US Army Corps of Engineers ®

Hydropower

Value to the Nation

2007

CIVIL WORKS

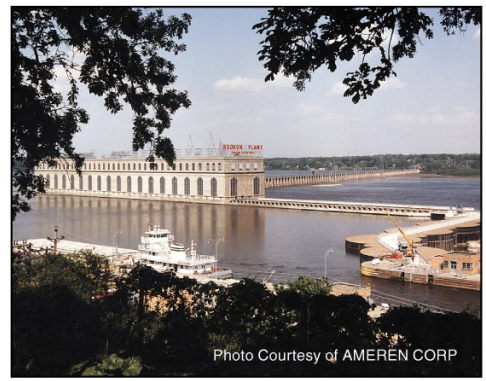
Hydropower and the Corps of Engineers...

The U.S. Army Corps of Engineers is the largest owner/operator of hydroelectric powerplants in the United States and one of the largest in the world. The Corps' 75 plants have a total installed capacity of 20,720 megawatts and produce nearly 100 billion kilowatt-hours a year. This is nearly a quarter of the nation's total hydropower output: enough energy to serve about ten million households, or roughly ten cities the size of Seattle, WA.

Definitions:
kilowatt-hour: unit for measuring electric energy; a typical home uses about 800 kilowatt-hours per month.
megawatt (one-thousand kilowatts): unit of electric power, is used for measuring rate of producing or consuming electric energy; a megawatt is equal to 746 horsepower.

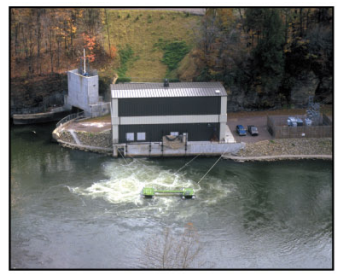
The Corp's Wolf Creek Dam and Powerplant (KY)

Hydropower is one of the products of developing rivers for multiple purposes. Over the years, Congress has directed the Corps to build water resource projects to serve public needs such as flood control, water supply, and navigation. Where feasible, hydropower has also been included.



Ameren's Keokuk hydropower plant at Mississippi River Lock and Dam 19 (IA), which at 125 megawatts was the largest hydropower plant in the country in 1913

The earliest hydropower plants at Corps projects were constructed at navigation dams, as joint efforts with electric utility companies. The utilities built the powerplants, and the Corps usually built the navigation locks. Later, Congress authorized the Corps to construct its own powerplants at dams being built for flood control, navigation, and other purposes. Most of these projects were placed in service during the decades following World War II. In the late 1970s, emphasis shifted back to allowing nonfederal hydropower development at Corps projects. More than 40 of these retrofits have now been completed, by municipalities, electric utilities, and independent power producers.



Non-Federal hydropower plant at Youghiogheny Dam (PA)

New turbine being installed at Bonneville Dam (OR)

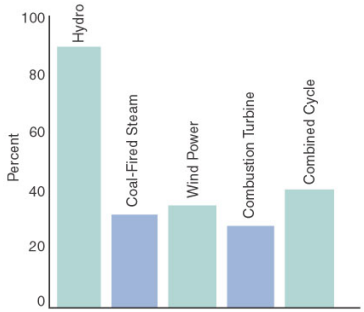
The Corps is working hard to keep its powerplants operating at peak efficiency and reliability. State-of-the-art equipment is used whenever possible to replace aging turbines, generators, and control systems.

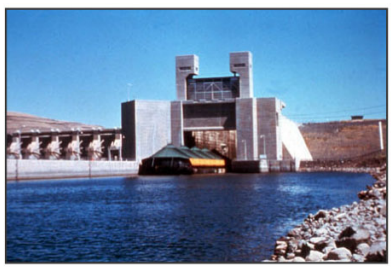
Value to Individuals and the Community...

Electricity plays an important part in our lives

Hydropower is a renewable resource

Efficiency of Power Generating Alternatives





Hydropower projects are multipurpose

The average American home uses about 10,000 kilowatt-hours of electric energy every year. Hydropower is an important source of that energy. It provides electricity to light our homes and to run our appliances, televisions, computers, and many labor-saving devices. Just as important is the electricity provided to our schools, hospitals, stores, offices, farms, and factories .

There are many ways to generate electricity, but hydropower has some characteristics that make it especially valuable to the community:

◆ **It's renewable** Hydropower is the nation's most productive source of renewable energy. The earth's hydrologic cycle provides a continual supply of water from rainfall and snowmelt. In addition, hydroelectric energy saves scarce, non-renewable fossil fuels.

◆ **It's efficient** Hydropower plants convert about 90 percent of the energy in falling water into electric energy. This is much more efficient than fossil-fueled powerplants, which lose more than half of the energy content of their fuel as waste heat and gases.

◆ **It's clean** Hydropower plants emit none of the waste gases that contribute to air pollution, acid rain, and global warming. They don't cause noise pollution. No trucks, trains, barges, or pipelines are needed to bring fuel to the powerplant site.

◆ **It's reliable** Hydropower plant machinery is relatively simple and runs at slow speeds. This makes it reliable and durable.

◆ **It's flexible** Hydropower units can start quickly and adjust rapidly to changes in demand for electricity. This makes them valuable for meeting peak loads and for serving as reserve capacity to protect power system reliability and stability.

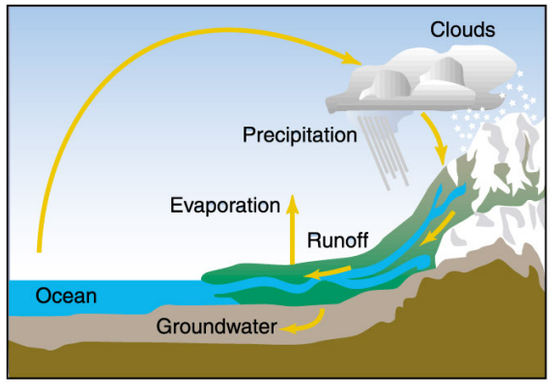
Corps dams with hydropower plants also serve other purposes, such as navigation, flood damage reduction, water supply, recreation, irrigation, and low flow augmentation.

Bringing Electricity to Farms. As late as the 1940's, many farms still did not have electricity. The 1936 Rural Electrification Act helped farmers organize electric cooperatives to bring power to their farms and communities. These co-ops and other publicly owned utilities were given first priority to power from Corps hydro plants. This power helped bring rural electrification to reality.

How Hydropower Works...

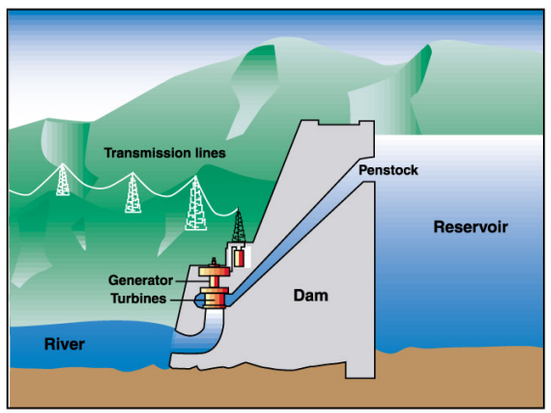
The Hydrologic Cycle

Water moves constantly through a vast global cycle. It (a) evaporates from the land, lakes, streams, and oceans, (b) forms clouds, (c) precipitates as rain or snow; and then (d) flows back to the ocean. The energy of this water cycle, which is driven by the sun, is tapped most efficiently with hydropower.

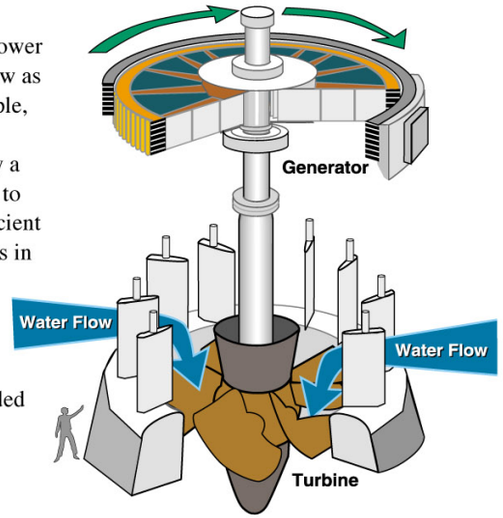


Generating Electricity

Hydropower plants capture the energy of falling water to generate electricity. A dam impounds water to form a reservoir and raises the water level to create head. Head is the vertical distance the water falls as it passes through the dam (i.e., the difference in water level between the reservoir and the river below the powerplant). The water is directed through penstocks to turbines, which drive generators to produce electric power.



Just having water in the river isn't enough. A good hydropower site must have enough streamflow as well as enough head. For example, the Mississippi River has tremendous streamflow, but only a few of its dams are high enough to provide the head needed for efficient hydropower development. Dams in the arid West may have plenty of head, but not enough streamflow. Where the right combination of streamflow and head exists, the Corps has included powerplants at its dams.



Hydropower Project Operation

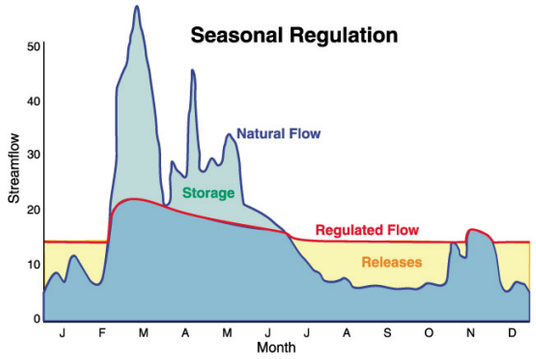
Corps of Engineers projects with hydropower generating facilities fall into two categories: storage projects and run-of-river projects.

Storage projects are usually located in the headwaters of river basins. Their purpose is to more evenly distribute the streamflow they release over the course of the year. In nature, river flow fluctuates widely. Streamflow is typically high during the rainy season and low in late summer and fall. In semi-arid regions, rivers become nearly dry in autumn. In many of the western river basins, flows remain low all winter as snow accumulates in the mountains and then swell with snowmelt in the spring.

Storage reservoirs capture river flow during the high runoff season and release it during dry periods. This creates a more dependable year-around flow for generating power. Keeping flows higher during the dry season also benefits other downstream river uses, like navigation, fisheries, recreation, water quality, and municipal water supply. Also, capturing part of the runoff during high flow periods helps reduce flood damage downstream. In fact, flood damage reduction is one of the major purposes of all Corps storage projects.

Allatoona seasonal storage project (GA)

Because storage projects follow a seasonal pattern of releasing water during dry periods and refilling in the high runoff season, water levels in the reservoirs behind dams fluctuate. They are usually full in early summer, but once the dry season begins, there is a gradual drawdown. Since reservoir recreation is an important project use, the Corps keeps reservoir levels as high as possible during the summer. However, droughts may keep reservoirs from filling in the spring or may force the drawdown to start before or during the recreation season.



The other major type of dam is the run-of-river project. It has little or no storage. The most common example of a Corps run-of-river project is the navigation lock and dam. Its purpose is to raise the river level to provide enough depth for commercial navigation. Such dams would typically be located on the lower reaches of a navigable river. Some lock-and-dam projects have a small amount of storage, called pondage. This is used to regulate powerhouse flow so that most of the generation is produced in the hours of peak power demand. Other lock-and-dam projects have no storage at all. They pass inflows straight through without any regulation.

Cordell Hull Lock and Dam, a run-of-river project (TN)

River basins like the Arkansas, Missouri, Columbia, and Cumberland have storage projects in the headwaters and run-of-river projects in the lower reaches. These projects operate together as a system. During the low flow season, the storage projects release water to increase downstream flows, some or all of which are used to increase power generation at downstream run-of-river projects. Power generation is only one of the objectives of these storage reservoirs, and careful management is required to ensure that all project purposes are served successfully.

Value to the Economy...

The greatest benefit from the Corps' hydropower program is the abundant low-cost energy the projects contribute to electric power grids. Because hydroelectric powerplants burn no fuel, operating costs are low and are immune to rising fossil fuel prices. In addition, most of these projects were built years ago, when construction costs were low. These factors help to make Corps hydropower among the least costly sources of electric power available today.

In most parts of the country, hydropower can carry only a portion of the system power load. The objective is to use this limited amount of energy in a way that will keep the overall cost of electricity to the consumers as low as possible. The highest-value use of hydropower is for "peaking" - generating as much energy as possible in the peak demand hours of the day. This saves having to produce this power at high-cost thermal peaking plants. Not all hydro plants can be used for peaking, but their power output is always used as efficiently as possible within the given project operating limits.

In years of ample runoff, hydropower plants produce extra energy. This is used to displace more expensive generation at fossil-fuel powerplants, which further helps to reduce consumers' electricity bills.

Corps hydropower pays its own way. The full cost of building and operating these plants must be repaid, with interest, in fifty years. This includes a share of the dam, reservoir, spillway, and fish ladders costs.

Concern about our Nation's limited energy resources is growing; many wonder if the output of hydropower plants can be increased. Four main options are available:

- Installing new high-efficiency turbines to increase energy output
- Installing uprated generators or adding more generating units to increase the power produced in the peak demand hours
- Upgrading aging equipment at older plants with newer, more reliable components
- Modifying project operation to increase powerplant productivity

The Corps considers these and other options as well as environmental factors in its ongoing program of powerplant renovation and upgrading.

Generators at The Dalles Dam (OR)

Fish ladder and spillway at John Day Dam (WA)

Recreation boaters on Corps reservoir

Recreation: An important benefit of many Corps hydro projects is recreational use of the lakes. These lakes are now among the most popular recreation sites in the country. Visitors enjoy a wide variety of water-based activities and also make a major contribution to local economies.

Hydropower and the Environment...

Lookout Point Dam (OR)

New aerating turbine like that being installed at J. Strom Thurmon Dam (SC)

Interior least terns nesting

Salmon smolts

The driving force behind the dams and reservoirs constructed by the Corps has always been to improve our quality of life. These flood control, navigation, water supply, and hydropower projects were constructed to improve the developed environment of the communities in which most of us live and work.

Water resource projects can often improve the natural environment as well. For example, increasing flow during dry months enhances aquatic habitat, while reducing flows in periods of flood runoff helps prevent damage to vegetation and wildlife habitat along stream banks.

However, dams and reservoirs change the natural river environment, and there is often a price to pay for these changes. Examples are the loss of open-river environment when a dam is constructed, and changes in river ecology that come with changes in flow patterns.

In recent years the public has come to realize that we need a balance between improving our immediate daily environment and in preserving the natural environment around us. The Corps' response is a concerted effort to mitigate dam and reservoir impacts to make the operation of these projects more compatible with the environment. Three examples illustrate this.

In the southeastern states, dissolved oxygen (DO) levels below dams may get so low in the summer that aquatic life is severely impacted. The Corps is improving DO levels by using aerating turbines and injecting oxygen directly into the streamflow.

When the six large reservoirs on the Missouri River were constructed, the emphasis was on navigation, flood damage reduction, irrigation, and generation of electric power. Fish and wildlife were also included in the development of reservoir operating plans. As part of its responsibilities to provide these multiple project purposes, the Corps continually assesses how well operating plans are satisfying basin-wide water needs. One such need has been the improvement of habitat for endangered species such as pallid sturgeon, piping plover, and the threatened interior least tern. This has led to a thourough review of the operating plans to see if a better balance can be given to environmental factors.

Columbia River salmon may be the biggest environmental challenge facing the Corps today. The Corps is working closely with the fishery agencies, the Tribes, and other interests to restore the declining salmon runs. Already, more than three billion dollars has been spent on research and dam modifications to improve salmon survival. The problem is not yet solved, but all parties are working diligently toward a solution - one that will restore the fish runs while ensuring that the projects continue to serve the purposes for which they were constructed.

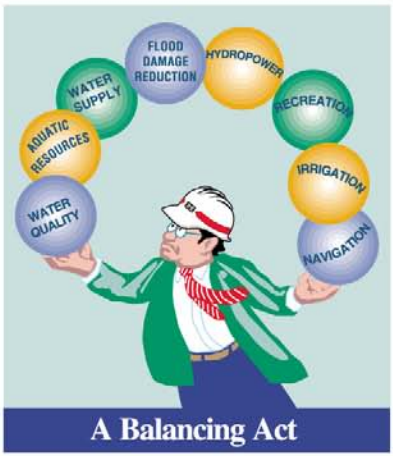
Sharing the Challenge...

Working Together

Hydropower operations at Corps of Engineers projects are a joint effort between the Corps and the regional offices of the Department of Energy (DOE). The Corps builds and operates the projects. The DOE's four Power Marketing Administrations (PMAs) market the power and deliver it to local utilities and other users. The PMAs also schedule the power generation to meet their customers' needs. This requires working closely with Corps water managers and powerplant operators to ensure that the available power is used most efficiently.

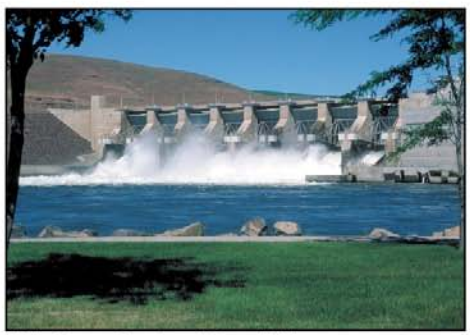
Power dispatcher at Bonneville Power Administration's Dittmer Control Center

Bonneville Power Administration (BPA):
the Pacific Northwest states
Southeastern Power Administration (SEPA):
the Southeastern states
Southwestern Power Administration (SWPA):
the South Central States
Western Area Power Administration (WAPA):
the remaining Western states



The Corps must also coordinate power operation with the projects' other purposes. Flood damage reduction, navigation, recreation, fish and wildlife, water quality, and water supply are some of the needs that must be considered. This involves working hand-in-hand with the many different government agencies and entities that are affected by or regulate Corps projects operation, such as the PMAs, US Environmental Protection Agency, National Marine Fisheries Service, US Fish and Wildlife Service, etc.

Another pre-eminent government agency is the Federal Energy Regulatory Commission (FERC) which licenses non-Federal hydropower plants at Corps dams. The Corps works with the plant owners and FERC to make sure that powerplant design and operation are consistent with the primary purposes of the dams.



Little Goose Lock and Dam (WA)

Learning More

To learn more about hydropower in the Corps of Engineers, go to the following website

http://www.usace.army.mil/public.html

or write to

U.S. Army Corps of Engineers, attn: CEPA
411 G Street, NW
Washington, DC 20314

Produced by the U.S. Army Corps of Engineers: The Institute for Water Resources (Alexandria, VA), in partnership with the Hydroelectric Design Center and the Hydropower Analysis Center (Portland, OR). To inquire about this brochure, please contact the IWR publications office at 703-428-9042.
Fall 2001