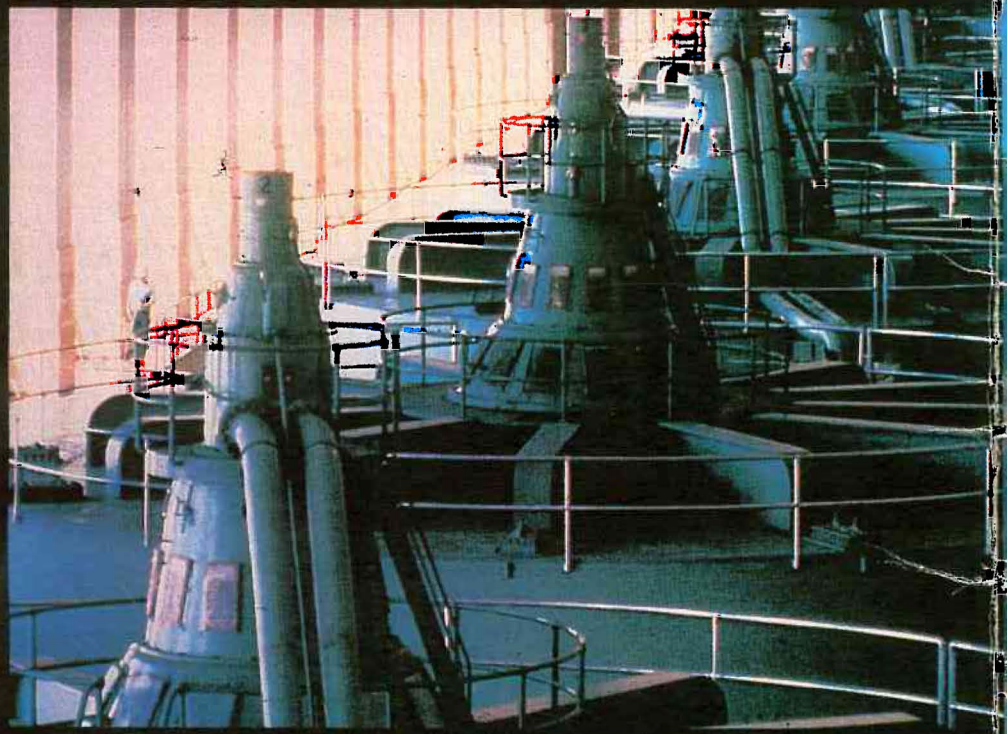
US Army Corps
of Engineers



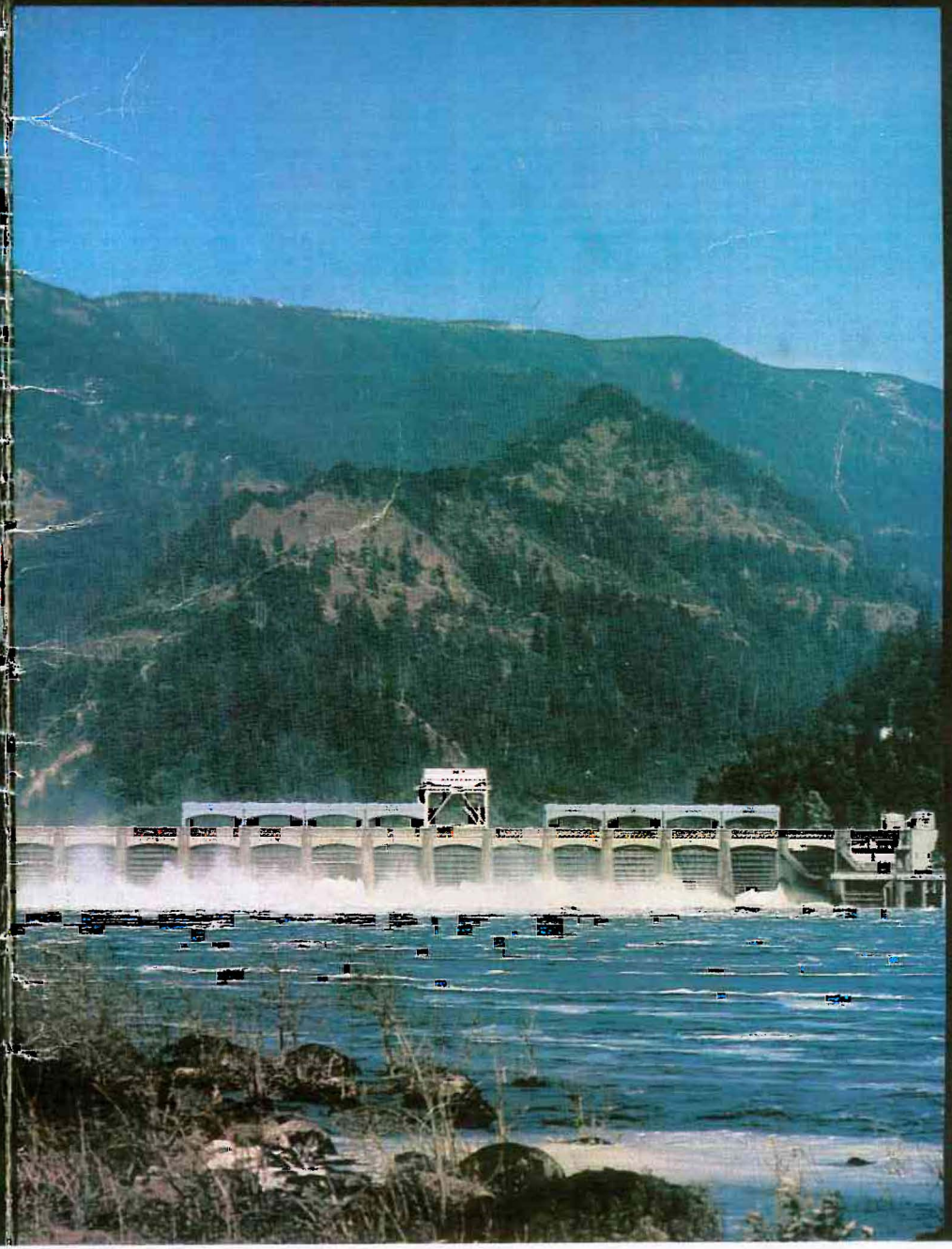
The 10 generating units at the Bonneville 1st Powerhouse have a total capacity of 518,400 kw. The second powerhouse has eight additional main units and two fish water generators which bring the total Bonneville capacity to 1,076,620 kw.

EP 1165-2-317
Nov 1987

This pamphlet supersedes EP 1165-2-317, Sep 1979.

Hydropower

The Role of the U.S. Army Corps of Engineers



This booklet explains how hydropower is a part of the nation's energy base and how the U.S. Army Corps of Engineers helps develop this resource.

As the nation's primary agency for water resources development and management, the Corps has played a significant role in meeting the nation's power needs by building and operating hydropower plants in connection with its large multiple-purpose dams.

Hydroelectric power plays an important role in meeting the electricity demands of our nation. It is a renewable energy source that helps conserve our non-renewable fossil and nuclear fuels. It also helps meet our needs at an affordable price in an environmentally safe way.

The Corps continues to consider the potential for hydroelectric power development during the planning process for all water resource projects involving dams and reservoirs. In most instances, hydro projects are now developed by non-Federal interests without Federal assistance. The Corps becomes involved with planning, constructing, and operating hydro projects only when it is impractical for non-Federal interests to do so.

John S. Doyle, Jr.
Acting Assistant Secretary of the Army
(Civil Works)

US Army Corps of Engineers

Cover: Bonneville Lock and Dam on the Columbia River

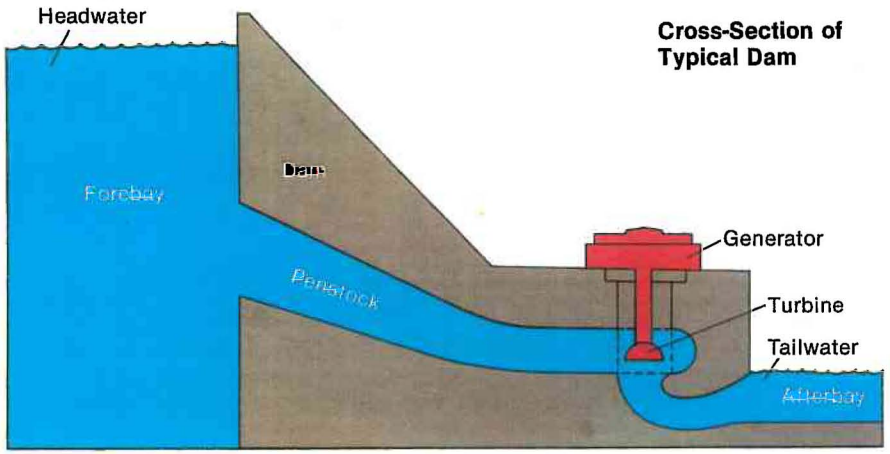
Hydropower

Our supply of fossil fuel is limited; we still buy a substantial portion of the oil we use from foreign countries. Dependence on foreign oil contributes to economic uncertainty and instability—and even our foreign sources will eventually be exhausted.

One of the nation's most promising energy alternatives is hydropower—electricity produced by flowing water. The U.S. Army Corps of Engineers has been actively involved in building and operating hydroelectric projects since the 1930's. Many Corps projects which were built primarily for navigation improvement, flood control or other purposes are also used to create hydropower.

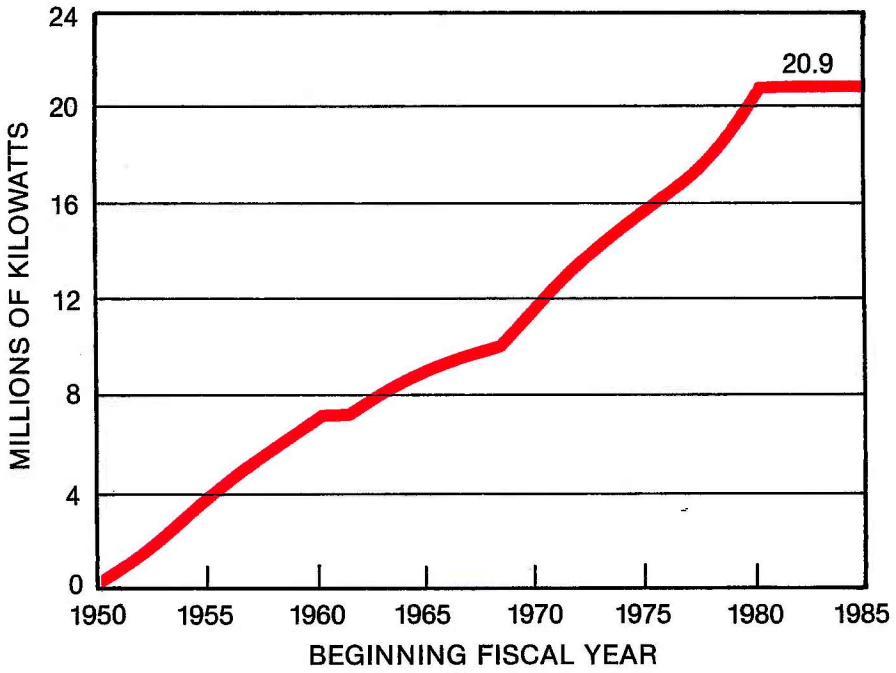
The Corps is the nation's largest single producer of hydroelectricity. It operates 70 projects housing 344 turbine-generator units with a total capacity of 20.9 million kilowatts. The Corps has about 30 percent of the nation's hydro-electric capacity and 3.5 percent of the nation's total electric power. About two-thirds of this capacity is in the Pacific Northwest, where the Corps provides nearly one-third of that region's electricity. Water power is so abundant in that part of the country that hydroelectric facilities developed by other agencies and private utilities comprise the major portion of the remaining electric power production.

A hydroelectric project harnesses the potential energy of a river's gravitational fall to produce electricity. Water is stored behind the dam—the storage area is called the forebay and the surface of the forebay is called the head-water elevation—and released at desired intervals through a conduit called a penstock or power intake. The penstock directs the water to a turbine-driven generator below the dam. The water is released from the turbine into an afterbay, the surface of which is referred to as the tailwater level. The force



Cross-Section of Typical Dam

HYDROELECTRIC GENERATING CAPACITY AT CORPS PROJECTS OPERATING OR UNDER CONSTRUCTION



exerted by the water on the turbine blades drives the turbine, which in turn, drives a generator to produce electricity. The energy-producing potential of a system depends on the height of its head—the difference in elevation between the headwater and tailwater—and the volume of water available.

In 1984, Corps' facilities produced 90.1 billion kilowatt-hours (kwh: production of 1 kw for 1 hour) of electric energy. This energy production was equivalent to the output of 20 average size nuclear plants. To produce that much power from the nation's non-renewable sources would have required burning 36 million tons of coal, 1,100 billion cubic feet of natural gas or 5.7 billion gallons of oil.

While the Corps builds and operates its dams, it doesn't sell the power. Under Federal law, power generated at Corps projects is marketed by the Department of Energy to public bodies, power cooperatives and private utilities. Although electricity is not sold directly to the consumer, the underlying goal of all Corps hydroelectric projects is to provide power to consumers at the lowest possible rates. Rates are set by the marketing agency and approved by the Federal Energy Regulatory Commission.

Five Department of Energy agencies sell power from Corps projects. These marketing agencies, each serving a different part of the country, are the Alaska Power Administration, Bonneville Power Administration, Southwestern Power Administration, Southeastern Power Administration, and the Western Area Power Administration.

History

The Corps' involvement in hydroelectric power production stems from its water resources mission. In 1824, Congress assigned the Corps its first water resources task—that of clearing snags and sandbars from the Ohio and Mississippi rivers. This initial assignment expanded to a general responsibility for navigation improvements.

Bonneville Lock and Dam-Lake on the Columbia River between Oregon and Washington is the oldest Corps-built hydroelectric project operated by the Corps. This is the second powerhouse which opened in 1986.

Then in 1909 the Federal government acquired a dam on the St. Mary's River in Michigan. Though the acquisition was primarily for navigation purposes, the site also contained a hydroelectric power plant, the Corps' first. Congress, recognizing the potential significance of hydroelectricity to the growing nation, directed the Corps to include assessments of water power potential in its periodic surveys of U.S. waterways. At that time, development of hydroelectric facilities was conducted almost entirely by private groups. But the Corps began its own hydropower construction in 1916 when it added a turbine and generator unit to the St. Mary's plant.

In 1918 the Corps began building the Wilson Lock and Dam on the Tennessee River in Alabama. Completed seven years later, the project contained hydroelectric generators with a total capacity of 184,000 kw. About that time the Corps, which in 1917 had been charged by Congress with flood control responsibilities, began comprehensive water resources planning in a series of studies known as the 308 Reports. And over 45 years ago the Corps started a comprehensive hydroelectric program with the design and construction of a 518,000-kw plant at the Bonneville Lock and Dam project on the Columbia River in Oregon.

Particularly since the end of World War II, the Corps' role in hydroelectric development has grown and expanded. While many public and private groups and two Federal agencies—the Interior Department's Bureau of Reclamation and the Tennessee Valley Authority—have also developed water power resources, the Corps of Engineers is the nation's largest builder, operator, and sponsor of hydroelectric facilities.

Hydropower and the Environment

Both the energy crisis of the last decade and our concern for the quality of the environment have sparked research into new, environmentally clean ways to produce electric power. Presently, fossil or nuclear-fueled steam-electric generating facilities are the only sources capable of producing enough electric energy to support our economy. These facilities are being supplemented with oil or gas-fired combustion turbine systems and with hydropower.

There are significant environmental and fuel supply problems associated with thermal generation. All steam-electric generating facilities require water for steam production and for cooling, and the discharge of the heated effluent into natural watercourses or reservoirs can cause thermal pollution. Fossil-fueled steam-electric plants and turbine systems have the additional disadvantages of consuming vast quantities of non-renewable natural resources and either emitting pollutants into the air or requiring costly control devices to reduce emissions. Nuclear-fueled

	Hydropower	Nuclear or Fossil Fueled	Gas-Fired Turbine
1977	1.24	15.16	37.38
1984	1.93	22.38	51.08

Examples of Production Cost (Mills*/kwh) for Different Power Sources, 1977 & 1984

* MILL IS 1/1000 OF ONE DOLLAR

plants may create health and safety hazards and have waste disposal problems.

All power facilities may adversely affect the environment in some way and further study is needed to correct the problems. Even hydroelectric projects, the cleanest source of electric energy available today, are not without environmental disadvantages. The construction of a dam and reservoir itself entails significant environmental consequences. Some of these can be avoided or mitigated by careful site selection and enlightened planning and management of the projects. The disadvantages of hydroelectric project construction are generally regarded as being more easily mitigated than those of other power projects.

In addition to the adverse environmental effects of dam and reservoir construction, hydroelectric power generation itself may adversely affect the environment. But scientists and engineers are making important advances in eliminating many of these effects. For example, water released from hydroelectric projects can have harmful effects on the temperature and oxygen content of the water downstream.

Technology is now available to minimize the adverse effects of this released water. And while there are costs associated with most remedial and mitigation measures required for hydroelectric projects, they are usually less than the costs of eliminating the adverse effects of other power generation projects.

Production Cost

Hydroelectric power production costs are less than those of most other power sources since the natural continuous flow of water makes hydropower a renewable resource. In contrast, fossil fuels are non-renewable and expensive. The United States is currently unable to produce petroleum at a rate which matches consumption. Our dependence on that fuel, coupled with foreign producers' power to control oil prices, has

had drastic economic consequences. Outlays for fuel to operate fossil-fueled plants now account for over 80% of production costs. Other fuels, even uranium for nuclear plants, are available only in limited quantities, and are expensive to produce.

Hydropower facilities are simpler to operate and maintain than thermal plants. Consequently, fewer supervisory and maintenance personnel are required and outages—inability to produce power—are less frequent.

For these reasons, operation and maintenance cost less for hydropower than for any alternative sources of energy. In 1984, the estimated average production expense at hydroelectric plants was 1.93 mills per kwh of electricity generated—a mill is one-tenth of a penny. Production costs for steam-electric generators using fossil or nuclear fuel were 22.38 mills per kwh and 51.08 mills for combustion turbines.

The lower costs of hydroelectric production are partially offset by higher construction charges. In 1984, average installation costs per kilowatt of installed capacity at selected hydroelectric, fossil fuel, nuclear fuel and combustion turbine plants were $819, $1,079, $1,367, and $200 respectively. On balance, however, hydropower is one of the most economic sources of electric energy. When total production and fixed (construction) costs are considered, hydropower is less expensive than nuclear power and considerably less expensive than power created by fossil fuel sources. If fossil fuel costs continue to rise, hydropower will have a greater advantage.

Peaking

Any regional power system must meet fluctuating demands for electricity. For instance, a utility in the southern part of the country must provide more power during the summer when its customers use air conditioners, with the greatest load occurring in the afternoons. This time of high energy use is called the "peak" and the provision of energy for it is called "peaking." Peaking patterns vary from utility to utility,

	Hydropower	Fossil Fueled	Nuclear	Gas-Fired
1977	$532	$275	$327	$140
1984	$819	$1,079	$1,367	$200

Examples of Installation Cost ($1/kw) for Different Power Sources, 1977 & 1984

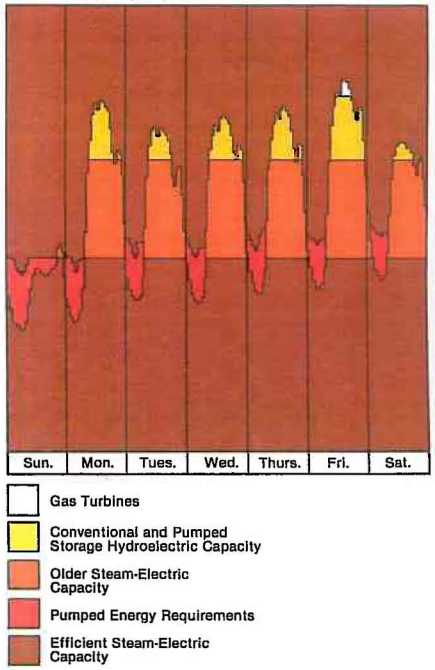
depending on the climate, power demands of industry, and living habits of consumers, but in all systems the power load varies in a fairly predictable fashion over the hours of the day, the days of the week, and the seasons of the year.

Meeting these changing demands is one of a utility's toughest tasks. In fact, the need for peak power is growing faster than the total demand for electricity. In an attempt to even out demand, some utilities vary their rate schedules, charging more for power during the peak periods. Most use a combination of power sources to provide a flexible output.

A utility's continuous power demand, called the "baseload," is usually supplied by large steam-electric plants—fossil-fueled or nuclear. These plants are well suited for baseload production but are not efficient for peaking. They do not operate efficiently at outputs lower than that for which they were designed. Therefore, they cannot be built to meet the peak demand unless they are to be operated continuously at near peak output. This cannot be done, since the load is not continuously present. Steam-electric plants also require long start-up and cool-down times—inefficient for peaking.

Utilities whose primary source of energy production is steam-electric or nuclear often turn to other sources for peaking. Sometimes they use older, less efficient thermal plants. Internal combustion engines and combustion turbines may also be used for peak loads; these plants are inexpensive to construct and may be run on a flexible schedule, but they are usually inefficient in terms of fuel consumption. Where it is available, hydropower is the best source.

Weekly Load Curve of a Large Electric Utility System



This is a typical weekly load curve for a large electric utility system. The peak energy demand occurs during the afternoon hours, with a lighter demand on weekends. The minimum load is met by efficient steam-electric units which are run continuously. These facilities also supply power for the pumping phase of pumped-storage operations during the early morning hours when total consumption drops below the basic steam-electric capacity. Conventional and pumped-storage hydro facilities supply electricity for the peak afternoon hours, and more expensive gas-fired turbines are employed when electric usage is so high that hydro and thermal units cannot meet the system's power needs.

Hydroelectric projects are generally capable of producing electric energy continuously. However, many hydroelectric projects are operated intermittently to satisfy peaking demands. Hydropower facilities can be especially useful for meeting peak demands since they can be stopped and started very rapidly by simply controlling the flow of water.

The ability to control water flow is a key to the economic advantage of hydropower. Within the limits of water supply and downstream water quality, projects can be planned which create maximum generating capacity at peak periods. So long as established minimum stream flow levels are maintained, impounded water can be released to flow through the turbines only at peak demand times. Generating facilities at many Corps projects are operated only a few hours a day during periods when low stream flow and high power demands coincide.

To provide more peaking power, new turbine units can be added to existing hydropower projects. Though at many of these projects the total energy output cannot be increased, the timing of the output can be improved. For instance, consider a project which has 10 generating units. In 12 hours it can generate a given amount of energy. With 20 units, the same amount of energy can be produced in 6 hours. The economic advantages are obvious.

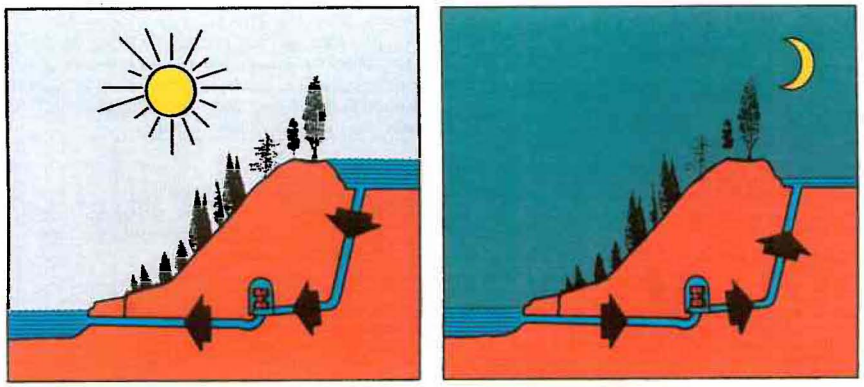
Pumped Storage and Other Innovations

During the past 20 years, considerable attention has been focused on the development of pumped storage hydroelectric projects in the United States. Though pumped storage has been in operation in Europe for many years, it has not received widespread attention in this country until recently. Now, due to technological advances such as reversible pump-turbines, pumped storage is becoming more economically competitive.

Pumped storage is a method of storing potential electric energy at a power project by pumping water from a lower reservoir to a higher storage site. The reversible turbine that pumps the water to the higher site also releases the stored water to generate the electric energy needed at the project's peak demand times. Water is pumped into the storage reservoir at low demand times so that the project can operate at full potential during times of peak demand.

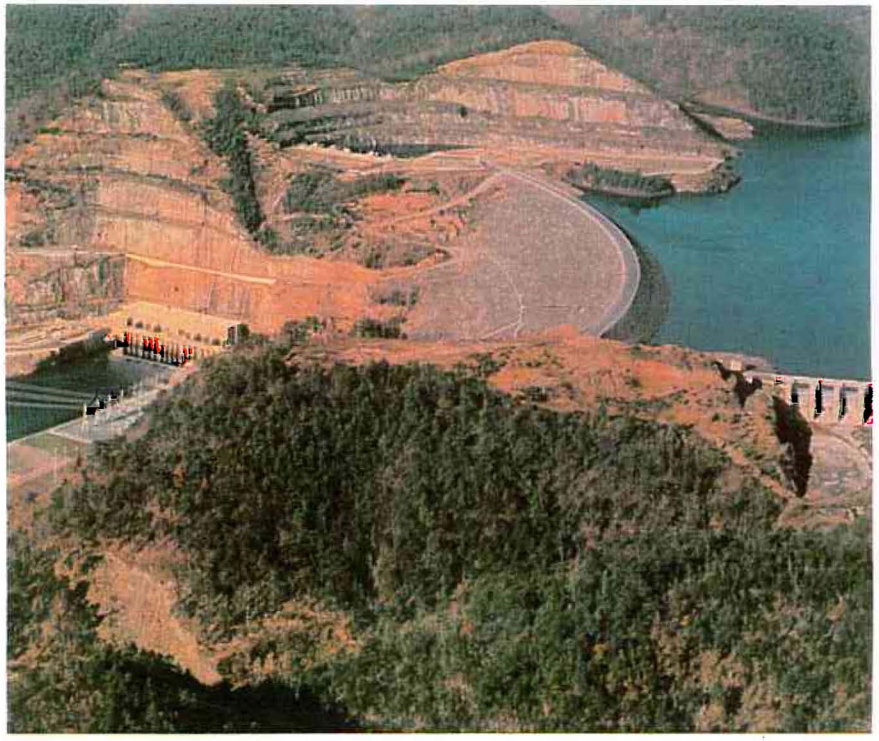
Although potential sites for pumped storage are plentiful, studies required to plan, design and construct pumped storage projects are often more complex than those for conventional hydroelectric projects. One of the complications is that pumped storage projects actually use more energy than they produce. Approximately three kwh of pumping energy are consumed for every two kwh of energy generated by the projects. Consequently, pumped storage

Pumped Storage



Generating

Pumping



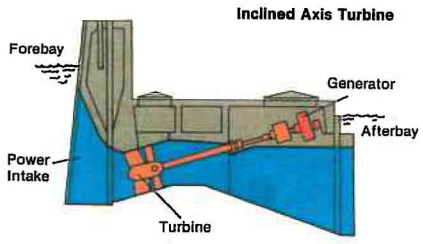
The Carters Dam powerhouse, located on the Coosawattee River in Georgia, is a pump storage facility with two conventional units and two pumped storage units rated 125,000 kw each.

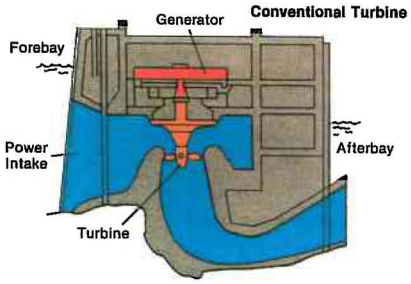
projects are economically feasible only when there is a source of low-cost off-peak pumping energy and a demand for high-value peaking energy. Such low-cost pumping energy comes from large steam-electric generating plants at their low demand hours, since these plants are not easily shut down for such short periods of time.

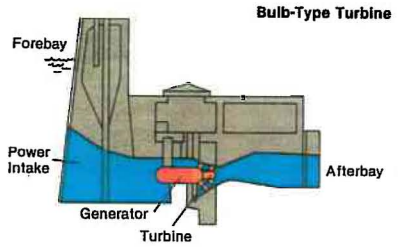
Pumped storage is considered worthwhile then since the pumping energy can be purchased at a low cost, and the peaking power produced has a high value. And, pumped storage is presently the only proven means of storing large amounts of electric energy.

While pumped storage is perhaps the most dramatic advance made recently in hydroelectric power development, it is by no means the only one. Technological advances which facilitate low-head hydropower generation have also been made. The Department of Energy defines a low-head project as one whose head is 20 meters or less, and turbine manufacturers have developed inclined-axis and bulb-type turbines that are particularly well adapted to these low-head projects. Because these turbines are smaller and more economical than their predecessors, the Corps is able to take advantage of hydroelectric potential at some low-head navigation dams.

Technology for operation of hydroelectric projects has also been developed. The Corps has worked in the development of modern techniques for automated remote operation of hydroelectric facilities. Some Corps projects are







operated remotely at considerably less cost then would be required for at-site manual operation.

Corps research programs have also played an important role in the development of devices and techniques to minimize the adverse environmental consequences of hydroelectric operations. Engineers and scientists employed or supported by the Corps have contributed to the development of selective withdrawal

outlets. These outlets permit a project operator to withdraw water from reservoir storage zones where temperature and oxygen content is most desirable. Research studies are underway to develop mechanical devices and operating techniques to improve the quality of downstream water at projects where selective withdrawal capability does not exist.

Finally, the Corps is working to maximize power production by taking advantage of differences in rainfall, streamflow, and power demands in different parts of a large river basin. By operating for longer hours or at greater capacity at hydroplants where stream flow is greatest or demand highest, for example, energy in the rivers can be used most efficiently. The Corps is developing mathematical models for reservoir management to aid this work.

Planning Corps Hydropower Projects

The U.S. Congress authorizes and partially funds Corps hydropower projects. Before authorizing a project, the Congress must be convinced that it will meet a legitimate need, will be well designed, economically feasible and environmentally sound.

The process usually begins when local citizens or agencies urge their Congressional representatives to introduce legislation authorizing the Corps to study a proposed multi-purpose project. When legislation authorizing a study is passed and money appropriated, the Corps District in whose area the proposed project is located begins engineering, environmental and economic investigations.

The overall study proceeds in two phases. Phase I, the Reconnaissance Phase is at Federal expense. It is a preliminary study, and among its goals are: (1) to determine if there is likely to be at least one economically feasible and engineeringly implementable alternative plan; and (2) to identify a non-Federal sponsor that agrees to contribute to Phase II study costs. Planning will not proceed to Phase II, which is more detailed and demonstrates the economic and engineering feasibility of potential projects, without a sponsor willing to share the Phase II study costs.

A non-Federal sponsor's participation is critical for there to be a hydropower analysis. Hydroelectric power is considered for inclusion at Federal expense only when there are compelling reasons why non-Federal ownership, operation and maintenance of hydropower at a multiple-purpose project are impracticable.

The District Engineer, who heads the District staff, holds public meetings. Citizens are asked to comment first during the early planning stages, later when alternative plans are being considered, and finally when a specific plan is formulated. District planning also involves state and municipal officials and various Federal agencies. These Federal

Green Peter Dam on the Middle Santiam River in Oregon.

agencies include the one which would market the proposed project's power and the Federal Energy Regulatory Commission (FERC).

During the study phase, the Corps and the non-Federal sponsor evaluate the proposed project according to stringent criteria. The project study must include investigations of the adverse environmental effects on the streams on which it may be located and on the surrounding countryside. The electricity produced must fit into the overall regional power needs. The FERC's and the marketing agency's analysis of this criterion is especially important.

In addition, the total economic benefit from the project must exceed its total cost, with benefits and costs calculated on an annual basis. A project's economic life is usually 100 years, and costs include the initial capital investment, interest over the project life, as well as estimated operating and maintenance expenses. Benefits include anticipated economic value of functions and services provided by the project—navigation, flood control, recreation, water supply, downstream low flow

maintenance, and hydropower. The economic value of a project's hydroelectric power production is estimated on the basis of the comparable cost of power production by the most likely alternative source of power, usually a thermal generating plant. The cost-benefit analysis of not only the entire multi-purpose project but also of the hydropower portion alone must be favorable.

The cost-benefit analysis insures that power is supplied at the least possible cost to consumers and that the Federal government invests in the most economically efficient projects.

The project must also pass a financial feasibility test. This test measures whether projected revenues from the sale of power will be sufficient to recoup the costs of producing and marketing that power. Future revenues are estimated by the marketing agency responsible for the distribution and sale of the power. If constructed at Federal expense, project costs allocated to power must be recovered within 50 years.

With the help of citizens and other government agencies, the Corps and the non-Federal sponsor evaluate the proposed multi-purpose project according to these criteria. Results of the study are incorporated into the final project plan.

The District Engineer prepares a detailed report on the planning phase of the proposed project. He also prepares an Environmental Impact Statement (EIS) outlining the facility's anticipated effects on the physical and social environment. After the report and the EIS are reviewed within the Corps,

The Dworshak Dam and Reservoir on the North Fork Clearwater River in Idaho.

they are submitted by the Chief of Engineers to the Secretary of the Army for approval. Before recommending projects, the Secretary seeks concurrence of the Office of Management and Budget. Finally, the report and EIS are submitted to Congress, where the House and Senate Public Works Committees hold hearings on the proposal.

If Congress finds the proposed project to be to the nation's benefit, it authorizes construction and appropriates money. Non-Federal sponsors must arrange financing for their part of the project costs so that funds will be available as design and construction progress. Then Corps District officials again take responsibility, first making final engineering designs, and later undertaking actual construction.

The installation of hydropower at Town Bluff Dam, near Jaspar, Texas, is an example of how most hydropower will be financed at Corps projects in the future. Town Bluff Dam is a Corps flood control project that was completed in 1958. The recent energy situation in that area indicated that adding a hydropower capability to the dam was economically feasible. After the local sponsors chose the Corps to construct the hydropower project, representatives from the Sam Rayburn Municipal Power Agency and the Southwestern Power Administration signed three agreements with the Federal government regarding financing construction and arranging for power sales. One of the provisions of the agreements was that the local sponsors would pay the full amount of estimated construction costs prior to the beginning of construction. Local sponsors would also be responsible for annual operating and maintenance costs.

The Future

The Corps of Engineers, at the direction of Congress, completed the National Hydroelectric Power Resources Study (NHS) in 1983. This comprehensive 23-volume study has set the stage for present and future direction in development of hydropower resources in the United States.

The NHS report indicates that despite the recent slowdown in growth of electric demand, a minimum of 150,000 MW of new electric capacity is expected to be constructed in the United States by the year 2000. Coal-fired and nuclear-fired power plants will provide most of the new capacity. However, hydroelectric power could play an important role in meeting these needs at an affordable price, since many of these projects could generate power at less cost than new steam generation plants and would have lower environmental risks. In addition to meeting a portion of new demand, hydroelectric power has a unique value as a renewable energy resource that conserves our non-renewable fossil and nuclear fuels.

Corps of Engineers Hydroelectric Projects

Project	River	Project Functions	Initial Power in FY	Existing Capacity (KW)	Ultimate Capacity (KW)
1. Bonneville, Ore.	Columbia	NPR	1938	1,076,620	1,076,620
2. The Dalles, Ore.	Columbia	NPR	1957	1,806,800	1,806,800
3. John Day, Ore.	Columbia	NPRFI	1969	2,160,000	2,160,000
4. McNary, Ore.	Columbia	NPRI	1954	980,000	980,000
5. Ice Harbor, Wash.	Snake	NPRI	1962	602,880	602,880
6. Chief Joseph, Wash.	Columbia	PIR	1956	2,069,000	2,069,000
7. Lower Monumental, Wash.	Snake	NPRI	1969	810,000	810,000
8. Little Goose, Wash.	Snake	NPRI	1970	810,000	810,000
9. Lower Granite, Wash.	Snake	NPRI	1975	810,000	810,000
10. Lost Creek, Ore.	Rogue	FPRISW	1977	49,000	49,000
11. Hills Creek, Ore.	Willamette	NFPRI	1962	30,000	30,000
12. Lookout Point—Dexter, Ore.	Willamette	NFPRI	1955	135,000	135,000
13. Cougar, Ore.	McKenzie	NFPRI	1964	25,000	25,000
14. Green Peter—Foster, Ore.	So. Santiam	PENIR	1967	100,000	100,000
15. Detroit—Big Cliff, Ore.	No. Santiam	NFPRI	1954	118,000	118,000
16. Dworshak, Idaho	Clearwater	PNFR	1973	400,000	400,000
17. Albeni Falls, Idaho	Pend Oreille	NFPR	1955	42,600	42,600
18. Libby, Mont.	Kootenai	FPR	1976	525,000	525,000
19. Fort Peck, Mont.	Missouri	NFPRIW	1944	185,300	185,300
20. Garrison, N. Dak.	Missouri	NFPRIW	1956	460,000	460,000
21. Oahe, S. Dak.	Missouri	NFPRIW	1962	640,000	640,000
22. Big Bend, S. Dak.	Missouri	NFPRIW	1965	468,000	468,000
23. Fort Randall, S. Dak.	Missouri	NFPRIW	1954	320,000	320,000
24. Gavins Point, Nebr.	Missouri	NFPRIW	1957	100,000	100,000
25. Keystone, Okla.	Arkansas	FNPWSR	1968	70,000	70,000
26. Fort Gibson, Okla.	Grand	FPR	1953	45,000	45,000
27. Tenkiller Ferry, Okla.	Illinois	FPR	1954	39,100	39,100
28. Webbers Falls, Okla.	Arkansas	NPR	1974	60,000	60,000
29. Robert S. Kerr, Okla.	Arkansas	NPR	1972	110,000	110,000
30. Eufaula, Okla.	Canadian	FNPWSR	1965	90,000	90,000
31. Broken Bow, Okla.	Mountain Fork	FWPSR	1970	100,000	100,000
32. Denison, Tex.	Red	FPSR	1945	70,000	70,000
33. Whitney, Tex.	Brazos	FPR	1954	30,000	30,000
34. Sam Rayburn, Tex.	Angelina	FPWR	1966	52,000	52,000
35. Clarence Cannon, Mo.	Salt	FPRSW	1984	58,000	58,000

Key

D — redevelopment
F — flood control
I — irrigation
N — navigation
P — power
R — recreation
S — water supply
W — fish and wildlife
UC — under construction

Corps of Engineers Hydroelectric Projects

Project	River	Project Functions	Initial Power in FY	Existing Capacity (KW)	Ultimate Capacity (KW)
36. Harry S. Truman, Mo.	Osage	FPRW	1980	160,000	160,000
37. Stockton, Mo.	Sac	FPRW	1973	45,200	45,200
38. Table Rock, Mo.	White	FPR	1959	200,000	200,000
39. Bull Shoals, Ark.	White	FPR	1953	340,000	340,000
40. Beaver, Ark.	White	FPSR	1965	112,000	112,000
41. Norfolk, Ark.	White	FPRS	1944	80,550	80,550
42. Ozark, Ark.	Arkansas	NPR	1973	100,000	100,000
43. Dardanelle, Ark.	Arkansas	NPR	1965	124,000	124,000
44. Greers Ferry, Ark.	Little Red	FPRS	1964	96,000	96,000
45. Blakely Mountain, Ark.	Ouachita	FPRWN	1956	75,000	75,000
46. Narrows, Ark.	Little Missouri	FPRW	1950	25,500	25,500
47. DeGray, Ark.	Caddo	FNPRS	1972	68,000	68,000
48. St. Marys, Mich.	St. Marys	NP	1952	18,400	18,400
49. Barkley, Ky.	Cumberland	NPFR	1966	130,000	130,000
50. Wolf Creek, Ky.	Cumberland	FPR	1952	270,000	270,000
51. Laurel, Ky.	Laurel	PRD	1978	61,000	61,000
52. Cheatham, Tenn.	Cumberland	NPR	1958	36,000	36,000
53. Old Hickory, Tenn.	Cumberland	NPR	1957	100,000	100,000
54. J. Percy Priest, Tenn.	Stones	FPRW	1970	28,000	28,000
55. Cordell Hull, Tenn.	Cumberland	NPR	1974	100,000	100,000
56. Center Hill, Tenn.	Caney Fork	FPR	1951	135,000	135,000
57. Dale Hollow, Tenn.	Obey	FPR	1949	54,000	54,000
58. Robert F. Henry, Ala.	Alabama	NPRW	1975	68,000	68,000
59. Millers Ferry, Ala.	Alabama	NPRW	1970	75,000	75,000
60. West Point, Ga.	Chattahoochee	NFDPRW	1975	73,375	73,375
61. Walter F. George, Ala.	Chattahoochee	NPRW	1963	130,000	130,000
62. Jim Woodruff, Ga.	Appalachicola	NPRW	1957	30,000	30,000
63. Carters, Ga.	Coosawattee	FPRW	1976	500,000	500,000
64. Allatoona, Ga.	Etowah	FPRW	1950	74,000	110,000
65. Buford, Ga.	Chattahoochee	NFPRW	1957	86,000	86,000
66. Hartwell, Ga.	Savannah	NFPRS	1962	344,000	344,000
67. Richard Russell, Ga.	Savannah	NFPRS	1984	300,000	600,000
68. Clark Hill, S.C.	Savannah	NFPRS	1953	280,000	282,000
69. Philpott, Va.	Roanoke	FPR	1954	14,000	14,000
70. John H. Kerr, Va.	Roanoke	FPR	1953	204,000	204,000

Key

D — redevelopment
F — flood control
I — irrigation
N — navigation
P — power
R — recreation
S — water supply
W — fish and wildlife
UC — under construction