emphasized the development and use of renewable resources and specifically discussed the potential of small existing hydroelectric facilities. This interest was recognized in recent passage of the National Energy Act (P.L. 95-617) 1/ which provides monetary incentives for development of small existing hydroelectric facilities. But with this emphasis on renewable resources and the renewed attention on hydropower come further questions. Seeking to answer them, we undertook a review to

- identify and evaluate U.S. hydroelectric potential;
- determine the impacts hydro development could have on the displacement of oil and gas;
- identify and evaluate the constraints on hydro development and their impacts; and
- identify actions needed to obtain optimal hydro development.

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1/Public Laws 95-617 through 95-621 were enacted November 9, 1978, and are collectively referred to as the National Energy Act.

## SCOPE OF WORK

We discussed hydroelectric potential and constraints on its development with officials from the Departments of Energy (DOE) and the Interior, U.S. Army Corps of Engineers (Corps), Tennessee Valley Authority (TVA), Water Resources Council (WRC), and Environmental Protection Agency, and met with representatives of regional, State, and local agencies; institutions of higher education; utilities; hydro and engineering consulting firms; manufacturers of hydroelectric equipment; and environmental groups. We also met with representatives of the French Government. Our review considered the principles and strategies of the National Energy Act, as well as other applicable laws and regulations.



## CHAPTER 2

### BACKGROUND AND PERSPECTIVE

#### WHAT IS HYDRO?

Hydropower, in its simplest form, is the production of energy produced from water flowing through a turbine which spins a generator. Conventional hydroelectric systems use dams and waterways to harness the energy of falling water (See figure 2.1.) These include reservoirs or storage systems at dams and run-of-river type operations which cause minimal fluctuations of streamflows. Pumped storage systems (see figure 2.2) use the same principle of falling water for the generating phase, but all or part of the water is made available for repeated use by pumping it from a lower to an upper reservoir.

There are two major categories of pumped storage systems: those which produce energy only from water that has previously been pumped to an upper reservoir (known as pure pumped storage), and those which use both pumped water and natural runoff. Pumped storage systems generate electricity by releasing water from the upper to the lower reservoir during peaking periods and using off-peak base load 1/ energy for pumping water back into the upper reservoir. These systems are generally considered to be net consumers of energy since, for a pure pumped storage project, more energy is required for pumping than is produced by the plant when generating. Overall economics are favorable, however, because pumped storage systems often provide the most dependable power to meet peaking demands. They also improve the plant factor 2/ of the base load thermal units by pumping during off-peak hours, thus reducing cycling of these units which improves their efficiency and durability.

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1/Load is the amount of power needed to be used at a given point on an electric system. The total load of a utility system is generally made up of base load and peak load. Base load is the component of load which is more or less constant throughout a period of time. Peak load is the load during an interval when demand is the highest.

2/The ratio of the average load on the plant for the period of time considered to the aggregate rating of all the generating equipment in the plant.

**FIGURE 2.1**  
**CONVENTIONAL HYDROELECTRIC SYSTEM**

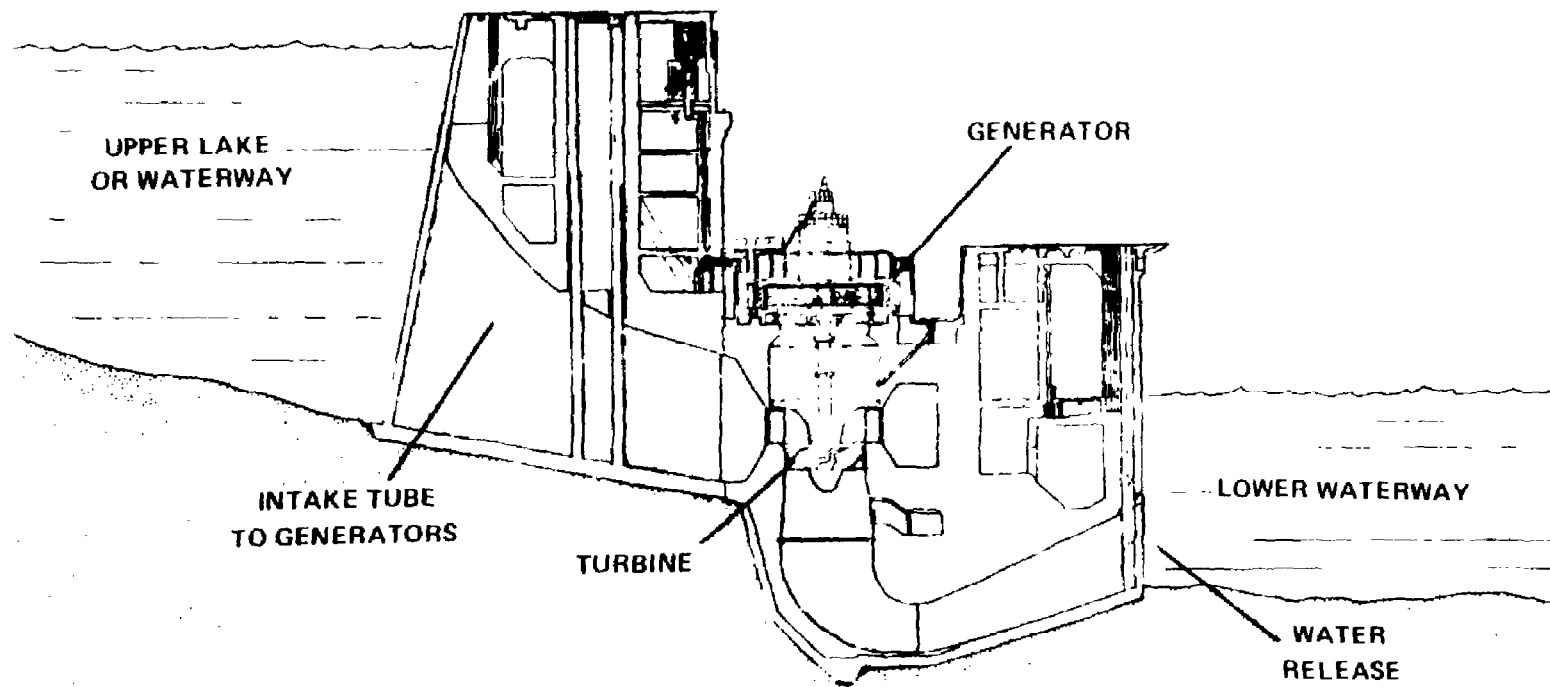
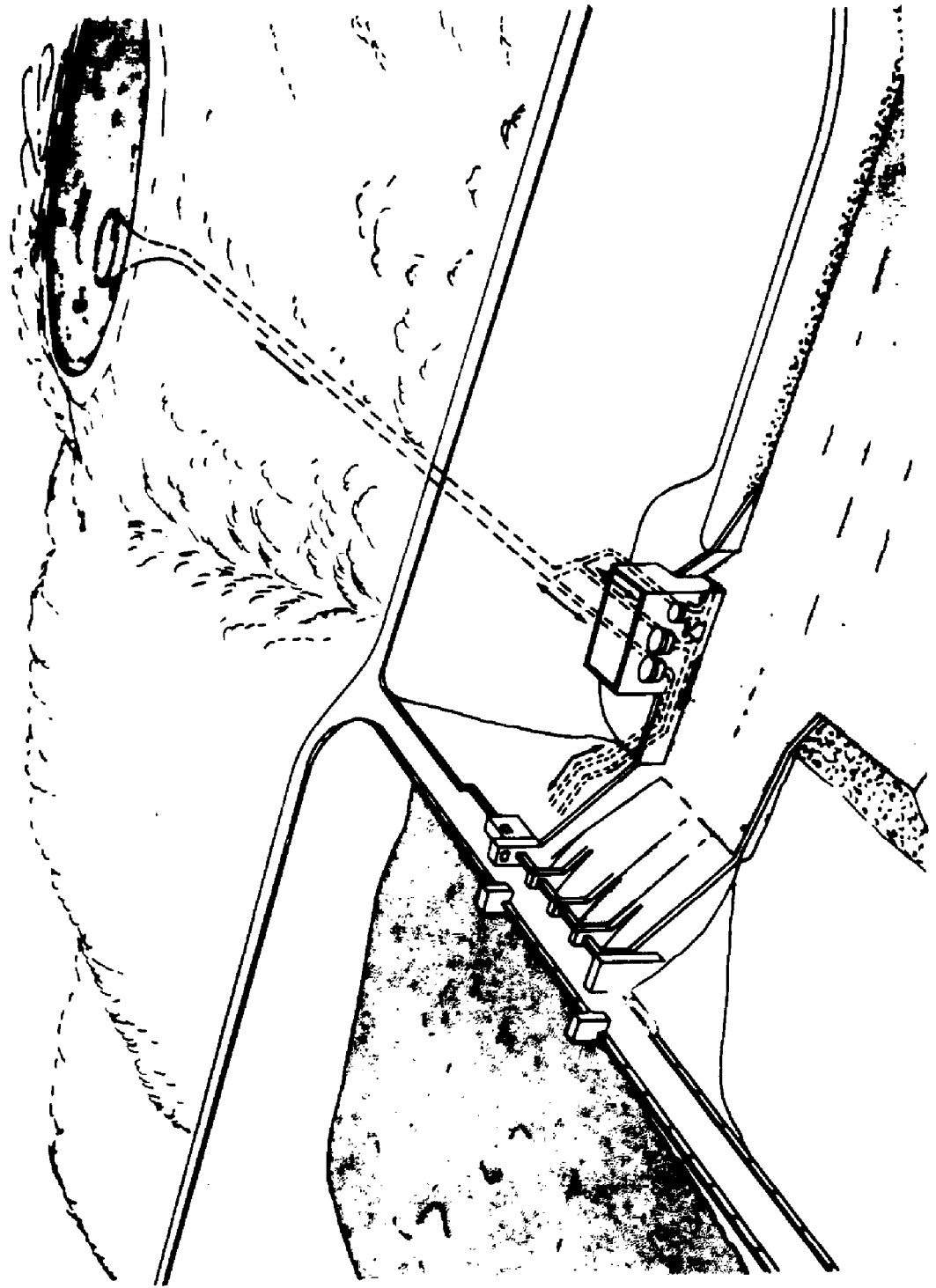


FIGURE 2.2  
PUMPED STORAGE SYSTEM



Hydroelectric plants have distinct advantages over thermal plants: 1/ they have long life, unscheduled outages are less frequent, and downtime for overhaul is brief because hydroelectric equipment is relatively simple. The cost of fuel, a major expense in most thermal installations, is not a factor in the operational costs of hydroelectric plants (except for pumping energy at pumped storage plants) because they use a renewable supply source--water. As a result, operation and maintenance costs are relatively low, and in many instances, the plants are designed for remote control. In addition, hydro facilities can provide peaking power in seconds when needed, a capability unmatched by any other form of power generation.

#### WHAT HAS BEEN DEVELOPED?

Hydroelectric plants have provided a substantial but declining proportion of the Nation's electric power supply. The developed hydroelectric power capacity 2/ in the United States totaled 59,000 megawatts (MW) 3/ of conventional capacity and 10,000 MW of pumped storage capacity as of January 1, 1978. The conventional capacity accounted for about 11 percent of total U.S. electrical generating capacity and conventional plus pumped storage capacity represents an estimated average yearly potential output of 289 billion kilowatt-hours 4/--equivalent to 462 million barrels of oil. 5/

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1/A type of electric generating station or power plant, or the capacity or capability there of, in which the source of energy for the prime mover is heat.

2/Capacity is the maximum power output or load for which a generator, turbine station, or system is rated.

3/One megawatt equals 1,000 kilowatts (kW).

4/The amount of energy consumed, delivered, or generated over a period of 1 hour at the rate of 1 kilowatt.

5/One billion kilowatt-hours is equivalent to 1.6 million barrels of oil.

Many significant changes have occurred over the years in the development of hydroelectric power in the United States. Most of the early projects were designed to serve base loads or to supply total system requirements. Approximately 40 years ago, hydroelectric plants provided 30 percent of the Nation's generating capacity and 40 percent of the electric energy. In recent years, as a result of the tremendous growth in electric power loads, the large installations of thermal electric generating capacity, and the increasing interconnection and coordination of electric power systems, hydroelectric projects are being designed to supply peak system requirements. This trend is expected to continue in the near future.

WHO HAS DEVELOPED IT?

Hydroelectric facilities have been developed by several parties but have included more Federal participation than any other electricity supply source. The growth in hydroelectric capacity by class of ownership is illustrated in table 2.1.

TABLE 2.1

Conventional Hydroelectric Capacity  
by Class of Ownership, 1940 to 1977

<u>Class of ownership</u>	<u>1940</u>	<u>1950</u>	<u>1960</u>	<u>1970</u>	<u>1977</u>
	—————(MW, 000 omitted)—————				
Investor-owned utilities	8.5	9.7	13.4	16.3	16.5
Non-Federal public utilities	1.1	1.5	4.4	11.9	12.8
Federal	1.7	6.5	14.6	23.0	29.2
Industrial	<u>1.1</u>	<u>1.0</u>	<u>0.7</u>	<u>0.7</u>	<u>0.7</u>
Total	<u>12.4</u>	<u>18.7</u>	<u>33.1</u>	<u>51.9</u>	<u>59.2</u>

As shown above, investor-owned utilities accounted for most of the earlier hydroelectric development. By the end of 1977, however, investor-owned capacity comprised only 28 percent of total capacity. The largest portion, 49 percent, was federally owned. Non-Federal public utilities accounted for 22 percent and industrial establishments about 1 percent.

The total installed hydroelectric capacity operated by Federal agencies at the end of 1977 is given in table 2.2.

TABLE 2.2

Total Federal Hydroelectric Capacity

<u>Federal Agency</u>	<u>Installed Capacity</u> (MW)
Corps of Engineers	16,500
Bureau of Reclamation	9,352
Tennessee Valley Authority	3,256
Alaska Power Administration	77
International Boundary and Water Commission	31
Bureau of Indian Affairs	14
National Park Service	3
Total	<u>29,233</u>

The Federal presence in hydroelectric development reflects a broad range of objectives and has occurred largely as an indirect result of achieving other goals. The U.S. Army Corps of Engineers and the Department of the Interior's Bureau of Reclamation, which have developed most of the Federal hydropower, have primary goals of constructing water resources projects for flood control, navigation, and irrigation. Power production has usually been considered a secondary benefit or purpose of the water resource projects. The Tennessee Valley Authority, on the other hand, was not only authorized to regulate the stream-flow of the Tennessee River "primarily for the purposes of promoting navigation and controlling floods," but also,

"so far as may be consistent with such purposes\* \* \* whenever an opportunity is afforded to provide and operate facilities for the generation of electric energy, in order to avoid the waste of water power\* \* \*." (16 U.S.C. 831 h-1)

Non-Federal development of hydropower facilities has had one main objective--to obtain a generating source of electricity. Before a non-Federal water power project can be built in most cases, a license must be obtained from the

Department of Energy's Federal Energy Regulatory Commission (FERC). 1/ The licenses are issued for a period up to 50 years and require that any hydroelectric project be adapted to a comprehensive plan for the development and use of water resources for multi-beneficial purposes, including recreation. FERC had issued 655 licenses as of January 1, 1978.

#### WHAT IS BEING DEVELOPED?

Although hydroelectric power now accounts for about 13 percent of the total U.S. generating capacity, that proportion is expected to decline to less than 10 percent by 1990. This trend is expected despite the construction of many large pumped storage plants, which will comprise about 70 percent of the planned capacity added through 1990. Currently, 7,200 MW of conventional hydroelectric capacity is being constructed. Of this, 5,600 MW is being constructed by the Federal water agencies and 1,600 MW by non-Federal entities. Another 4,200 MW of capacity has been authorized for future Federal construction. In addition, 26,600 MW of capacity from pumped storage was under construction, authorized, or included in the licensing approval process as of January 1, 1978.

A January 1978 FERC inventory of hydroelectric potential with sites over 5 MW estimated remaining capacity at about 110,000 MW. This figure will increase, however, because of recent interest in the development of smaller projects. Rising fuel and construction costs of thermal powerplants and the need to develop renewable energy resources have given emphasis to reevaluation of projects which were considered marginal or uneconomical a few years ago. The following chapter discusses the reasons for renewed optimism in hydropower and the status of studies on hydro potential.

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1/Previously the Federal Power Commission.

## CHAPTER 3

### HYDRO POTENTIAL

Hydroelectricity, as a percentage of total electricity, has been declining for several years. Many plants having relatively small capacities have been retired because they were not economical when compared to fossil fuel plants. This trend is beginning to change, however, because of increased fossil fuel costs. Some electricity planners now see hydroelectric generation as a possible economical option to fossil fuel plants. This raises the question of just how much hydro potential the United States has and how much of it can be developed.

#### FOREIGN EXPERIENCE

If the experience of several European countries in hydro development is an example of what can be developed, indications are that the United States has more hydro potential than once believed.

An example of aggressive hydro development has been demonstrated in France. Hydropower on the average accounts for 35 percent of France's electrical generating capacity. More important, however, is its approach to getting the hydro developed and the makeup of the hydro system. France has a national policy that anyone who develops a hydro project of under 8 MW capacity will be guaranteed a market for that power, regardless of the cost. Also, under sponsorship of the French Government, low-interest bank loans are made available to hydro developers, with the Government providing the difference in the interest rates. The rationale behind such policies is to develop maximum potential of domestic energy and renewable resources so there is less dependence on energy imports. The result has been a country with one of the most intensively developed hydro systems which includes many small projects and a significant small-hydro technology and manufacturing base.

The United States, in comparison, has developed a part of its water resources system, but small-hydro projects in recent years have not been pursued. In fact, older small projects have been shut down as the equipment has worn out. The result is that the United States has about 49,000 identified dams, but only 1,400, or 3 percent of them, produce



electricity. Also, only one major U.S. turbine manufacturer is still in the small-hydro business.

An example of the contrasting approaches of France and the United States is to compare two rivers with similar characteristics--the Rhone and the Ohio. The Rhone, which has been developed extensively, has a capacity of about 3,000 MW, while the capacity of the Ohio is about 180 MW. This means that the Rhone has over 16 times more hydroelectric generation potential than the Ohio.

A major reason for French and other European interest in hydro is purely economic. Hydro has been seen as a method to reduce expensive fossil fuel imports.

#### RECENT U.S. INTEREST IN HYDRO

The increased cost of alternative supply sources is the major reason for the new U.S. interest in hydro. This, along with comparative environmental impacts of alternative sources and the advantages of using a renewable supply source, has added to the attractiveness of hydropower and increased interest in its development to a level not seen since World War II.

In the 1950s and early 1960s, utilities enjoyed economies of scale in building large thermal powerplants which burned fossil fuels--coal, oil, and gas. During this period, fuel supplies were abundant and costs changed little. However, with more recent periodic shortages of some fossil fuels and increased fuel costs, alternative supply sources are receiving a closer look. For example, 1970 electric utilities production expense, which was made up mostly of fuel costs, accounted for about 36 percent of total expenses, whereas in 1978 production expenses were estimated to be about 58 percent of total expenses.

Another comparison shows the escalating costs of fossil fuels for electric generation. (See figure 3.1.) This dramatizes the increased cost of fossil fuels. Since a great deal of the fuel (oil) is imported, it has been a major contributor to the country's record balance of payment deficit in calendar year 1977 and to the country's second highest

FIGURE 3.1

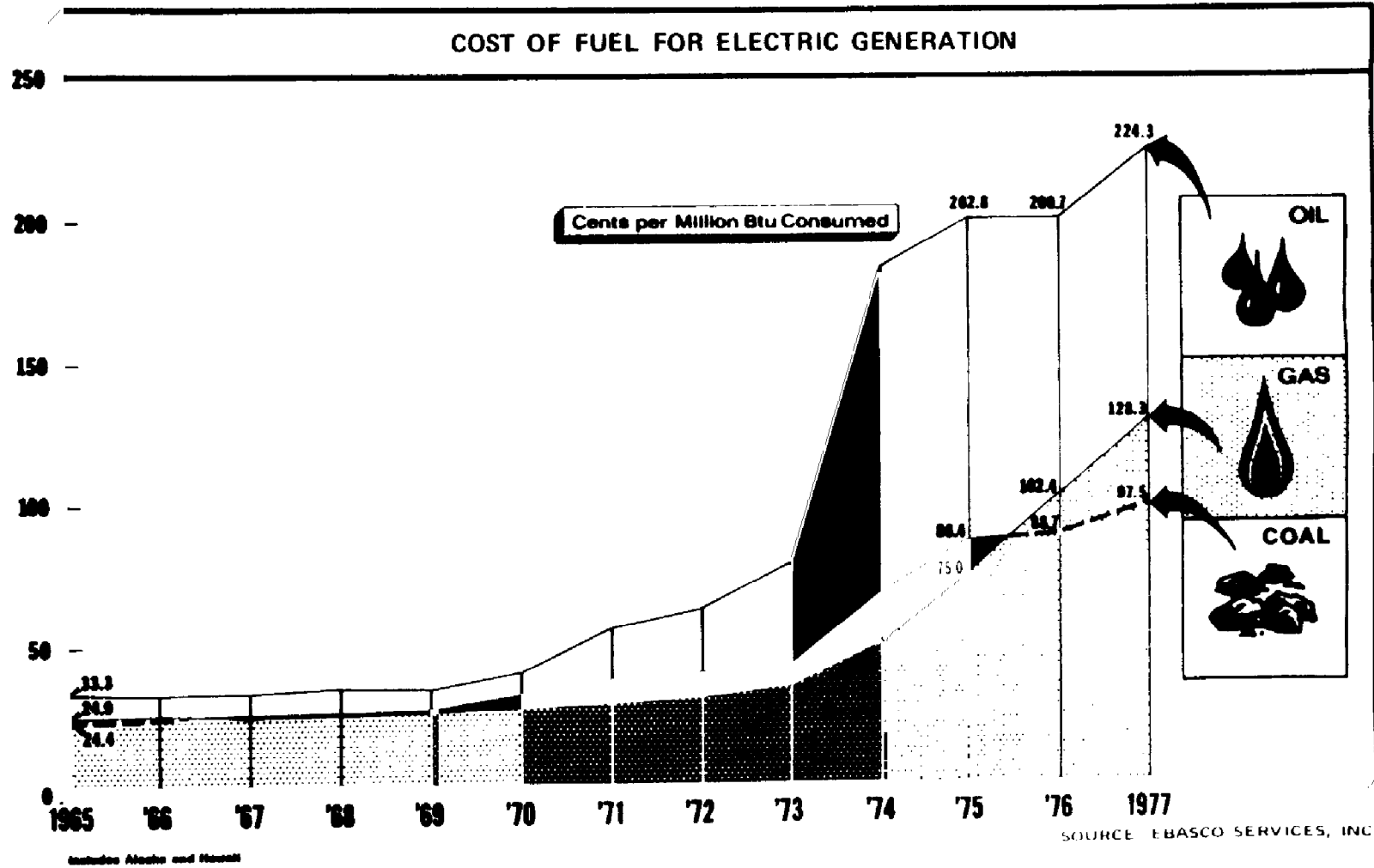


TABLE 3.1

Studies to Assess Hydro Potential and Source of  
Funds for the Studies

<u>Organization doing study</u>	<u>Funds being provided by</u>	<u>Fiscal year expenditures</u>			
		<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
		(000 omitted)			
New England River Basins Commission	WRC	\$ 325	\$ 425	\$ 225	-
Bureau of Reclamation	Congress	-	a/ 400	-	-
Corps of Engineers	DOE	250	200	-	-
Corps of Engineers	Congress	1,000	2,250	3,000	\$ 750
Bureau of Reclamation	Congress	-	420	420	120
Corps of Engineers (note b)	Congress	5,000	5,000	-	-

a/Eighteen site specific hydro facilities.

b/Authorized in section 167 (d) of the Water Resources  
Development Act of 1976 but not funded at this time.

balance of payment deficit in calendar year 1978. <sup>1/</sup> With the economic climate for the resurgence of small-scale hydro installations, Federal and utility planners are focusing more attention on hydropower.

Another reason for interest in retrofitting small existing dams is that few environmental barriers exist. The dam structure is in place and retrofitting or adding a power house would appear to have few unfavorable impacts on biological production and diversity.

Various other factors have contributed to the renewed interest in small-hydro plants. Municipalities and small public utilities, which have traditionally been dependent on large privately-owned utilities for power supplies, visualize development of small local dams as a means of becoming more independent. For this reason, the greatest interest in small dams has been shown by publicly owned utilities, municipalities, cooperatives, and irrigation districts.

#### HYDRO STUDIES

With renewed interest in hydropower comes increased optimism that the United States has more potential power than previously believed. This has led to studies, some of which have been completed, to assess the total U.S. hydro potential. Most of the studies have been or are being conducted or funded by different Federal agencies (see table 3.1). Those studies which have been completed offer optimism for hydro potential.

#### Corps of Engineers

The Corps of Engineers has completed one study on hydro potential from existing dams and is identifying total U.S. potential in another. The completed study was requested by the President in announcing the National Energy Plan; the study in process was requested by the Congress.

The President, in introducing the National Energy Plan, pointed out the potential for developing power at small-hydro

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<sup>1/</sup>1978's balance of payments deficit was mitigated due to Alaskan crude oil coming on line.

projects and requested that the Corps do a 90-day assessment at existing dams. The Corps' assessment was announced in a July 20, 1977, report 1/ to the President. It identified total potential of 54,600 MW of capacity from existing facilities. Specific development would include:

- 5,100 MW of additional capacity by installing more efficient turbines and more powerful generators at existing dams; 2/
- 15,900 MW of capacity by installing additional turbines and generators to existing dams; and
- 33,600 MW by constructing power houses at existing non-hydro power dams.

The report further pointed out that, if developed, this potential capacity could save 727,000 barrels of oil per day, but it indicated that constraints could stand in the path of some development. It recommended that emphasis be placed on small-hydro demonstrations to measure the severity of any constraints. A recent Corps assessment of this study indicates that potential will be somewhat less than previously identified.

The Corps' study of total hydro potential which is currently in process was authorized by the Congress through passage of Public Law 94-587 in 1976. The Corps estimated that this effort would take 3 years and started the assessment (referred to as the National Hydropower Study) in the summer of 1978. The assessment, which will cost about \$7 million, is being conducted by the Corps' Institute for Water Resources and should be concluded by September 1981.

The study primarily will assess (1) the physical potential for hydroelectric development and how certain factors--economic, social, environmental, and institutional--will affect the realization of hydropower's physical potential and (2) the regional distribution of hydropower potential and its

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1/"Estimate of National Hydroelectric Power Potential at Existing Dams."

2/A similar recommendation is in our report, "Power Production At Federal Dams Could Be Increased By Modernizing Turbines And Generators," EMD-77-22, Mar. 16, 1977.

maximum integration with other types of generating facilities in order to meet electricity needs. This study will be the most comprehensive hydro assessment performed in the United States. The assessment will include all hydro potential, regardless of size.

### Bureau of Reclamation

The Department of the Interior's Bureau of Reclamation, which operates hydroelectric projects in 15 western States completed a study <sup>1/</sup> in February 1977 on hydroelectric potential in its service area. The study concluded that 34 specific sites representing a potential installed capacity of 11,300 MW were appropriate for further study. Dams are already constructed at some of these sites, and by uprating these existing units and adding units, these dams would provide more capacity. Sixteen of the potential sites would have 460 MW of capacity and could produce energy at plant factors equivalent to base load facilities. These plants could generate 2,290 billion kWh of energy, thus saving an equivalent of about 1.1 million tons of coal annually in base load energy. Another 11 potential sites would provide intermediate and peaking power with an 800-MW capacity, which could generate 600 billion kWh of energy and save 1 million barrels of oil annually.

The remaining seven sites are pump storage facilities with 10,040 MW of capacity capable of generating 16,400 billion kWh of peaking power annually, which could save 28.5 million barrels of oil each year. The pumping would require an equivalent of 11.5 million tons of coal annually in base load energy. These potential developments would, therefore, shift fuel consumption from limited supplies of oil and natural gas for peaking power to the more abundant coal resource for base load power.

In addition, the Bureau is conducting a three year study of hydropower potential in the seventeen western States. This study will assess areas never seriously considered previously such as potential derived from drops in irrigation canals and conduits.

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<sup>1/</sup>"Western Energy Expansion Study."

## Other studies

Several other recent studies reflect similar optimism for hydro. An October 1978 preliminary report 1/ on small-scale hydroelectric potential in North Carolina identified 195 dams as having good potential for development. The report also pointed out that these are not the only dams in the State that have unused hydroelectric potential. The report adds that many individuals in the State are ready and willing to develop the small facilities.

In addition, a December 1978 interim report 2/ on hydro potential in the six New England States, published by the New England River Basins Commission, indicates that nearly 1,800 MW of power potential could be developed at approximately 2,000 existing non-generating dams. This amount of electricity would be equivalent to about 8 percent of today's total electrical generating capability in New England and about 15 percent of the additional power needed by the region over the next 10 years. The development of this hydro potential could save 7 million barrels of oil and assuming \$20.00 per barrel could reduce our balance of payments by about \$140 million per year.

Our analysis of various ongoing studies leads us to believe that there is a greater amount of total U.S. hydro potential that can be developed than previously recognized by most energy planners. There are also indications that more of this potential may be developed than had been forecast. The following two chapters look at what Federal programs and action plans exist to get the untapped hydro potential developed and what problems and constraints preclude or hinder such development.

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1/"Small-Scale Hydroelectric Development Potential in North Carolina," Research Triangle Institute.

2/"Interim Report on Inventory of Existing Dams In New England," New England River Basins Commission.

## CHAPTER 4

### FEDERAL HYDRO PROGRAMS

The Federal Government plays an important role in planning, constructing, operating and regulating domestic hydroelectric projects. Several Federal agencies--Corps of Engineers, Bureau of Reclamation, Tennessee Valley Authority, Water Resources Council, Federal Energy Regulatory Commission, and the Department of Energy--are involved in one or more of these aspects.

#### DEPARTMENT OF ENERGY Small Hydro Program

The Department of Energy's Small Hydro Program was established to foster the development of small hydro projects at existing sites. The program has been moved around within DOE's organization and at times appears to have been low on DOE's and the administration's list of funding priorities.

A July 1978 DOE regional memorandum provides insight into the formation of the Small Hydro Program. The memo states that, until fairly recently, small hydro was an unwanted stepchild within DOE. When the Energy Research and Development Administration (ERDA) had been approached over 3 years ago by a regional Federal Energy Administration 1/ office about funding a regional hydro feasibility study, ERDA admitted that it had no personnel with hydro expertise. After a lengthy period of no apparent interest, DOE quickly started a program after President Carter's National Energy Plan proposed the development of small hydro potential. DOE has transferred hydro from one section within the Department to another, and not until recently did the program have more than one staff member assigned to it. At one point, it was under the Geothermal Branch of Energy Technology and currently is under Resource Applications.

Although the President, in his energy plan, spoke of developing existing small-hydro potential, the administration's fiscal 1978 budget did not request any money for it.

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1/Energy Research and Development Administration and Federal Energy Administration were incorporated within the Department of Energy on October 1, 1977.



Instead, through congressional initiative, \$10 million for DOE's hydro program was included in its fiscal 1978 appropriations. The administration's hydro program request for fiscal 1979 was \$8 million; but again, because of interest in the Congress \$28 million was appropriated. The following table reflects the program's budget for fiscal 1978 through 1980.

TABLE 4.1

Small Hydro Program Budget

	<u>Fiscal year</u>		
	<u>1978</u>	<u>1979</u>	<u>1980</u>
	(millions)		
Feasibility studies:			
Grants	2.5	-	-
Loans <u>a/</u>	-	\$10.0	\$10.0
Demonstration projects			
Idaho Falls	2.0	2.0	2.0
Other	1.52	2.0	2.0
Equipment standardization and engineering development	1.58	5.0	-
Experiments (more effective ways to get power)	-	5.0	-
Analyzing barriers to development	1.25	4.0	2.0
Resource assessment	.7	-	-
Technology transfer and information dissemination	.45	-	2.0
Other	-	-	-
Total	<u>\$10.0</u>	<u>\$28.0</u>	<u>\$18.0</u>

a/Portion of \$30 million feasibility study loan program authorized by National Energy Act (P.L. 95-617).

### Feasibility studies

DOE's major effort under the Small Hydro Program has been to make grants for feasibility studies of specific hydro sites. This began with a December 2, 1977, announcement soliciting proposals for feasibility assessments at existing sites with a capacity of between .05 MW and 15 MW with heads <sup>1/</sup> of less than 20 meters. The announcement attracted 202 proposals--and 54 feasibility studies were subsequently awarded. These 54 studies were completed in August 1979. A FERC official told GAO that the 15-MW limitation excluded the development of many good small sites. He further stated that the engineering definition for a small-hydro project was 100 MW or less. In our opinion, although most sites fall within the 15-MW limitation now established, several good sites are larger. It would be unfair to exclude them from the feasibility study loan program. If the limit is not increased, the potential exists that such projects will not be developed to full capacity solely in order to qualify for a loan.

### Demonstration projects

The program objectives of DOE's demonstration projects include developing small hydroelectric powerplants in order to (1) acquire performance data and experience with which to demonstrate engineering and economic viability and (2) identify the marketing, environmental, institutional, and legal constraints associated with small hydroelectric power development. Up until early 1979, the only demonstration project under construction was the rebuilding of three sites in Idaho Falls, Idaho, two of which were destroyed by the collapse of the Teton Dam in 1976. DOE's contribution to this project is \$7.2 million, to be allocated over fiscal years 1978 through 1981. Seven other projects were awarded grants in February 1979 (see appendix 1). A second Program Opportunity Notice (PON) for DOE participation in small-scale hydroelectric power demonstration projects was mailed out June 22, 1979. The closing date for this solicitation was August 27, 1979. Over forty proposals were received and proposal evaluation is in progress.

### Loan program

The National Energy Act (P.L. 95-617) authorizes \$330 million for loans over a 3-year period to hasten the development of small hydroelectric plants at existing dams. Interest on the loans have been established at 6-7/8 percent through

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<sup>1/</sup>The head is the difference of elevation between the headwater and tailwater surfaces at a hydroelectric powerplant.

September 30, 1979. It has been anticipated that the rate will increase by 1/4 percent in fiscal year 1980. The loans are broken into two categories: \$30 million for feasibility studies and \$300 million for construction. The feasibility study loans can cover up to 90 percent of the cost for a prospective developer to conduct a feasibility study at a small-hydro site. The loan must be paid back within 10 years. In the event economic or technical feasibility is not justified, the loan including interest may be forgiven. Ten million dollars of this authorization was included in DOE's appropriations for fiscal 1979 and 1980's budget.

The construction loans can cover up to 75 percent of the costs of a small hydroelectric power project. The project loans must be paid back within 30 years. No construction loan money was appropriated for fiscal year 1979 or 1980. According to an Office of Management and Budget official, the \$300 million construction loan money was not requested by the administration because it believed small hydro technology was available and, therefore, development would occur without the loans. Technology was considered the most important factor for development, and other constraints were not considered significant enough to warrant the loans.

#### Commercialization

DOE selected small hydro as one of eight technologies to push toward commercialization. It was selected because the technology is considered ready for the marketplace and DOE believed it could make short-term contributions to the Nation's energy needs. The goal of the commercialization program was to develop the following small-hydro capacity above what was in the planning stage in 1977.

<u>Year</u>	<u>Capacity (MW)</u>
1985	1,500
2000	20,000
2020	50,000

The Resource Manager of the small-hydro commercialization program said these goals were extremely optimistic and only under a very aggressive program could they be met. However, recent estimates from the Corps of Engineers have resulted in DOE reducing its goals to

<u>Year</u>	<u>Capacity (MW)</u>
1985	1,000
2000	12,000
2020	No Estimate

#### FEDERAL ENERGY REGULATORY COMMISSION

The Federal Energy Regulatory Commission is the Federal Government's regulator of non-Federal hydroelectric projects. It was established in 1920 because demand for electric power, which at that time was supplied mostly by hydropower, suddenly increased, and the Congress believed such development on navigable waterways should be regulated.

The Federal Water Power Act gave the Federal Power Commission, FERC's predecessor, responsibility for licensing all non-Federal hydroelectric power projects constructed on navigable waters, U.S. public lands, or on any streams which use water or water power at Federal dams or affect interstate commerce. Licenses are issued for a period up to 50 years. It also gave the Commission responsibility for relicensing hydroelectric projects. As of December 31, 1977, FERC had issued 655 licenses.

Over the past year, interest in hydroelectric development has grown rapidly. In November 1977, FERC had 54 applications for licenses and permits; in November 1978, there were 120 applicants; and in September 1979, 138 applicants were awaiting preliminary permits and licenses. A FERC official attributes the increased interest to the escalating cost of fossil fuel.

#### WATER RESOURCES COUNCIL

The Water Resources Council establishes the principles and standards which Federal water resources agencies--Corps of Engineers and Bureau of Reclamation--and TVA must follow in conducting benefit-cost studies in order to get authorization and funding. WRC gets its authority from the Water

Resources Planning Act (Public Law 89-80 as amended) to provide for the optimal development of the Nation's natural resources through the coordinated planning of water and related land resources. In addition, WRC is authorized under the provisions of the Federal Non-nuclear Energy Research and Development Act of 1974 to conduct studies of energy potential from water.

In a June 1978 message to the Congress on water resources policy reforms, President Carter called for a restructuring of WRC's principles and standards to emphasize economic efficiency and environmental impact of water resources development. The revised principles and standards were published as a draft in the May 24, 1979, Federal Register.

#### FEDERAL CONSTRUCTION OF HYDRO FACILITIES

The Federal Government has several agencies involved in constructing, operating, and maintaining hydroelectric projects. Table 2.2 (p. 8) identifies these agencies and their installed generating capacity. Table 2.1 (p. 7) shows their significance in relation to total hydroelectric development. The Corps of Engineers and Bureau of Reclamation have constructed most of the hydroelectric projects but this has occurred more as an indirect result of achieving other goals. The main charter of these two agencies' is the development of water resource projects for the primary benefits of flood control, navigation, and irrigation. Power production from the projects has usually been considered a secondary benefit or purpose.

Approval and funding for Federal projects is a long and, at times, slow process. Before authorization by the Congress, each project must be studied and evaluated for its engineering and technical feasibility and economically evaluated through a benefit-cost study. The principles and guidelines followed in doing these studies are provided by the Water Resources Council. After projects are authorized by the Congress, the agencies must then seek appropriations before proceeding with construction.

The Corps and the Bureau are also actively involved in studies of hydro potential. Two completed studies and one currently underway were discussed in chapter 3 (see p. 14).

## CHAPTER 5

### CONSTRAINTS AND PROBLEMS

#### LIMITING HYDRO DEVELOPMENT

While there is a large physical potential for hydro-power in the United States, potential developers have encountered problems and constraints. Although the obstacles associated with development are complex and at times seem insurmountable, some efforts have been made to alleviate them. During our review, we considered those problems and constraints which can be broadly categorized as institutional, environmental, economic, and operational.

#### INSTITUTIONAL

Because the prospective hydro developer must work within the policy and legal framework of the Federal Government, the developer faces many institutional considerations. These include:

- Complex licensing requirements.
- Uncertain relicensing policy.
- Lack of presence and direction of the small hydro program.
- Inflexibility of Federal Water Project Study Plans.

#### Complex licensing requirements

Chapter 4 points out the responsibilities of the Federal Energy Regulatory Commission for licensing all non-Federal hydroelectric projects. The licensing program has evolved into a highly complex decisionmaking process with a large number of participants. Many laws (see table 5.1) have been enacted to assure the development of a hydroproject is evaluated from a multiple-use standpoint--recreation, water quality, irrigation, fish and wildlife enhancement, and overall environmental effect.

TABLE 5.1

Laws Involved in FERC's Hydroelectric  
Licensing Procedures and Federal  
Water Resource Programs

<u>Federal legislation</u>	<u>Agency contacts required</u>
Fish and Wildlife Coordination Act (Public Law 85-624)	U.S. Fish and Wildlife Ser- vice, State Fish and Game Commissions
Endangered Species Act of 1973 (Public Law 93-205)	U.S. Fish and Wildlife Ser- vice, State Fish and Game Commissions, et al.
National Historic Preserva- tion Act of 1966 (Public Law 89-665)	Advisory Counsel for Historic Preservation, Department of the Interior, State Histori- cal Preservation Office
Act of May 24, 1974 (Public Law 93-291)	Advisory Counsel for Historic Preservation, Department of the Interior, State Histori- cal Preservation Office
National Environmental Policy Act of 1969 (Public Law 91-190)	U.S. Environmental Protection Agency, Federal Land Holder (U.S. Forest Service, Depart- ment of the Interior), U.S. Fish and Wildlife Service or other agencies designated as the lead agency
Wild and Scenic Rivers Act (Public Law 90-542)	Departments of the Interior and Agriculture
Clean Water Act of 1977 (Public Law 95-217)	Environmental Protection Agency
National Trails System Act (Public Law 90-543)	Department of the Interior, National Heritage Act Conservation and Recreation Service, Department of Agri- culture, U.S. Forest Service

Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500)	Corps of Engineers, Environmental Protection Agency, Various State EPAs
Wilderness Act (Public Law 88-577)	Federal Land Holder (Department of the Interior, Department of Agriculture) State Land Management Organizations
Coastal Zone Management Act of 1972 (Public Law 92-583)	Federal Land Holder, U.S. Forest Service, Department of the Interior, State of Alaska
Act of May 28, 1963 (Public Law 88-29)	National Heritage Conservation and Recreation Service
Federal Land Policy and Management Act of 1976 (Public Law 94-579)	Bureau of Land Management, U.S. Forest Service, or other Federal land holders, such as the Corps of Engineers

Each license application must be supported by detailed data covering the full range of the project's uses and impact. As part of the licensing process, FERC seeks the views of Federal, State, and local agencies (see table 5.1) having jurisdiction over water resources development or expertise in a subject area affected by a proposed project. Moreover, construction of a hydroelectric project is often controversial, which can lead to challenges of FERC's decisions in the courts. As a result, the licensing process can take many years. Until recently, the same process was followed for adding power at an existing dam as it was for constructing a new dam.

For example, the Vanceburg, Kentucky, Electric Light and Power Company filed for a license with FERC in December 1969 to install power at an existing Corps of Engineers navigational dam on the Ohio River. FERC issued the utility its license in March 1976. It took the city of Vanceburg over 6 years to get a license in order to add power to an existing dam site, partly because the city was not experienced in the licensing process and because delays resulted from an incomplete application.



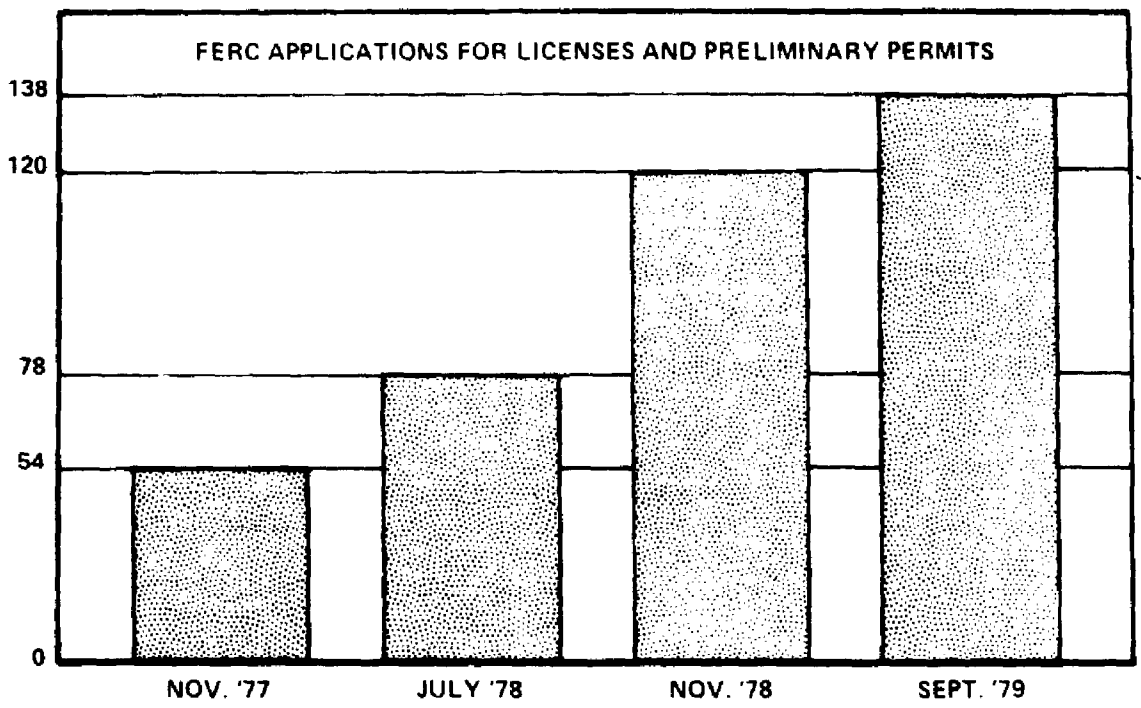
In contrast to the Vanceburg experience, a license recently issued by FERC to Essex Development Associates of Lawrence, Massachusetts--adding power to an existing dam--took just 18 months from license application to issuance. FERC and Essex considered this a brief time and in fact it was one of the shortest recent processing times, probably because Essex officers were experienced in the licensing process. The application submitted required few revisions and the officers also knew the appropriate Federal and State personnel staff to contact in order to obtain approval.

Federal agencies located in New England, the region where many small dams are located, have recognized for some time that if the regulatory process was less involved, it would spur small-scale hydroelectric development in the area. Recognizing this, FERC issued Order No. 11 in September 1978 which is designed to simplify the licensing procedure for power projects with a capacity of under 1.5 MW. Briefly, compared with the former regulations, the simplified application lessens the descriptive information needed, reduces the details required on maps and drawings, and simplifies procedures required to meet environmental regulations. In addition, FERC has revised its procedures for obtaining comments from other agencies.

The National Energy Act (P.L. 95-617) directed FERC to also streamline its licensing procedures for existing dam sites with 15 MW or less of hydroelectric potential. FERC has developed a number of procedures to carry out this mandate. On March 5, 1979, FERC issued a notice of proposed rule making to provide general filing requirements for all license and preliminary permit regulations involving existing dams. These regulations became final in October, 1979. On April 20, 1979, FERC issued proposed regulations to implement Section 213 (P.L. 95-617) which gives the Commission discretionary authority to exempt conduit hydroelectric facilities from licensing. On April 19, 1979 FERC streamlined its procedures for all sites with existing dams. A FERC official estimates the revised procedures will result in applications being processed within 9 to 12 months. If this occurs, an application such as was submitted by Essex Development Associates could be issued in about half the time. FERC has pointed out, however, that the States also have complex licensing and permitting requirements which impact on hydroelectric development, but that no State agency (except Massachusetts) has made an effort to date to simplify regulations.

Requests to FERC for permits and licenses have increased significantly over the past year. As figure 5.1 below shows, the applications pending in September 1979 were more than double the applications pending as of November 1977. An increase in applications is understandable due to the increased interest in small projects. FERC had anticipated and projected an increase in its permit and licensing workload for fiscal 1979 and, as a result, requested and received an additional 25 staff for this work. FERC's ability to handle the increased workload could be strained, however, because as of January 1979 the volume of applications has been much heavier than projected. As a result, a backlog of applications could still occur, even with a streamlined licensing process and some additional staff.

FIGURE 5.1



## Uncertain relicensing policy

A FERC hydroelectric license is issued for periods up to 50 years, after which the holder can file for another 50 year license renewal. Under the Federal Water Power Act's preference clause, public agencies can challenge a private agency's right to renew its license. The act gives preference to public agencies over a private ownership, where competing applications are equal for the same site.

At present, five relicensing applications are being challenged for takeover by public bodies. Table 5.2 shows the dams and the applications in competition for the dams. A FERC official said that in 1968 FERC's General Counsel declared that municipalities should not have preference over relicensing applications. But in 1971 a staff counsel investigation took the opposite position. In the 1971 case no final ruling was made because the public entity in the case was ruled not to be a municipality. Therefore, a decision on the relicensing issue has not been made.

In September 1978, the cities of Santa Clara, California, and Bountiful, Utah, two public bodies which have submitted competing applications, requested that FERC issue declaratory order notices. As a result, FERC announced in December 1978 through a public notice that intervenors should submit briefs. A FERC official said that 50 intervenors have responded to the notice. The official believes it may take years before a final ruling is given by FERC, and any decision would probably be pursued in the courts.

Until FERC makes a decision, hydro potential could go undeveloped because private owners may be hesitant to expand existing sites unless ownership is assured. Although the competing applications shown in table 5.2 do not involve capacity expansions, such competing applications would restrict capacity expansions of projects with licenses expiring in the near future.

Table 5.3 on page 31 lists hydro projects whose licenses are subject to relicensing or takeover and have additional capacity available. For licenses expiring through June 1981, about 425 MW of capacity could be added.

TABLE 5.2

Projects That Have Competing Applications

<u>Stream</u>	<u>Location</u>	<u>License expiration date</u>	<u>Present license holder</u>	<u>Date of application</u>	<u>Competing applicant</u>	<u>Date of application</u>
Mokelumne River	California	Nov. 23, 1975	Pacific Gas & Electric	1972	City of Santa Clara, Calif.	1974
Weber River	Utah	June 30, 1970	Utah Power & Light Co.	1969	City of Bountiful, Utah	1974
Big Pigeon River	North Carolina	Nov. 22, 1976	Carolina Power & Light Co.	1973	No. Carolina Elec. Membership Co.	1974
Flat Head Lake and River	Montana	May 22, 1980	Montana Power Company	1976	Flathead Indian Tribe	1974
Lewis River	Washington	Dec. 11, 1979	Pacific Power & Light Co.	1977	Clark Cowlitz Joint Filing Agency	1977

TABLE 5.3

Projects for Which Licenses Have Expired or  
Will Expire by June 30, 1981, Which Are Subject  
to Relicensing or Takeover and Have Undeveloped  
Potential

<u>Project number</u>	<u>Stream</u>	<u>Location</u>	<u>Licensing expiration date</u>	<u>Present license holder</u>	<u>Installed capacity (MW)</u>	<u>Ultimate capacity (MW)</u>
485	Chattahoochee River	Alabama	Dec. 14, 1974	Georgia Power Co.	65	165
618	Coosa River	Alabama	Nov. 6, 1975	Alabama Power Co.	100	125
271	Ouachita River	Arkansas	Feb. 6, 1973	Arkansas Power & Light Co.	65	93
77	Eel River and Branch of Russia River	California	Apr. 14, 1972	Pacific Gas & Electric Company	9	11
289	Ohio River	Kentucky	Nov. 10, 1975	Louisville Gas & Electric Company	77	96
199	Santee and Cooper Rivers	South Carolina	Apr. 1, 1976	So. Carolina Public Service Authority	135	165
588	Elwha River	Washington	June 3, 1976	Crown Zellerbach Corp.	12	42
814	Beaver River	Utah	Aug. 31, 1979	MOON Lake Elect. Assn. Inc.	3	6
935	Lewis River	Washington	Dec. 12, 1979	Pacific Power and Light Co.	135	180
1025	Susquehanna River	Pennsylvania	Apr. 21, 1980	Safe Harbor Water Power Corp.	196	336

### Lack of presence and direction of Small Hydro Program

DOE has the main responsibility in the Federal Government for stimulating small-scale hydroelectric resources. To date, most of the efforts by the agency have been concentrated on long-term efforts such as research, site identification, and feasibility studies. These actions have so far not greatly helped projects to become operational. During the course of our review, we noted that short-term opportunities exist which could have been exploited by DOE through an outreach program.

We found a great deal of sharing of information between prospective developers but, except in isolated instances, very little help and guidance being offered by the Federal Government. An official at DOE regional office in Boston, who had assisted hydro developers in the past, told us that--organizationally and officially--the regional office has had no role to play in hydro development and had received no money for a hydro program, even though a great many small hydro projects are in New England. He added that any assistance he had provided developers had been in an unofficial capacity.

Because many potential small hydro developers are not experienced in hydro development, it would seem an outreach or assistance-type program from DOE would be a necessity. However, we talked to many developers in New York State and New England who were not aware of anyone in DOE to contact for help and assistance. One project we visited in Vermont consisted of a planned series of small-scale sites totaling approximately 30 MW which was issued a 3-year permit in January 1976 and applied for a license in June 1978. During this period, the developer had neither sought nor received help or encouragement from DOE. The project officials admitted, however, that some sort of Federal guidance would have been helpful. Other developers who had not begun the licensing process told us that they had no idea what was involved in obtaining a Federal license or what assistance or guidance DOE or anyone else could provide, and any help would greatly improve their pessimistic outlook in proceeding with the licensing process.

As chapter 4 points out, most of the hydro budget for fiscal 1978 was for grants made to potential developers for pre-development feasibility studies. About 45 percent of these grants were awarded for sites in New York State and

the six New England States. In awarding these grants, however, DOE did not gain maximum benefit from its field office. As pointed out, DOE's Boston regional office staff has informally provided information and advice on small hydro, and because of regional experience is very familiar with several specific hydro sites and potential developers. DOE, however, did not contact nor use any of this experience in awarding its feasibility grants. Grants were awarded in New England on sites previously studied for feasibility--and, thus, duplicate efforts. In addition, grants were made on sites where, even if feasible, the grantees are not going to develop the project. The Boston regional office was not given an opportunity to provide input into the selection process.

The uncertainty of Federal money is also impacting on hydro development. A project spokesperson for one of the prospective developers we visited told us that despite the \$43,000 DOE grant, it was doubtful whether the municipally owned project will ever be completed unless Government funds are also available for hardware. The dam and powerhouse for the project were restored before May 1977. The town had received an 80-percent grant for \$400,000 from the Department of Commerce's Economic Development Administration's Public Works Jobs Opportunities Program to do the restoration. In addition, a prior feasibility study indicated the project would be economically feasible if the power were sold for \$.02 per kWh even if the developer payed for all equipment and restoration. The project spokesperson said there is not a great deal of local interest in the project, and that most of the people in the small New England town are quite skeptical about the energy shortage.

At another project we visited, which was awarded a \$66,000 DOE grant, an official said it was doubtful whether the city would provide additional money for the project even if the study proved it to be economically feasible. When the city decided to allow the State Energy Office to perform a feasibility study, it was hoped that the Federal Government would provide money for a demonstration project if the project was economically sound.

An official from DOE's Boston regional office told us that he was not surprised by the developers' statements. He said the chance that Federal money would be available for development is a possible impediment to small-scale hydro development, in that as long as prospective developers feel there is an opportunity for Federal money, they will

be reluctant to spend their own. A researcher doing hydro-power studies for the New York State Energy Research and Development Authority and an official of a hydro turbine manufacturer also told us that many people do not want to go ahead with projects that they feel may eventually get Federal money.

#### Demonstrations

Objectives of DOE's Small Hydro Program includes demonstrating the feasibility of small hydro through development of specific sites; measuring the impacts of constraints and problems through development of the demonstrations; and nurturing U.S. manufacturing of small hydro equipment. Many individuals we talked with believe small-hydro demonstration is the key to getting maximum hydro developed in a shorter time. They believe a demonstration or two per State in the Northeast would show those skeptical of small hydro its positive features. This would lead to further development and have a "snowballing" effect. This position was also taken in two small-hydro seminars funded by DOE in September 1977 and May 1978 which recommended that several sites be developed in the near term to demonstrate small-hydro viability and to measure the extent of constraints.

However, up until early 1979 DOE had only one demonstration project under development and grants were not awarded to assist in further demonstrations until February 1979--2 years after the Small Hydro Program was developed. The first site under development is at Idaho Falls, Idaho, at three dams, two of which were damaged by the Teton Dam collapse in 1976. The original site operated at 5MW, but it is presently being expanded to a capacity of 22 MW. Several individuals and groups we contacted while doing this review were concerned about the Idaho Falls project and the general lack of effort by DOE to demonstrate small hydro. Views expressed include:

- The project was operating prior to 1976, and thus there is little doubt it will be successful.
- The project has chosen to use the bulb turbine from a Austrian manufacturer, which does nothing to nurture and demonstrate the U.S. turbine manufacturing capabilities.



DOE has recently awarded grants for seven small-hydro sites which will cover up to 25 percent of the costs to reactivate the sites. These seven projects represent a total capacity of 18 MW and are not expected to be generating power until the mid-1980s. (See app. I.)

### Technology

Potential hydro developers also expressed concern about DOE's funding in the technology area. The purpose of this funding has been to standardize small-hydro equipment with the objective of decreasing equipment costs, thus making projects more economically attractive. However, an official of Allis-Chalmers Company, the only major U.S. manufacturer of small hydro turbines, said the company's small-hydro turbine was already standardized. The official further pointed out that the company had received no DOE money for any type of research or demonstration, even though it is the only major U.S. manufacturer and an objective of DOE's program is to nurture the development of U.S. small turbine manufacturing.

### Inflexibility of Federal water resources study requirements

The Bureau of Reclamation and Corps of Engineers develop detailed plans and conduct feasibility, engineering, and benefit-cost studies in order to obtain congressional authorization and funding before constructing new water projects. This process takes years to complete and the same process is required for making additions or adding power to existing projects. Since the process for obtaining a license at an existing site has been or is in the process of being streamlined by FERC, it can be argued that the planning and study process for adding power at existing Federal water projects should also be streamlined.

This is not occurring, however. The Bureau of Reclamation's Western Energy Expansion Study, published in February 1977, identified several existing Federal sites with potential for additional electricity capacity. Benefit-cost studies included as part of this effort have shown several projects with favorable benefit-cost ratios.

Legislation has been introduced (H.R. 1688, 96th Congress) to authorize the construction of additional powerplants at eight of these existing dams. (See table 5.4.)

The administration opposed an identical Senate bill (S. 2187, 95th Congress) because the planning and study process had not been followed and recommended that more feasibility studies be performed.

We feel it is logical that the Bureau and Corps streamline their procedure for adding power at existing dams along the lines recently implemented by FERC for granting licenses for non-Federal dams.

#### ENVIRONMENTAL

There is much State and Federal legislation designed to maintain or enhance the quality of the environment. Appendix II lists and describes the purposes of Federal environmental legislation which may affect development of a hydropower dam. Many States have enacted similar legislation. For the purpose of analysis, the legislative constraints are divided into three segments:

- Wild and scenic river restrictions.
- Fish and wildlife restrictions.
- Other actions.

#### Wild and scenic rivers

The intent of the Wild and Scenic Rivers Act (Public Law 90-542, Oct. 2, 1968) is to preserve and protect in their scenic and free-flowing condition certain selected rivers of the United States for the benefit and enjoyment of present and future generations. Initially, the Congress established the National Wild and Scenic River System by designating all or portions of eight rivers to be administered by the Departments of the Interior and Agriculture. The 1968 act designated 27 other rivers for detailed study as potential additions to the national system. Several pieces of legislation have been enacted which have designated more rivers for study. During a study period, no alteration of the environment is allowed. As of February 1979, 28 rivers had been designated as wild and scenic. FERC estimates these designations preclude the development of 12,750 MW of hydroelectric capacity and 41.5 billion kWh of energy. Fifty-nine river segments are currently under study by the Departments of the Interior and Agriculture. FERC estimates these rivers preclude the hydroelectric development of 9,500 MW of capacity

TABLE 5.4

Bureau of Reclamation Existing Projects  
with Additional Capacity (note a)

<u>Project/State</u>	<u>Capacity MW</u>	<u>Cost (millions)</u>	<u>Benefit- cost ratio</u>
Friant powerplant, Central Valley project, California	22.7	\$ 19.4	1.92
Whiskeytown powerplant, Central Valley project, California	4.0	2.7	1.74
Palisades powerplant enlargement, Idaho	90.0	42.0	2.09
Canyon Ferry powerplant enlargement, Pick-Sloan Missouri Basin program, Montana	90.0	60.1	1.21
Colorado-Big Thompson powerplants, Colorado	108.0	48.9	1.07
Hoover Dam outlet works powerplant, Arizona, Nevada	260.0	40.0	1.12
Buffalo Bill Dam power- plant replacement, Wyoming	20.0 added (5.0) replaced	16.0	1.60
Yellowtail Afterbay powerplant, Pick-Sloan Missouri Basin program, Montana	<u>14.4</u>	<u>12.5</u>	1.53
Total	<u>604.1</u>	<u>241.6</u>	

a/As identified in H.R. 1688.

and 29.4 billion kWh in energy. If these potentials were developed, it could save the Nation about 114 million barrels of oil annually and, assuming \$20.00 per barrel, 1/ could displace about \$2.28 billion in oil imports.

Additionally, many States have also designated river systems as wild and scenic. (See table 5.5.) For example, the State of Oregon has designated 524 miles of eight rivers as part of the Oregon Scenic Waterways System. Table 5.6 shows that 2,371 MW of capacity and 1,460 average annual MW of energy could be developed on these rivers.

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1/Average price for a barrel of OPEC oil as of June, 1979.

TABLE 5.5  
State Wild and Scenic River Systems  
as of December 31, 1977

<u>State</u>	<u>Number of miles</u>
California	1,030
Indiana	59
Iowa	80
Kentucky	110
Louisiana	2
Maryland	441
Michigan	641
Minnesota	200
New York	144
North Carolina	36
North Dakota	213
Ohio	415
Oklahoma	151
Oregon	524
South Carolina	60
Tennessee	360
West Virginia	205
Wisconsin	91
Virginia	<u>83</u>
Total	<u><u>4,845</u></u>

Source: "Free Flowing" prepared by the River Conservation Fund.

TABLE 5.6

Oregon Scenic Waterways

<u>River system</u>	<u>Potential sites</u>	<u>Energy</u>	
		<u>Peak MW</u>	<u>Average MW</u>
Deschutes	12	550	394
Minam	0	-	-
Rogue	3	693	474
Owyhee	0	-	-
Illinois	6	719	294
John Day	3	161	129
Sandy	2	70	55
Clackamas	<u>3</u>	<u>178</u>	<u>114</u>
Total	<u>29</u>	<u>2371</u>	<u>1,460</u>

## Fish and wildlife restrictions

Both the Fish and Wildlife Coordination Act and the Endangered Species Act of 1973 establish national policy to preserve and protect fish and wildlife. The Fish and Wildlife Coordination Act states that wildlife conservation shall receive equal consideration with other features of water-resource development programs through planning and coordination of wildlife conservation and rehabilitation. Likewise, the Endangered Species Act establishes that the policy of the Congress is that Federal departments and agencies shall use their authorities to "seek to conserve endangered species and threatened species\* \* \*."

Hydropower facilities may conflict with the intent of these acts by altering the habitats of fish and wildlife. For example, the Department of the Interior's Fish and Wildlife Service has identified several possible reasons for intervention in development of hydropower facilities as a result of these acts. They stated that impoundments resulting from hydropower development could

- flood anadromous fish spawning beds,
- flood winter habitat for many species including elk and deer,
- destroy feeding and sheltering areas for animals,
- cause supersaturation of nitrogen in water, which kills fish.

The major effect on small-scale dams under the Fish and Wildlife Coordination Act is the requirement that fish ladders or fish elevators (fish facilities) be constructed to facilitate the passage of anadromous fish. The Fish and Wildlife Service recommends the addition of fish facilities if it finds them necessary.

In addition, a recent study by the Franklin Pierce Law Center indicated that each of the Northeast States has created at least one agency to protect the fish and game of the State. Many of these State fish and game agencies are empowered to require fish facilities. The cost of fish facilities can have an impact on an otherwise cost-effective project.

Some studies have identified the fish ladder requirement as one of the major obstacles to developing small-scale hydro. One recent report by the New Hampshire Governor's Commission estimated that such requirements for the transportation of fish on currently operating projects in New Hampshire are estimated to cost up to \$25 million. In addition, at one recently licensed 14.8 MW capacity project we visited, the developer told us that fish facilities represented \$1.2 million, or approximately 8 percent, of total direct project cost of \$17 million.

This project had an existing fish facility, but in order to meet Federal licensing requirements a new one was required. The developer also told us that fish facilities at many unlicensed existing sites would have to be upgraded if a developer wanted to license the project. Since the facilities would remain as is, even if the sites were not developed, the developer feels the Federal Government should provide direct assistance to the developer for improving these facilities.

The Federal and State fish protection agencies in Oregon indicated that one of the greatest problems caused by river impoundments is the movement of young anadromous fish to the ocean. Many fish are injured or killed going through turbines and over spillways or disoriented in reservoirs by slow-moving water. For example, the Northwest Fisheries Center stated in its report, "The Snake River Salmon and Steelhead Crisis," that in 1973, a low flow year in which almost all of the young migrants had to pass through turbines, a 95 percent loss of both chinook salmon and steelhead populations was measured from the "Salmon River to The Dalles Dam."

The National Marine Fisheries Service and the Oregon State Fish and Wildlife Service indicated the degree of impact hydropower facilities and impoundments would have on anadromous fish at 158 sites in Oregon as follows:



	<u>Number</u>	<u>Percent</u>
Agencies agreed impact on anadromous fish is high	99	63
One agency felt impact on anadromous fish is high	19	12
Agencies agreed impact on anadromous fish is medium, low or unknown	<u>40</u>	<u>25</u>
Total	<u>158</u>	<u>100</u>

#### Other actions

In a suit brought by the National Wildlife Federation, the Federal District Court in South Carolina noted that a hydroelectric dam may, under certain circumstances, be regarded as a "point source" of pollution, thus requiring the issuance of a EPA permit. EPA is currently considering the advisability of adopting that point of view in an agency regulation. This would impact on the development of small scale hydro projects. FERC and TVA believe that such actions would not only impact on the development of hydro expansions, but could reduce the generation from existing hydroelectric projects.

#### ECONOMIC

Economics is the bottom line in deciding whether to develop hydro projects. At the onset, there are a few generalizations that can be made about the economic and resource efficiency of hydropower. In terms of economic efficiency, hydropower has several inherent advantages over thermal power. The useful life of hydro structures is two to three times longer than that of thermal plants; conventional hydropower consumes no fuel (a major cost item for thermal power generation); hydropower efficiency is about 85 percent or more than twice that of a thermal plant; operation and maintenance costs are lower because equipment is less complex; and hydropower is capable of almost instantaneous response to increased load demands.

These inherent advantages have historically been offset by the fact that initial investment costs per unit of

capacity have been greater for hydropower than for thermal plant and equipment. But this advantage is being narrowed by the sharp increases in investment costs associated with the siting and construction of fossil fuel and nuclear plants including cost increases associated with equipment and operating costs for air pollution control.

In addition, economic feasibility is heavily dependent on the rates charged by utilities. For instance, the economics of developing a hydro project are better in Central Vermont than certain areas of Upstate New York where the electric rates are much cheaper. Overall, however, the economic attractiveness of hydro projects will constantly improve as the price for fossil fuels continues to increase.

We examined the following factors as they relate to the economic feasibility of hydro developments:

- Methods for determining project feasibility.
- Marketing.
- Hydroelectric financing.

#### Methods for determining project feasibility

During the course of our review, we identified several methods of assessing a project's economic feasibility. In some cases the method of analysis can determine whether a project should be built or not. Most economic analyses compare the net expected cash receipts and cash disbursements for the project with similar cash flows that can be expected from the next best alternative project. 1/

Analysis of non-Federal power projects usually recognizes the inflationary increases in variable costs, such as operations, maintenance, and fuel expenses over the projects' lives. Thus, by increasing the variable costs in an economic analysis, the capital-intensive hydropower project becomes more favorable when compared to non-renewable power sources.

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1/When projects are compared, their cash flows are discounted to reflect the time value of money on a constant dollar basis.

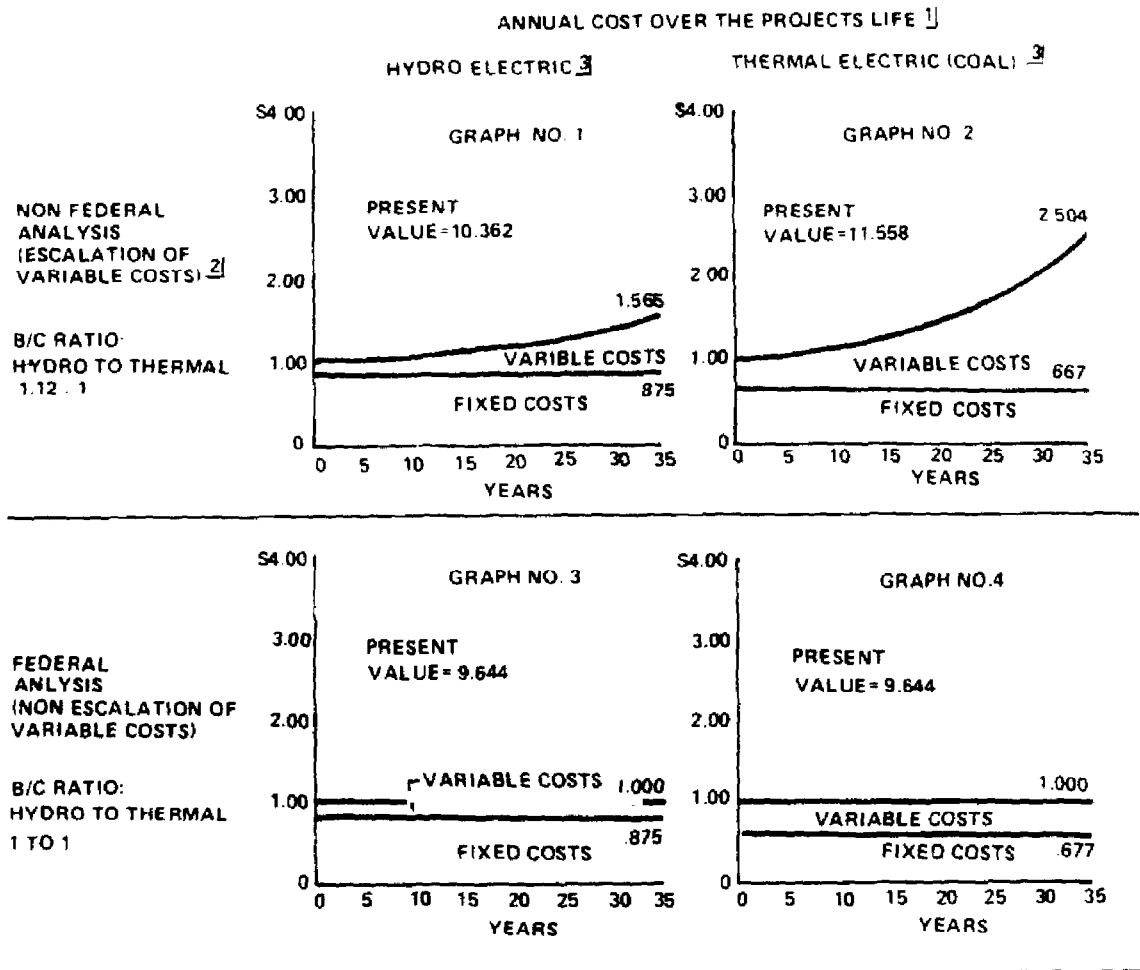
Several Federal and non-Federal energy planners told us that realistic comparisons of the economic feasibility of hydroelectric projects to alternative electricity supply sources must be done on a life cycle basis. This technique of analysis makes the assumption that the fuel cost of non-renewable electricity supply sources will continue to rise, due to inflation and scarcity. Through this method of analysis, several otherwise marginal hydro projects become feasible. But the Federal water resources agencies--the Corps of Engineers and the Bureau of Reclamation--and TVA are required by WRC's Principles and Standards to make economic comparisons using current costs, without considering increasing variable costs. This constant-dollar analysis technique works to the disadvantage of projects which have large initial capital investment compared to projects with lower initial cost and high operating costs, which is the case with hydroelectric in comparison to some thermal electric development. This technique does not consider that the relative economics of hydro will improve as fuel costs rise at a faster rate than inflation. Thus WRC's economic analysis reflects a conservative position and is somewhat misleading in evaluating hydroelectric projects.

Figure 5.2 illustrates the difference between hydro and thermal electric projects when using different analysis techniques. The Federal analysis (graphs 3 and 4, figure 5.2) required by WRC assumes that the relative difference between total costs for the project and those for the alternative project will remain the same throughout the project's useful life. Thus, projects with equal costs today (year zero) will continue to have equal costs throughout the project's life. Using WRC's analysis, each project has a 1-to-1 benefit-cost ratio when compared to the other.

However, if variable thermal costs increase over time, as recognized in most non-Federal analysis, then total costs at year 35 will be 60 percent higher than the hydro costs, (See graphs 1 and 2, figure 5.2.) The benefit-cost ratio for the hydro plant when compared to the coal thermal plant, using this approach, is 1.12 to 1.

FERC studies in evaluating non Federal hydroelectric projects, have indicated that a 0.7-to-1 benefit-cost ratio would produce a break-even return on investment because hydro projects have a much longer service life and lower variable costs than thermal electric projects. But WRC

**FIGURE 5.2**  
**EFFECT OF DIFFERENT ANALYSES METHODS**  
**ON THE VIABILITY OF HYDROELECTRIC**  
**AND THERMAL ELECTRIC PROJECTS**



<sup>1)</sup> FOR PURPOSES OF ILLUSTRATION THE PROJECT USEFUL LIFE HAS BEEN ASSUMED TO BE 35 YEARS EVEN THOUGH THE HYDRO PROJECTS USEFUL LIFE IS LONGER

<sup>2)</sup> PRESENT VALUE COMPUTED USING 5 PERCENT ANNUAL VARIABLE COST ESCALATION AND A 10 PERCENT DISCOUNT RATE FOR 35 YEARS FOR A PROJECT COSTING \$1.00

<sup>3)</sup> FOR A TYPICAL PROJECT TUDOR ENGINEERING ESTIMATED THAT 12.5 PERCENT HYDROELECTRIC COSTS ARE VARIABLE WHILE 33 PERCENT OF ELECTRIC (COAL) ARE VARIABLE

continues to require at least a 1-to-1 benefit-cost ratio for Federal hydro projects to qualify for congressional authorization and funding.

A proposed rulemaking of the Water Resources Council's principles and standards was published in the May 24, 1979 Federal Register. These changes, if adopted in the final rulemaking, would allow life cycle economics to be taken into consideration when conducting a benefit-cost study.

### Marketing

Although the cost for hydropower will become economically feasible over the life of a hydro project, initially its cost may be higher than alternative sources. In order to make these projects operational, developers have had to devise unique marketing schemes to overcome this economic constraint. At one project we visited, the developer was able to negotiate a marketing arrangement with the local utility that compensated for the project's lack of economic feasibility in the early years. Briefly stated, the utility will pay the developer a rate that is made up of the utility replacement cost of fuel and a purchased power credit. The purchased power credit is designed to allow the developer to achieve a positive cash flow from the start of the project and the utility to accumulate a purchased power credit to draw on once the replacement cost of fuel exceeds the cost for hydro.

In another case, a developer uses a method similar to the royalty method used in the oil and gas industry to make projects economically feasible. This method allows the developer to refurbish a site and sell the power without incurring the site acquisition costs. In return, the developer pays the owner a royalty for the site's use.

The State of New Hampshire has also attempted to deal with the marketing problem by passing legislation on June 16, 1978, to guarantee a developer a market for hydropower. The law requires the local utility to purchase the power at a rate determined by the State Public Utility Commission. This is similar to policies followed in France, as discussed on page 10 where the French Government guarantees a market for hydropower--regardless of cost--from sites under 8 MW.

The Congress has addressed the marketing problem in the National Energy Act (P.L. 95-617) by authorizing FERC to order interconnection and "wheeling" of power at reasonable rates from small production facilities when it is in the public interest. FERC is in the process of developing proposed rules to implement this provision of the act. This could be accomplished in regions where Federal power agencies--TVA, power marketing agencies, and Rural Electric Cooperatives--are located, whereby these agencies would purchase the hydropower output if no other market is available.

### Hydroelectric Financing

The U.S. Treasury and the Internal Revenue Service set rules that affect the taxability of bonds. IRS regulation 1.103.7 states that if more than 25 percent of the electricity generated at a power project is sold to a private utility or transmitted over private utility lines, then the bonds sold by a public utility are subject to Federal income tax. Under this rule the public utility must pay 2 to 3 percent more in interest to attract investors. The added costs could increase the interest costs by 50 percent over the project's life. For example, the Nevada Irrigation District started the \$8 million (13 MW) Rollins small hydro project expecting to sell Federal tax exempt bonds at around 6 1/2 percent interest. <sup>1/</sup> Instead the Irrigation District had its bond declared taxable by IRS because the District sold the power to a private utility. The market rate for the taxable bonds was 9-7/8 percent.

This situation indicates how State and Federal tax policies can seriously inhibit hydroelectric development. Public non-profit agencies, such as irrigation districts, want to develop hydroelectric resources as a means of reducing the cost of their principal activity, selling irrigation water. But revenues from a successful hydro project could subject them to State and Federal regulation and taxation as an electric utility.

The House of Representatives passed legislation to expand the use of tax-exempt bonds to include certain private hydroelectric energy facilities. Presently the bill is awaiting passage by the Senate.

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<sup>1/</sup>It should be noted that a non-taxable status is a subsidy from the general public to serve a designated, specific social purpose.

The Department of the Treasury does not support this because the agency feels the extension will put additional burdens on the tax-exempt market and drive up the cost of conventional municipal financing. The Treasury went on to say that the legislation would result in an increased level of subsidy of conventional municipal borrowing as a consequence of generally higher interest rates in the tax-exempt market.

#### OPERATIONAL

Decisions on whether to develop small hydro sites, purchase the power output of small-hydro sites, or develop other sources of electricity are very dependent on the reliability of the power supply sources. For many smaller dams the power output is limited to run of the river (little or no reservoir storage). Because of widely varying river flows, many utilities feel they cannot depend on small-hydro projects to produce power when needed. For example, in the Northeastern United States streamflows are highly variable. In the driest 2 months of the year, flows are one-tenth of the flows in the wettest 2 months. Unless substantial flow regulation exists, small-hydro energy generation will vary accordingly and the small-hydro plant has little worth as a source of dependable capacity. Because of this, the motivation to develop small-hydro can vary significantly. Major utilities have not yet shown a great interest in small hydro because it usually does not provide firm energy and they believe it takes as much staff time for them to obtain a license and build a 10-MW plant as it does for a large thermal plant.

Irrigation districts, on the other hand, are motivated to operate projects that generate any amount of electricity needed to reduce irrigation costs. Smaller utilities and municipalities can add the small-hydro plant to their system and increase their total generation. This has resulted in most small-hydro interest coming from small public utilities, municipalities, cooperatives, and irrigation districts. These groups also have more problems than large utilities have in obtaining financing to proceed with project development and to obtain a market for non-firm energy.

Reliability of small projects is also greatly influenced by the maintenance provided by the developer. At one 1.8-MW project we visited in upstate New York, the owner

told us he has an advantage over most developers because he also owns a company which performs repair and maintenance on hydro equipment. He claimed this advantage gives his project a very high reliability. He told us he receives 9 mills per kWh from the local investor-owned utility and contrasted this to the 4 mills per kWh price another small-hydro development with poor maintenance was receiving from the same utility.

We also talked to an official from a local utility who told us that the utility is willing to buy more power from private developers if the developers can operate at the price the utility is willing to pay. This price is greatly influenced by project reliability. The official said streamflow and maintenance are the main factors impacting on reliability.

Even if a small-scale developer decides to use the power he generates for his own use, reliability can still be a problem. Unless the developer has back up capacity, he cannot completely divorce himself from the local utility and is, therefore, still subject to the utilities' monthly demand charge.

We visited a proposed project in upstate New York that a university is considering developing. An official told us that the proposed project could deliver from 3 to 5 percent of the institution's electrical needs. The spokesperson told us that because the university would still have to pay a heavy demand charge, even if it generates its own electricity, the project may not be economically feasible. He also told us that the utility had offered to buy the power from the university, but that the rate offered would only allow them to break even.



## CHAPTER 6

### CONCLUSIONS AND RECOMMENDATIONS

Recent price increases in imported oil demonstrates the urgency for the United States to rapidly develop its renewable resources so dependence on such imports can be decreased. The United States has additional hydropower potential which if developed could displace oil consumption. Opportunities for building large conventional hydroelectric plants are limited, however, because sites are less desirable and often involve adverse environmental impacts.

Prospects for additional development lie primarily in those existing sites which offer few environmental barriers. The dam structures are in place and many of them have generated electricity in the past. But reactivation of these sites is not a simple process. Prospective developers face many problems which many feel outweigh the benefits. This is unfortunate because development of these sites, while not providing a total solution to our energy problems, could make a contribution toward reducing our oil consumption and imports. Hydro also has advantages because it is one of our renewable resources for which technology is available and because it does not require a long-term research and development effort. But recognition and development of small hydro has been slow. The following are our conclusions and recommendations on actions we feel are needed to obtain the most expeditious and optimal hydro development.

#### CONCLUSIONS

The administration's interest in small hydro has been somewhat inconsistent even though (1) its National Energy Plan focused on small-hydro sites as a potential renewable resource for reducing oil and gas dependence, (2) it was subsequently included in the National Energy Plan, and (3) it was designated by DOE as one of eight energy supply sources to "key on" for commercialization. But, if the Congress had not taken the initiative, there would have been no money available for small hydro in fiscal year 1978, the first year of the program.

The Small Hydro Program was established rather quickly by DOE in fiscal 1978 when money became available for such a program. Since then the Program has moved slowly. For example, even though it was recognized that actual demonstrations should occur in order to measure constraints and

show hydro viability, DOE's program had been in existence for over 2 years before any demonstrations were awarded.

Lack of staffing and clear direction for the hydro program have also resulted in little assistance and information being offered to potential hydro developers to help them overcome or reduce the many obstacles to getting a site developed. Most potential developers we talked with are not in the business of hydro development and are inexperienced in the development process. Assistance through an outreach program would be a key element in providing an impetus for hydro development. In addition, the hydro program has developed no strategy for achieving its objective of nurturing the United States manufacturing of hydro equipment.

DOE's failure to aggressively foster demonstrations and provide guidance will result, we believe, in the Program not attaining its updated 1985 development goal of 1,000 MW of small hydro capacity. More recent actions which have a negative impact on attaining these goals is the administration's contradictory actions in trying to clearly define how it plans to foster small hydro development. Although the administration did not oppose the \$300 million construction loan program authorized in the National Energy Act, which was signed into law in November 1978, its budget request submitted in January 1979 did not request such funds. According to an OMB official, funding was not requested because it was believed (1) small-hydro technology was available and (2) small hydro sites would be developed regardless of whether the loans are made. According to the official, economic and other constraints were not considered overriding restrictions. But recently, the administration announced its rural energy development initiative which redirects almost \$300 million for grants, loans, and loan guarantees to encourage small-hydro development. Actions not to implement one incentive program because the administration believed it was unnecessary and then to provide money through non-energy agencies offers no clear understanding of the administration's policy on fostering hydroelectric power.

We applaud FERC's attempts to streamline its licensing process. Actions such as this are positive and could result in eliminating the doubts and concerns of potential hydro developers. However, FERC is receiving requests for hydro permits and licenses more rapidly than anticipated. If this continues, application backlogs could occur because staffing

levels would not be adequate. The result would be time delays which could counteract the streamlining. In this regard, if additional staffing is needed, the net effect on FERC's budget would be minimal because FERC's hydroelectric licensing functions are essentially self-sustaining and licensees are assessed an annual charge for the costs of administration.

We feel FERC should expeditiously decide who has preference--public or private entities--in applications for relicensing of existing hydro facilities. Such facilities sometimes have additional capacity, and until the issue is resolved the capacity will not be developed.

WRC's principles and standards for assessing the economic benefits of hydropower are outdated. As a result, the Federal water resources agencies--Corps of Engineers and Bureau of Reclamation--and TVA must make economic assessments that penalize the use of a renewable resource such as hydro even though the National Energy Plan emphasizes its development. The principles do not recognize the life cycle benefit-cost ratio of power generation from a renewable resource such as hydro. But recent proposed changes to the principles and standards could correct this situation.

Although the licensing process for adding power at existing non-Federal facilities has been and is in the process of being streamlined, no similar actions are being taken to reduce the approval process for adding power at existing Federal dams. If additional units at existing Federal dams are to be installed faster than can now occur, the approval process must be steamlined.

#### RECOMMENDATIONS

We recommend the Secretary of Energy:

- Increase efforts to provide assistance, information, and guidance to prospective hydro developers through an outreach program. DOE regional office staff should be used to provide such information because of the knowledge and experience they have gained on a local basis.
- Expedite efforts to develop hydro demonstrations through its grant program in order to provide the earliest measurement of constraints and

demonstrate the capabilities of small hydro. Until constraints are actually experienced, actions cannot be taken to correct them.

- Reassess its goals for hydro development. We believe the 1985 goals as now stated cannot be attained. Optimistic goals are worth striving for, but realistic goals should be made, based on current programs.

We recommend the Chairman, FERC:

- Expeditionously review and make a ruling on who has preference when competing applications for relicensing exists. An early decision could mean earlier capacity expansions at some sites.
- Closely monitor the applications for hydro licenses and, if the volume continues to increase, request and assign additional staff so backlogs will not occur.
- Seek statutory authority, in dealing with interconnections, similar to that in the Public Utility Regulatory Policies Act for TVA, to require that the Federal power marketing agencies and Rural Electric Cooperatives purchase the hydropower output when no other markets are available.

We recommend the Director, OMB, assess OMB's position on the need for incentives to encourage small-hydro development in light of its decision not to request funding for one incentive program in the Department of Energy because it was not believed necessary and then to introduce a similar type incentive program in non-energy agencies. In performing the assessment, OMB should consider the appropriate agency or agencies to carry out the rural energy development initiative program taking into consideration the fact that DOE would have more expertise in the energy area and it would seem to be in a better position to evaluate the overall considerations in awarding these incentives.

We recommend the Director, Water Resources Council, adopt the provisions in WRC's updated draft of its principles and standards as proposed in the May 24, 1979, Federal Register. These changes would require Federal hydro benefit-cost studies be done on a life-cycle plus inflation costing basis. We would expect the water resource agencies--Corps and Bureau--and TVA to immediately implement these changes into their planning process when the updated principles and standards are finalized.

We recommend the Secretaries of the Interior and the Army direct the Bureau and Corps, respectively, to streamline their procedures for adding power at existing dams when such additions require no structural changes and result in minimal environmental impact.

We recommend the Congress amend the National Energy Act (16 U.S.C. 2708) by defining a small-hydro project as one that could have up to 100-MW capacity. While most sites fall within the 15-MW limitation now established, several good sites are larger. It would be unfair to exclude them from the feasibility study loan program. If the limit is not increased, the potential exists that such projects will not be developed to full capacity solely in order to qualify for a loan. The 100-MW limit is an engineering definition of a small site.

## AGENCY COMMENTS AND OUR EVALUATION

Copies of the draft of this report were furnished to the Departments of the Interior, Energy, Defense, and the Army; Federal Energy Regulatory Commission; Tennessee Valley Authority; Water Resources Council; and Office of Management and Budget for their comments. The Department of Defense was unable to provide us with formal comments within our requested time frame. The other departments and agencies responded to the draft report and their comments are included in appendixes III to IX. The report was revised in several sections to reflect technical comments. The following sections summarize the overall comments and present our views on these matters.

### Department of the Army

The Department of the Army stated that the report is objective and thorough. In regards to our discussion and recommendation on life-cycle analysis they pointed out that the Corps of Engineers is initiating a study on the feasibility of conducting life-cycle analysis as part of project feasibility studies.

### Federal Energy Regulatory Commission

FERC stated their general concurrence with the report's conclusions and recommendations and made several comments for the purpose of clarification. FERC pointed out that its actions to simplify its licensing procedures have resulted in new less complex or costly licensing requirements if considered alone. FERC adds, however, that its ability to totally streamline the licensing process is limited. For instance, FERC points out that before it issues a license, it must assure compliance with some 17 other Federal statutes that have given other agencies conflicting or overlapping authority and no other Federal or State agency has made an effort to simplify regulations. Because of this, FERC believes consideration should be given to establishing a single Federal agency for hydropower licensing.

FERC stated that a final resolution to the issue of competing applications for relicense will take a long time to resolve because there may be extensive litigation, regardless of FERC's outcome. We agree that litigation will probably occur regardless of the outcome and the situation could take a long time to resolve. This is the reason why

we make the recommendation that FERC expeditiously rule on this matter. The sooner the ruling, the sooner the litigation will proceed, and a final resolution obtained.

FERC stated that economic constraints to hydropower development are perhaps the most significant. Economic incentives for small-scale hydropower development have not been forthcoming, and there is a general reluctance by small developers to proceed without these incentives. Further, hydropower has not been provided the same tax incentives, loan guarantees, and other economic incentives as other renewable energy technologies. We agree with FERC's assessment that economic constraints are the most significant in preventing hydropower from being developed. We further concur that a lack of financial incentives has prevented the development of many small sites. This is precisely the reason why we make the recommendation that OMB assess its position on the need for incentives to encourage small-hydropower development and who should carry out an incentive program.

#### Department of the Interior

The Department of the Interior stated that the report correctly describes the responsibility and involvement of Interior in the development of hydroelectric power. Interior had no objection with the report's recommendation directing it to streamline its procedures relating to adding power at existing dams, when a structural change is not necessitated by such action and if the environmental impact is "minimal." The Department further stated that the Secretary's guidelines for the fiscal year 1981 Bureau of Reclamation budget places a very high priority on increased hydroelectric capacity at existing facilities.

#### Tennessee Valley Authority

TVA stated that it supports the basic philosophy of increasing power production from renewable resources where it is economically feasible. Accordingly, TVA believes it is important that increased use be made of the hydropower potential in the TVA region, as well as the rest of the Nation.

TVA further pointed out that in instances where small hydropower purchases would be available in their marketing area, it would not object to such purchases as long as the power costs over the long run did not exceed the incremental

cost of alternative electrical energy sources available to the region. Our recommendation to FERC reflects the provision of the Public Utility Regulatory Policies Act of 1978 which would result in such actions.

#### Water Resources Council

WRC stated that the report did not take into consideration recent proposed modifications to its principles and standards. In addition, this point was raised by TVA and the Department of the Interior. A proposed rulemaking was completed and published in the Federal Register on May 24, 1979, which specifically addresses the subject of benefits and alternative costs of hydropower and allows consideration of escalation of fossil and other fuels.

GAO agrees with the thrust of the proposed modifications and recommends that the rulemaking concerning this area be adopted as proposed.

#### Department of Energy

DOE stated that many of the report's recommendations will be useful in accelerating the development of small-scale hydropower. But DOE did take exception with two recommendations directed at OMB and DOE which state:

1. Request from the Congress the loan money authorized by the National Energy Act (\$300 million) and
2. Speed up the grant program for demonstration projects.

Because of the administration's rural energy initiative, we revised our recommendation requesting the (\$300 million) loan money. However, we are questioning how this incentive program will be administered. This point is addressed on page 59 in our discussion of OMB's comments.

We disagree with DOE's conclusion that the speedup of the grant program for demonstration projects would not considerably increase the pace of the Small Hydro Program. In conducting our review, we spoke to many individuals who believe that small-hydro demonstration is the key to getting maximum hydro developed in a shorter timeframe. They believe a demonstration or two per State, particularly in the Northeast, would show those skeptical of small hydro its positive features. This would lead to further development and have a "snowballing" effect. This position was taken in two small-hydro seminars funded by DOE in September 1977 and May 1978.



DOE implies that United States firms would have difficulty competing on the world hydro equipment market. Thus, new firms are not likely to seek entrance into the market. This observation by DOE is not in line with the Small Hydro Program's objective to nurture the United States' manufacturing of hydro equipment. If, in fact, DOE believes the United States manufacturers could not compete, then the objective of nurturing domestic development should be reevaluated.

DOE stated it currently has an outreach program underway and has assigned 7.5 staff years of effort in the regional offices for low head hydro activities in fiscal year 1979. These resources are distributed among those regions with the greatest potential for increased hydropower generation.

We are pleased to see DOE has begun recent actions to implement an outreach program, but feel it will be awhile before it can become an effective tool in helping potential developers get their projects on line. As of June 1979 only two regions had submitted action plans to implement an outreach program and in addition the first coordination meeting between headquarters and the regions to discuss this activity was not held until June 1979.

#### Office of Management and Budget

OMB agrees with our view that small-hydro technology is available, but states that a new construction loan program (\$300 million), as authorized by the National Energy Act (P.L. 95-617), to subsidize small-hydro applications is not appropriate. Rather, OMB believes encouragement of small-hydro technologies will come from realistic pricing of conventional energy alternatives such as through phased decontrol of oil and gas prices and through reduced institutional barriers.

We concur with OMB that increased small-hydro development will result from increased prices of alternative energy sources. However, it is unclear why OMB on the one hand would not provide \$300 million for construction loan incentives through the Department of Energy as authorized by the National Energy Act (P.L. 95-617), while on the other, redirect a \$300 million small-hydro grant, loan, and loan guarantee rural energy initiative to foster its development.

If the administration believes, as indicated in its rural energy initiative, that small hydro should receive incentives, then perhaps the moneys should be funneled through the Department of Energy, which has more expertise in the energy area and would seem to be in a better position to evaluate the overall considerations in awarding these incentives.

SEVEN PROJECTS AWARDED DEMONSTRATION GRANTS

1. Antrim County, Michigan--Elk River Dam at Elk Rapids, Michigan.

Antrim County, Michigan, proposes to refurbish three existing turbine units and add a 350-kW generator to each unit at the power plant on Elk River in the Village of Elk Rapids, Michigan. Each generator will operate as a peaking unit with either 700 kW or 1050 kW, depending on water availability. This site is unique as a peaking unit because of its very large storage area.

2. Brown-New Hampshire, Inc.--sawmill site at Berlin, New Hampshire.

Brown-New Hampshire, Inc., proposes to install five turbines with a total capacity of 2,800 kW at the sawmill site in Berlin, New Hampshire. This installation would produce 20.4 million kWh annually. The Federal Energy Regulatory Commission has issued an order requiring Brown-New Hampshire, Inc., to proceed with rehabilitation of the project.

3. F.W.E. Stapenhorst, Inc.--Goodyear Lake Power Station at Milford, New York.

F.W.E. Stapenhorst, Inc. proposed to install a turbine generator at the Goodyear Lake Power Station at Milford, Ostego, New York, on the north branch of the Susquehanna River. The turbines, with a capacity of approximately 1,325 kW, would generate about 7.5 million kWh per year.

4. Green Mountain Power Corporation--Bolton Falls Dam near Waterbury, Vermont.

The Green Mountain Power Corporation proposes to renovate the existing Bolton Falls Dam and install a new power plant on the Winooski River near Waterbury, Vermont. Power has not been produced at this site since 1938. The plant would generate 6,500 kW. The estimated annual energy production is 28 million kWh.

5. Reigel Textile Corporation--Fries, Virginia.

The Reigel Textile Corporation proposes to add a 2,160 kW generator to its existing 3,000-kW capacity at its Fries, Virginia, plant. This plant is located on the New River. It would bring the generation capacity up to the optimum for that site. The annual energy

production for the proposed generator would be 13 million kWh. The power produced will be used by Reigel Textile during plant operation 24 hours a day for 5 or 6 days per week.

6. Salt River Project Agricultural Improvement and Power District--South Consolidated Canal site near Mesa, Arizona.

The Salt River Project Agricultural Improvement and Power District (Salt River Project) proposes to install a 1,400-kW turbine generator at a site on the project's south consolidated canal located just northeast of Mesa, Arizona. The average annual energy generation would be 5.9 million kWh.

7. Turlock Irrigation District--Drop Number One site at Turlock Lake Dam near Modesto, California.

Turlock Irrigation District proposes to install three turbine generators at Drop One on Turlock Lake Dam. The turbine generators are each rated at 1086 kW and will produce an overall total of 12.1 million kWh annually during the 7-month irrigation period.

LEGISLATION RELATING TOHYDRO DEVELOPMENTFederal  
legislationPurpose of legislation

Endangered Species Act  
of 1973  
(Public Law 93-205)

Conserve the ecosystems upon  
which endangered and threat-  
ened species depend.

Coastal Zone Management  
Act of 1972  
(Public Law 92-583)

Preserve, protect, develop,  
and where possible, restore  
or enhance, the resources of  
the Nation's coastal zones for  
this and succeeding generations.

Wild and Scenic Rivers Act  
(Public Law 90-542)

Protect and preserve selected  
rivers in free-flowing condition.

National Trails System Act  
(Public Law 90-543)

Establish a national system of  
recreation and scenic trails.

Wilderness Act  
(Public Law 88-577)

Protect and manage undeveloped  
Federal land to preserve its  
wilderness character.

Act of May 24, 1974  
(Public Law 93-291)

Preserve historical and arche-  
ological data which might  
otherwise be irreparably lost  
or destroyed caused as a re-  
sult of any Federal construc-  
tion project or federally  
licensed activity or program.

National Historic Preser-  
vation Act of 1966  
(Public Law 89-665)

Preserve historical and cul-  
tural foundations of the  
Nation as a living part of  
our community life and de-  
velopment in order to give  
a sense of orientation to  
the American people.

Federal  
legislationPurpose of legislation

Act of May 28, 1963  
(Public Law 88-29)

Assure adequate outdoor recreation resources and conserve, develop and use such resources for benefit and enjoyment of the American people.

National Environmental  
Policy Act of 1969  
(Public Law 91-190)

Establish policy to use all practicable means and measures, including financial and technical assistance. In a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

Federal Water Pollution  
Control Act Amendments  
of 1972  
(Public Law 92-500)

Restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

Fish and Wildlife Coordina-  
tion Act  
(Public Law 85-624)

To recognize the vital contribution of our wildlife resources to the Nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation.

Clean Water Act of 1977  
(Public Law 95-217)

The objective of this act is to restore and maintain the chemical, physical, and biological integrity of the Nation's water.

Federal Land Policy and Management Act of 1976  
(Public Law 94-579)

To establish public land policy; to establish guidelines for its administration; to provide for management, protection, development, and enhancement of the public lands and for other purposes.



## United States Department of the Interior

OFFICE OF THE SECRETARY  
WASHINGTON, D.C. 20240

JUN 1979

Mr. J. Dexter Peach  
Director  
Energy and Minerals Division  
United States General Accounting Office  
Washington, D.C. 20548

Dear Mr. Peach:

We have reviewed the report on "Hydro Power--An Energy Source Whose Time Has Come Again" submitted with your letter dated May 24, 1979, and have the following comments:

The report presents the findings of a GAO survey on recent U.S. experience in hydroelectric power development to meet national energy demands, particularly in recognition of the substitutability of hydroelectric power for power generated by use of fossil fuels and the potential reduction in oil importation. The emphasis is on "small hydro" development, a program included in the President's Energy Policy Messages of 1977 and 1978 and incorporated in the National Energy Act of 1978. The program is administered by the Department of Energy and has as its goal the identification of economic potential and institutional barriers to a goal of 1,500 megawatts of installed capacity by 1985.

The responsibility and involvement of Interior in hydroelectric power development is correctly described, and one recommendation is addressed directly to the Secretary. That is, GAO says that the procedures of the Bureau of Reclamation relative to adding power at existing dams should be streamlined, when a structural change is not necessitated by such action and if the environmental impact is "minimal." We have no objection with this recommendation because if the two conditions prescribed by the GAO exist--no structural change and minimal environmental impact--then the study time and costs involved are less and the conclusion and recommendation can be developed more readily. The Secretary's guidelines for the FY 1981 Bureau of Reclamation budget put increased hydroelectric capacity at existing facilities in a very high priority. The Bureau "Program Strategy Paper, FY 1981" places hydropower as its "principal thrust" in plan formulation category.

In reference to the application of non-Federal entities for authority to install power generation facilities at BuRec dams, each request is reviewed on the merits. There is no exclusive Interior policy on this



subject. Non-Federal entities must obtain a license from FERC--first, to study the feasibility and then to construct, and Interior has the opportunity to comment. The applicant must conduct the necessary studies and meet all applicable environmental statutory requirements and arrange contractual payment terms with the Federal owner for use of the facility. Though the FERC licensing procedures may be "streamlined," Interior's interest in the environmental protection, the complete achievement of the project's authorized purposes, and the assurance of proper repayment requirements cannot be slighted.

In addition to these comments on the particular references to Interior, the following remarks are in order:

On page 20, the first full paragraph, the reference to savings in oil from a pumped storage project appears to be misleading. It appears from the statement that pumped storage projects save energy when actually they are energy users. They do, however, effectively provide additional capacity for meeting premium-peak energy needs at economical costs.

On page 27, in the second paragraph, the Federal Power Commission was established in 1920, not the FERC.

On page 28, in the last paragraph, the reference should be to the President's message to the Congress on "water resources policy reforms" of June 6, 1978.

On page 33, the reference to Table 5.1 and the statutes cited should be corrected to note that the laws apply to all Federal water resources projects and programs not just to hydroelectric projects, and some of the statutes apply to nonwater projects as well.

On page 49, the reference to "the planning and study process" for adding power at existing Federal dams exaggerates the time involved by saying that it takes as long as planning and developing a completely new structure. However, the Federal responsibility for the broad public interest, including establishing the proper costs involved, should not be slighted for "streamlining."

On page 60, in the last paragraph, the reference to "economic feasibility" should be more completely developed or explained. Electric power rates are subject to change and the local utilities that may be expected to purchase the new small project generation must, of necessity, bargain for acceptable terms, and also must justify the arrangement to the regulatory commission involved. The proper term is "financial" feasibility rather than "economic."

On pages 62 and 63, the references to Federal agency power evaluation methods and the WRC "principles and standards" do not acknowledge the recent (May 24, 1979, Federal Register, Vol. 44, No. 102, Part II) proposed rules by the Water Resources Council to provide for changes in evaluation procedures and methods including hydroelectric power. The evaluation system does not preclude a "life cycle" comparison, but that method may be required, among other valid methods, as the result of comments from the 60-day period of public review that expires July 27, 1979. (See also, page 76 and page 78.)

On page 67, the reference to the Federal income tax on the interest from certain revenue bonds should acknowledge that a nontaxable status is a subsidy from the general public to serve a designated, specific social purpose. Irrigation is an already heavily subsidized endeavor and so a further subsidy should be specifically noted. This point also should be noted in regard to the last paragraph on page 69. Further comment on the subsidy issue is induced by the list of projects awarded demonstration grants (Appendix I.2).

Sincerely,



William L. Kendig  
Acting Deputy Assistant Secretary  
Policy, Budget and Administration

GAO note: Page numbers in appendixes III and VI refer to the draft report and do not necessarily correspond to this final report.



Department of Energy  
Washington, D.C. 20545

June 8, 1979

J. Dexter Peach, Director  
Energy and Minerals Division  
U. S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review and comment on the GAO draft report entitled "Hydro Power -- An Energy Source Whose Time Has Come Again." Our views with respect to the text of the report and recommendations are discussed below.

The subject draft report makes a number of recommendations which affect DOE, FERC, and OMB. The Department believes many of these recommendations will be useful in accelerating the development of small scale hydro power. The notable exceptions are the recommendations directed at OMB and DOE which state:

- o Request from Congress the loan money authorized by the National Energy Act (\$330 million) and
- o Speed up the grant program for demonstration projects.

In recommending these two actions the report indicates that the pace of the small scale hydro program would be considerably accelerated. The report asserts that the resource base is sufficient, a number of economically viable processes exist, and that loans would alleviate what is perceived to be major constraint to implementation--capital availability. The Department does not believe this to be the situation and has not found evidence which would allow the pursuit and acceptance of these two recommendations.

The draft report also cites a number of estimates of the resource base, including that of the Corps of Engineers, which identified 54,600 MW of capacity from existing facilities. The report further stated "that constraints could stand in the path of some development." The Presidential Solar Domestic Policy Review examined the Corps of Engineers' report and found that its estimates assumed that maximum hydraulic head would be available continuously, that all other uses of reservoir storage would be subject to preemption for hydro power,

and that all available sites would be utilized regardless of environmental constraints. Thus, the number of sites and goals of the program are probably unrealistic and other studies initiated since then have indicated a more realistic ceiling of 5000 to 10,000 MW.

The economics of small scale hydro are affected to a significant degree by the cost of turbines, generators, inlets and outlets, penstocks, and associated equipment. For the most specialized items, turbines, generators, foreign wares are (with some exceptions) priced much lower than their domestic equivalents. It is possible, therefore, that only a few selected items for engineering development would have a reasonable chance to alter the situation in favor of United States components. Thus, cost and feasibility would not be affected by Federal RD&D. The present modest market is mostly overseas and is being supplied by foreign manufacturers. Due to the limited size of the domestic market and since the high capital investment requirements outweigh the benefits, new United States firms are not likely to seek entrance into the market.

Concerning the loan funds authorized under the NEA, the availability of funds will not overcome institutional nor environmental constraints which in many instances constitute the principal barriers. With regard to regulatory issues, the State, not the Federal Government, has the operational capability to enhance small hydroelectric development. If a project is desirable, the State Public Utility Commission (PUC) agrees that utilities can purchase that power without regard to price, and then utilities roll in the cost (average cost pricing). In this process the local investor or utility developing small scale hydroelectric power receives a fair return, and a complex set of issues are resolved through an appropriate incentive mechanism. A set of actions, such as these, are much more efficient and equitable on a national basis than a Federal loan program.

Another report recommendation required DOE to utilize regional office staff to provide assistance, information, and guidance to prospective hydro developers through an outreach program. Such an effort is already underway. The Department has assigned 7.5 staff years of effort in the regional offices for low head hydro activities in fiscal year 1979. These resources are distributed among those regions with the greatest potential for increased hydro power generation.

We appreciate your consideration of these comments in the preparation of the final report and will be pleased to provide any additional comments you may desire. Comments of an editorial nature have been provided to members of your staff.

The Federal Energy Regulatory Commission is providing independent comments to you by a separate letter.

Sincerely,



Donal C. Gestiehr  
Director  
Office of GAO Liaison



DEPARTMENT OF THE ARMY  
OFFICE OF THE ASSISTANT SECRETARY  
WASHINGTON, D.C. 20310

13 JUL 1979

Mr. Henry Eschwege  
Director  
Community and Economic  
Development Division  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Eschwege:

This is in reply to your letter to the Secretary of Defense of 25 May 1979, regarding your draft report on "Hydro Power -- An Energy Source Whose Time Has Come Again," Assignment Code 008730, OSD Case #5199.

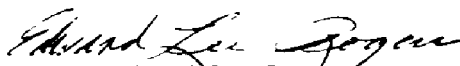
From our viewpoint the report is objective and thorough. Comments, therefore, are limited in nature.

The last sentence of the second paragraph of page 19 should be deleted from the discussion of U.S. Army Corps of Engineers activities. The National Hydropower Study will not include a significant effort to identify hydropower potential associated with irrigation canals and conduits. The Bureau of Reclamation does have a three year study of low-head hydropower potential in the seventeen western states which includes an indepth look at irrigation facilities under its jurisdiction. We therefore recommend the subject be added to the section concerning the Bureau of Reclamation.

Footnote 1 in Table 4.2 on Page 31 is not correct, as there was no Water Resources Act of 1978. The 10 million dollars shown in the Table were authorized in Section 167(d) of the Water Resources Development Act of 1976. Legislation to modify Section 167(d) to authorize expenditure of 5 million dollars in fiscal years 1980 to 1982 has been proposed but not enacted.

Pages 61 to 65 of your report discusses life-cycle analysis. The Corps of Engineers has initiated a study of the feasibility of conducting life cycle analysis as part of project feasibility studies. A contract to develop data and analytical procedures for forecasting relative price shifts, such as increasing fossil fuel costs, is expected to be awarded in June 1979.

Sincerely,



Edward Lee Rogers  
Deputy Assistant Secretary of the Army  
(Civil Works)

## FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON, D.C. 20426

Mr. J. Dexter Peach  
Director  
Energy and Minerals Division  
United States General Accounting Office  
Washington, D. C. 20548

JUN 3 1979

Dear Mr. Peach:

Chairman Curtis has asked me to reply to your letter of May 24, 1979, requesting comments on the draft report, "Hydro Power -- An Energy Source Whose Time Has Come Again". We have reviewed the report and generally concur with its recommendations and conclusions. Therefore, our comments are for the purpose of clarification and of noting minor corrections to certain statements.

We view the constraints to small scale hydropower to be twofold, i.e. institutional and economic. Institutional problems facing a small scale hydropower developer, as the report notes, relate to the many statutes with which a developer must comply. The report should note that licensing and permitting requirements are at two levels - Federal and State. Each has become complex because of a number of statutes that require compliance by licensing and permitting agencies and developers. For instance, before the FERC issues a license, it must assure compliance with some 17 other federal statutes that have given other agencies conflicting or overlapping authority, each of which relates to one or more specific interests rather than an overall comprehensive assessment of a particular development. We believe the report should emphasize that the FERC's ability to streamline its licensing process is therefore limited. For instance, as the report indicates, FERC has taken steps to simplify licensing, and we believe the new licensing requirements are not complex or costly if considered alone. However, no other Federal or State agency (except Massachusetts) has made an effort to simplify regulations implementing legislation under their authority. In fact, several Federal agencies have issued new regulations recently that will result in an even more complex licensing process and further duplication of effort.



We believe the time may be appropriate for consideration of the establishment of a single federal agency responsible for hydropower licensing. FERC would be the obvious choice for this responsibility because Section 10(a) of the Federal Power Act already gives FERC broad responsibilities for overall non-federal water resource development, and because the Federal Power Act and FERC regulations assure that all Federal, State, and local agencies have input to the licensing process so that agency statutory authority and interests are not compromised. Such a policy would need to include time constraints for agency input so as not to frustrate the purpose or intent of the implementing legislation.

The report expresses concern that should there be a large and unexpected influx of applications for license, the FERC licensing process may not be able to cope. There are two approaches that could assure that this does not occur. First, the licensing process must be simplified, and as discussed in the report and above, FERC has initiated steps toward that end. Two significant proposed changes in the FERC's regulations that are a part of its overall program to simplify licensing are not mentioned in the report. On March 5, 1979, the FERC issued a proposed rulemaking (Docket No. RM 79-23) to provide general requirements for all license and preliminary permit applications, and to revise and simplify preliminary permit regulations. These regulations are expected to become final in a few weeks. Also, on April 20, 1979, the FERC issued proposed regulations (Docket No. RM 79-35) to implement Section 213 of the Public Utility Regulatory Policies Act (PURPA) which gives the Commission discretionary authority to exempt conduit hydroelectric facilities from licensing. Second, although we expect the overall program to simplify the licensing process to increase our ability to react to increased workload, additional staff may be necessary as the volume of permit and license applications increases. In this regard, you should note that the hydro licensing functions of FERC are essentially self-sustaining because licensees are assessed an annual charge pursuant to the Federal Power Act for the costs of administration.

With respect to the delays experienced when there are competing applications for relicense, a particular problem is created by the fact that Section 7(a) of the Federal Power Act is unclear as to the preference between public and

private entities. To resolve this issue, the Commission has initiated a proceeding (Docket No. EL 78-43). However, we believe that regardless of the outcome of an FERC decision, there may be extensive litigation so that final resolution may not be possible for an extended period of time.

Economic constraints to hydropower development are perhaps the most significant. Economic incentives for small scale hydropower development have not been forthcoming, and there is a general reluctance by small developers to proceed without economic incentives. Financing a small scale development is extremely difficult and costly. Quite often the cost in legal and other fees to obtain financing exceed the engineering costs. Further, hydropower has not been provided the same tax incentives, loan guarantees, and other economic incentives as other renewable energy technologies.

In addition to economic and financial feasibility, marketing aspects are also important. Our view of PURPA is that it should encourage development. Contrary to the report's findings, PURPA provides for purchases from small power producers by utilities at reasonable rates. The FERC is presently developing proposed rules so that states and non-regulated utilities can implement these provisions.

With respect to GAO's specific recommendations regarding FERC, it should be noted that:

- (1) FERC has initiated a proceeding on the preference issue for competing applications for relicense as noted previously (Docket No. EL 78-43).
- (2) The FERC already has in place a monitoring system. Information on its monitoring system is available to the public in the report, "Critical Project Status Report" (Orange Book) published monthly. Each project has a manager that is held accountable for delays within the control of FERC.

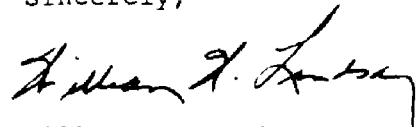
In addition to the above, the following comments (noted by page and line number) are offered for correction and clarification of certain statements in the report:

- (1) p. 12, line 8 - "168,000 MW" should read "110,000 MW"

- (2) p. 14, last line - "3 million kWh" should read "3 million kW"
- (3) p. 15, first line - "180,000 kWh" should read "180,000 kW"
- (4) p. 32, line 11 - change "Federal Government" to "Federal and State Governments"
- (5) p. 32, line 14, - change "complex licensing requirements" to "complex Federal and State licensing and permitting requirements"
- (6) p. 35, lines 3 to 11 - We do not believe the City of Vanceburg case is a good example because the City was not a diligent applicant. For instance, despite issuance of the license almost 3½ years ago, the project is still not under construction.
- (7) p. 44, lines 2 to 8 - The 30 MW site referred to in Vermont has not been before FERC for 3 years. An acceptable application for license was filed in January 1979. Delays have been caused by opposition of land owners in area and a deficient application.
- (8) p. 44, lines 8 to 10 - The report should note that the FERC proposed regulations issued March 5, 1979, (RM 79-23) offers FERC Staff assistance to prospective applicants.
- (9) p. 48, lines 2 to 4 - The Idaho Falls Project is licensed. The application for license was filed on March 20, 1978, and the project was licensed February 8, 1979.
- (10) p. 60, lines 3 and 4 - We do not agree that the useful life of hydro structures is only 2 to 3 times thermal plants. Hydro structures should last indefinitely with proper maintenance. Also, when comparing hydro and thermal, it should be emphasized that hydro efficiency is about 90% or more than twice that of a thermal plant.
- (11) p. 66, lines 22 to 24 - We believe the report misinterprets PURPA's interconnection and wheeling provisions, as discussed above.

Please advise if you wish any further comments on the report.

Sincerely,

A handwritten signature in cursive script, appearing to read "William W. Lindsay".

William W. Lindsay  
Director, Office of Electric  
Power Regulation

TENNESSEE VALLEY AUTHORITY  
KNOXVILLE, TENNESSEE 37902

OFFICE OF THE BOARD OF DIRECTORS

JUNE 18 1979

Mr. J. Dexter Peach, Director  
United States General Accounting Office  
Washington, D.C. 20548

Dear Mr. Peach:

Thank you for your May 24 letter enclosing for our comment the draft of a proposed report "Hydro Power--An Energy Source Whose Time Has Come Again."

TVA has encountered, as I am sure other Federal agencies have, a growing public interest in hydroelectric generation. As the draft report notes, there is some justification for the public's interest, since hydroelectric plants have some distinct advantages over thermal plants. We at TVA certainly support the basic philosophy of increasing power production from man's renewable resources where it is economically feasible, and we are actively pursuing opportunities to increase the power produced from renewable resources. We consider this effort to be an important part of the overall conservation efforts being undertaken by TVA. Accordingly, we believe it is important that increased use be made of the hydro power potential in the TVA region, as well as the rest of the Nation.

We have reviewed the proposed report as you requested, particularly as it relates to TVA, and we have several comments.

In table 2.2 on page 10 the TVA-installed hydroelectric capacity at the end of 1977 should be shown as 3,256 megawatts, rather than 3,197 megawatts. Also, on page 10 the sentence which begins at the bottom of the page should be changed to read as follows:

The Tennessee Valley Authority (TVA), on the other hand, was not only authorized to regulate the streamflow of the Tennessee River "primarily for the purposes of promoting navigation and controlling floods," but also, "so far as may be consistent with such purposes . . . to provide and operate facilities for the generation of electric energy in order to avoid the waste of water power . . ."

The draft report comments that the Water Resources Council (WRC) requires economic comparisons of hydroelectric projects and alternate electricity supply sources using current costs, without considering increasing variable costs, and the report points out that this technique does not consider the relative economics of hydro improving as fuel costs rise at a faster rate than inflation. However, WRC has published in the Federal Register, Volume 44, Number 102, May 24, 1979, as proposed rules

and regulations, a manual of procedures for evaluation of National Economic Development (NED) benefits and costs in water resources planning which includes the following statement in section 704.126 relating to economic evaluation of hydro power projects:

. . . relative price relationships and the general level of prices prevailing during the planning study will be assumed to hold generally for the future, except where specific studies and considerations indicate otherwise. Examples of the latter could include real fuel cost escalation due to increasing scarcity or increasing capital costs to accommodate expected increased environmental or safety criteria.

It may be desirable to have the report reflect this.

We also understand that WRC proposes to require that the manual of procedures be applicable to separable project features such as the addition of power generating facilities to existing hydro projects. We have recently informed WRC that this would seem to extend coverage beyond that of WRC's Principles and Standards which relate to the total projects. As was pointed out to WRC with respect to TVA's power system improvements which are not appropriation financed, we believe the National Environmental Policy Act already provides an appropriate procedural framework for handling additions and improvements of power generating facilities at existing projects. If the addition of units at existing Federal dams is included in WRC's procedures, this could result in delays which could counteract the streamlining of the approval process which your report recommends.

The report discusses on page 59 the possibility of an EPA rulemaking requiring the issuance of an EPA permit for the discharges from dams. The draft report noted that requiring a permit for turbine discharges would impact the future development of small-scale hydro projects. In addition, it would likely impact the development of all hydro expansions and could reduce the net generation available from existing hydroelectric projects by altering the discharge schedules for power generation and by requiring the installation of treatment facilities which use energy.

The draft report describes on page 66 a policy followed in France whereby the French Government guarantees a market for hydro power--"regardless of cost"--from sites under 8 megawatts. The report goes on to suggest that this could be accomplished in regions of this country if Federal power agencies would purchase the hydro power output if no other market is available. On page 79 the report proposes recommending that the Congress require TVA and other Federal power agencies to purchase the hydro power output when no other markets are available. No mention is made of the cost for this hydro power. The implication would seem to be that TVA

should provide a market for hydro power in our region regardless of cost. If this is the case, we could not agree that such a policy would be wise. This would not be consistent with the congressional mandate of the TVA Act, which specifically includes the objective "that power shall be sold at rates as low as are feasible." We do not object to the idea of Federal agencies providing a market in the absence of another outlet, but we believe the recommendation should also stipulate that the rate paid for such power should be just and reasonable to the power consumers and in the public interest. In this regard, at least where the power consumers must bear such costs, as is true in the TVA region, we do not believe the rate for such power should over the long run exceed the incremental cost of alternative electric energy sources available to the region. This is in keeping with the provisions of the Public Utility Regulatory Policies Act of 1978 relating to cogeneration and small power production, where similar conditions are prescribed for rates established for purposes of purchases of power from such sources by electric systems.

We appreciate very much the opportunity to review the draft report. I hope our comments will be useful to you.

Sincerely,



S. David Freeman  
Chairman



## UNITED STATES WATER RESOURCES COUNCIL

SUITE 800 • 2120 L STREET, NW WASHINGTON, DC 20037

June 15, 1979

Dr. Henry Eschwege  
 Director  
 Community and Economic Development  
 Division  
 U.S. General Accounting Office  
 Washington, D.C. 20548

Dear Dr. Eschwege:

Following are comments on your draft report on hydroelectric power submitted with your letter of May 25, 1979.

1. Methods for Determining Project Feasibility.--The report's interpretation of the existing WRC Principles and Standards for Water and Related Land Resources is incorrect. The P&S encourage the measurement of benefits of the electric power generation of a water project "by taking account of the cost of power from the most likely alternative source." Both capacity (capital) and energy costs are suggested for analysis. Use of renewable resources are not "penalized" as implied within the report.

On July 12, 1978, President Carter directed the Water Resources Council to "publish a planning manual that will ensure that benefits and costs are calculated accurately, consistently, and in compliance with the Principles and Standards and other applicable economic evaluation requirements." In response to the President's directive, the draft manual was completed and published for public review in the Federal Register on May 24, 1979. The manual addresses specifically the subject of benefits and alternative costs of hydropower and allows consideration of escalation of fossil and other fuels (i.e., 704.126 (d) (vii) (B) (3): "For this purpose, relative price relationships and the general level of prices prevailing during the planning study will be assumed to hold generally for the future, except where specific studies and considerations indicate otherwise. Examples of the latter could include real fuel cost escalation due to increasing scarcity...").

We suggest redrafting of pages 62-63, and recommendations regarding the Water Resources Council to reflect the above.

MEMBERS: SECRETARIES OF AGRICULTURE, ARMY, COMMERCE, ENERGY, HOUSING AND URBAN DEVELOPMENT, INTERIOR, TRANSPORTATION ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY - OBSERVERS: ATTORNEY GENERAL, DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET, CHAIRMEN, COUNCIL ON ENVIRONMENTAL QUALITY, TENNESSEE VALLEY AUTHORITY, BASIN INTERAGENCY COMMITTEES, CHAIRMEN AND VICE CHAIRMEN, RIVER BASIN COMMISSIONS



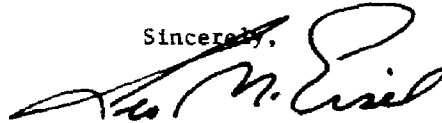
2. The Water Resources Council funded under its comprehensive planning program an innovative study of low-head hydroelectric power in the New England Region through the New England River Basins Commission. The study was funded in 1977.

3. The Water Resources Council conducts water assessments of energy technologies under the provisions of Section 13 of the Federal Non-nuclear Energy Research and Development Act of 1974. Ongoing assessments in the Pacific Northwest, California, and Great Basin Regions will address low-head hydroelectric power. These studies are being conducted to complement efforts of other agencies (i.e., DOE, USCE).

4. The planning and licensing of small hydro projects must also be coordinated with the mandates of the Clean Water Act of 1977 and the Wild and Scenic Rivers Act of 1976 (p. 33).

We have enclosed supplemental materials to support your further appreciation of the above comments. The opportunity to review and contribute to your report is gratefully appreciated.

Sincerely,



Leo M. Eisel  
Director

Enclosures  
cc: Jim Flannery



EXECUTIVE OFFICE OF THE PRESIDENT  
OFFICE OF MANAGEMENT AND BUDGET  
WASHINGTON, D.C. 20503

JUN 15 1979

Mr. Allen R. Voss  
Director  
United States General  
Accounting Office  
Washington, D.C. 20548

Dear Mr. Voss:

Thank you for your letter of May 25, 1979, directing our attention to portions of the draft GAO report on U.S. hydroelectric power development that relate to the Office of Management and Budget.

The comments in the draft report attributed to an unnamed OMB official appear to us to relate to two issues:

- (1) The commercial availability of suitable technology versus the need for Federally sponsored R&D; and
- (2) The need for Federal subsidies and incentives to accelerate hydroelectric development.

Regarding the availability of technology, the draft report expresses the GAO staff view that small hydro technology is available and indicates that this view is also held by OMB. It is our understanding that suitable small hydro technology is, in fact, commercially available.

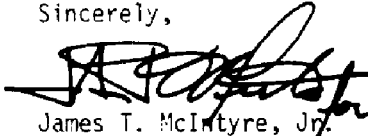
Regarding the need for Federal incentives, we do believe that, where suitable technology is commercially available, greater use of the technology is impeded by non-technological barriers, principally financial risk and institutional barriers. We do not believe however that it is appropriate to initiate now a new Federal program to subsidize applications of technology which are not economic such as would be done through beginning a new program of heavily subsidized loans as authorized by the NEA and advocated by the draft GAO report. Rather, we believe that the greatest encouragement of technologies such as low head hydro will come from more realistic pricing of conventional energy alternatives such as through phased decontrol of oil and gas prices; reduction of institutional barriers such as the NEA supported Administration initiative to simplify licensing procedures, and some initial Federal assistance to reduce project uncertainties and financial risk of potentially economic small hydropower sites.

With respect to Federal assistance in overcoming project feasibility uncertainties and financial risk, the report correctly observes that the Administration has requested funds for feasibility studies to the limit authorized by law, but we are dismayed that the report fails to recognize the Administration's recent hydropower assistance initiative as part of the Rural Energy Initiatives. Those initiatives provide that existing general purpose credit programs in EDA, FNMA, CSA, REA, and HUD will apply over \$300 million in grant, loan, and loan guarantee resources for the purpose of stimulating construction of up to 100 small scale hydroelectric projects by 1981 and up to 300 projects by 1985. A copy of the interagency agreement describing this initiative is enclosed for your information.

We believe these initiatives, combined with the ongoing programs for small hydroelectric demonstration and information dissemination, provide an aggressive program to accelerate development of small hydropower that is consistent with the urgent need for stringent fiscal restraint.

Thank you for providing us the opportunity to comment on your draft report.

Sincerely,



James T. McIntyre, Jr.  
Director

Enclosure

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