SMALL HYDRO: SLEEPING GIANT

Ignored in the age of cheap oil, small dams are a big deal these days. Their output could help double the hydropower capacity of the United States.

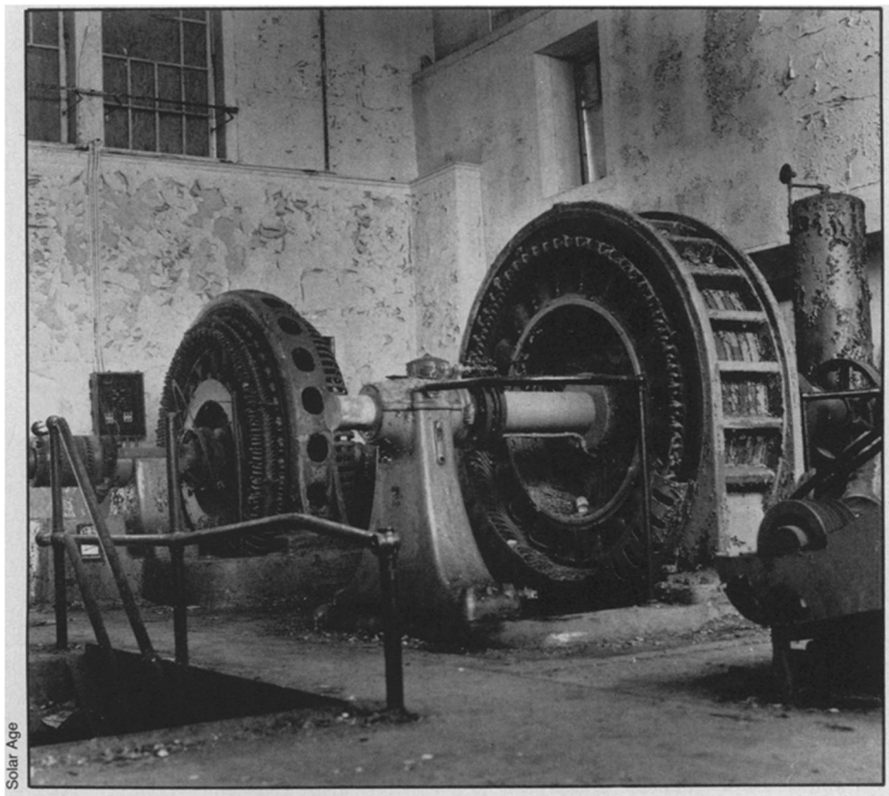
BY WILLIAM J. BROAD

Its paint was peeling, finding replacement parts was a headache, and its output, even when the river was running high, was a mere 650 kilowatts. In other words, the Lamprey River hydroelectric plant outside Newmarket, N.H., had seen better days. So with the quick approval of its stockholders, the Public Service Company of New Hampshire closed the old plant down. The generators were removed and concrete was poured into the penstocks that carried water from the dam to the turbines. On the far side of the reservoir, an old man hung a sign, "canoes for rent."

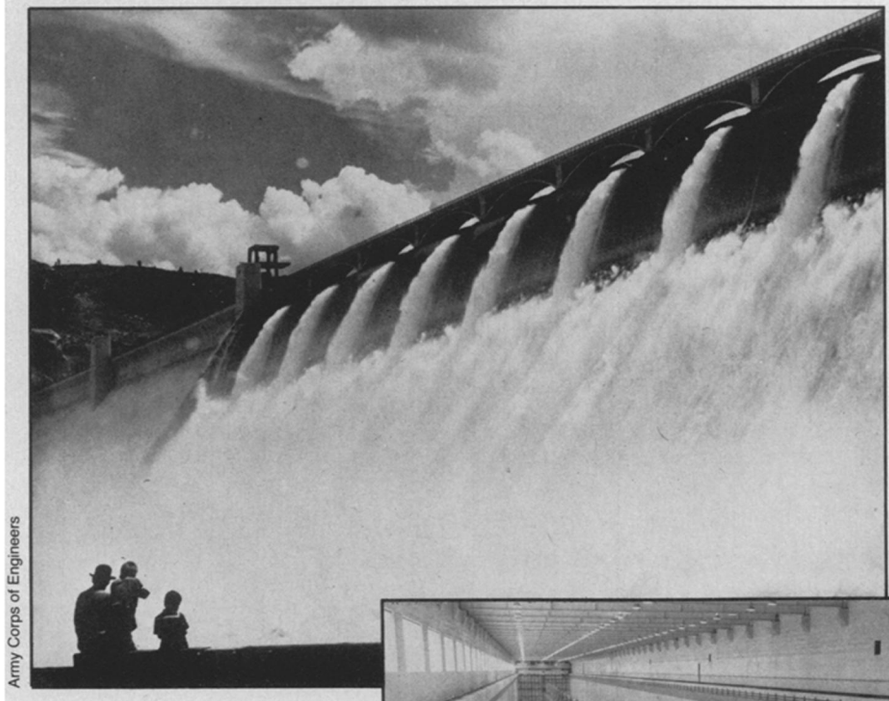
The shutdown seemed like a good idea in 1955. Fueled by cheap oil, the company's steam-driven generators cranked out close to a million kilowatts of electricity. The small, old hydros just couldn't compete. It was simple economics and it was repeated all across the country. According to the Federal Power Commission, no fewer than 770 hydro plants have been abandoned since 1940.

Then came the Arab oil embargo. Says David E. Lilienthal, a founding director of the Tennessee Valley Authority: "Before the embargo raised energy prices, many of these sites would not have been economical. But now the situation has changed drastically." For some, it is nothing short of a white-water renaissance.

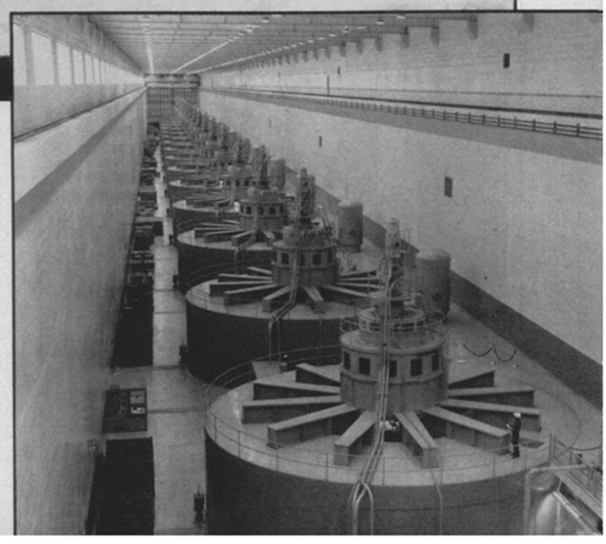
Entrepeneurs are buying old dams and refitting them for power production. Utilities are adding new generators to working hydroelectric plants and thinking twice about the abandoned ones. Municipal, state and federal agencies have ordered pilot studies. The U.S. Department of Energy is funding demonstration projects. The Army Corps of Engineers has completed an extensive inventory of old and new dam sites. Turbine manufacturers are coming out with special lines of small-hydro equipment. Says Fred Springer, chief of the Applications Branch



Solar Age



Army Corps of Engineers



Generators rust in abandoned hydro plant (top) at High Falls, N.Y. Until 1971, the plant cranked out 3,000 kw. A utility is now weighing restoration. About 1,300 times more powerful, the Grand Coulee Dam (above and right), the nation's largest, will expand to produce two million more kw.

of DOE's Energy Regulatory Commission: "We have forty-two requests for preliminary hydro plant permits at the moment. That's the most we've had at one time in the last ten years."

In the 1920s, hydro supplied a third of the country's electricity. Today it supplies only 13 percent. And much of that comes from storage facilities at large-hydro plants. During off-peak hours, they import electricity and pump water into elevated reservoirs. At peak periods, the water runs down, releasing its power potential. With small hydro, on the other hand, electric power is continuously produced at the site. Small, "low-head" dams are usually less than 65 feet in height and generate less than 15,000-kw of electricity. "Small" may be a deceptive word, however, since even a 5,000-kw hydro plant can serve the needs of several thousand families. Small-dam sites are scattered throughout the country, with the largest percentage located in the eastern and Great Plains states.

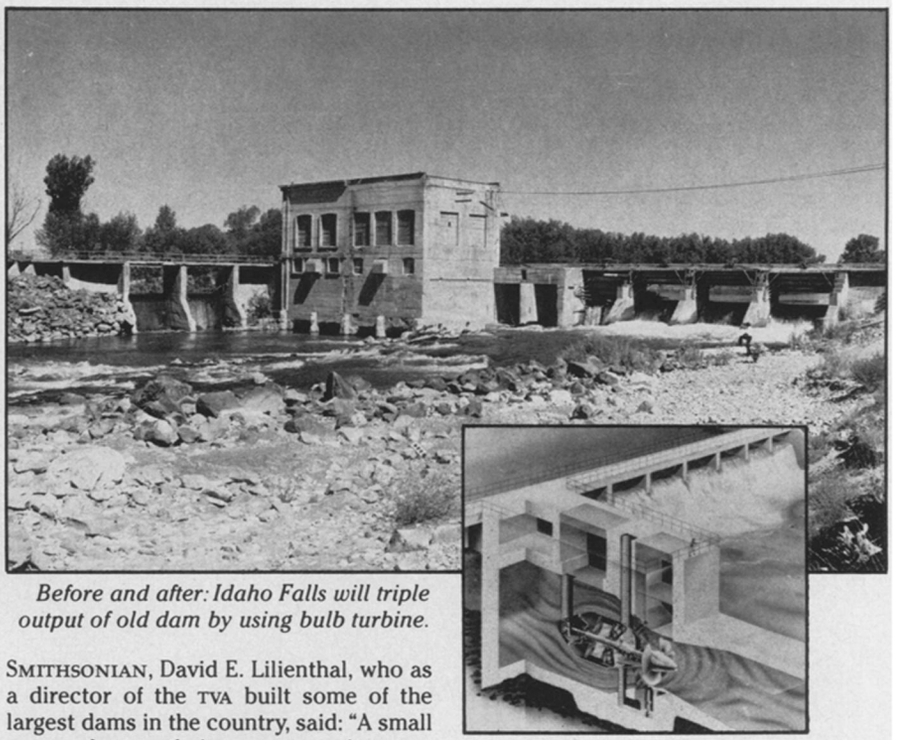
At President Carter's request, the Army Corps of Engineers counted and evaluated all the dams in the United States. Of the 49,500 they found, less than three percent produced power. The rest were used for flood control, navigation, irrigation, water supply or recreation, and a large number were just old and abandoned. The Corps estimates that the installation of additional generating capacity at existing dam sites could add to the nation's power pool about 54.6 million kw — the equivalent of 85 good-sized nuclear power plants. Almost half of that power would come from tiny, undeveloped dams with capacities of less than 5,000 kw, while the rest would come from installing more powerful and efficient equipment at dams that already produce power.

Tapping that potential has already begun. One of the first utilities to move into small hydro was Niagara Mohawk Power Corp. of Syracuse, N.Y. It announced more than a year ago that it would expand, rehabilitate, or build units at 15 small sites. The 14-year program will cost more than $150 million and will add 205,000 kw to the system. The smallest unit is 2,000 kw. There are other signs that small hydro is moving ahead. Of 26 hydro projects pending before the Federal Energy Regulatory Commission, 21 use an existing dam. In Massachusetts, Holyoke Water Power Co. plans to build a $12 million, 15,000-kw plant at an old dam on the Connecticut River. And Boise Cascade Corp., the paper company, is weighing the rehabilitation of a 1,000-kw, 50-year-old plant in Beaver Falls, N.Y., to supply two paper mills.

Small guys are squeezing into the act as well. Lawrence Gleeson of Belfast, Maine, became the first on record to start a company to exploit small-hydro sites two years ago. Now, with corporations in Maine and Pennsylvania, Gleeson has plans for 20 dams. He contracts with the dam's owner, develops the site, sells power to the local utility and returns a share of the revenues to the owner. His first unit, in Belfast, came on line in February of 1978 and is now feeding 100 kw into Central Maine Power Co.'s grid.

Obvious advantages come with hydro. It is renewable, unlike oil, coal and uranium. It is nonpolluting and available throughout most of the country. Most hydro systems have two or three times the expected life of a conventional thermal power plant, have lower operating costs, produce no thermal pollution and offer high efficiencies (up to 94 percent). Adding hydropower to existing dams, moreover, is cheaper than building new power plants.

Not the least of small hydro's advantages may be its emphasis on local self-reliance. Writing in the September 1977 SMITHSONIAN, David E. Lilienthal, who as a director of the TVA built some of the largest dams in the country, said: "A small power plant on their own stream is something that people can see and understand and take pride in, something that represents treasured associations with their past while confering substantial benefits in the present, something peculiarly their own. It would be foolish to discount such emotions, which lie at the roots of local initiative, identity and well-being."



Photos: DOE

Before and after: Idaho Falls will triple output of old dam by using bulb turbine.

Yet despite its advantages and vast potential, small hydro has problems. According to the Corps' report, many dams are old and need repair. Silting has probably cut reservoir capacity in at least 16 percent of the nation's dams — those more than 50 years old. A community receiving most of its power from small hydro could be in for trouble: About 60 percent of the nation's 49,500 dams are on streams that dry up for one week to six months almost every year. Some dams preclude hydro development, as can be the case with residential, irrigation, industrial, flood control, recreational and water quality control dams. And even when a good site is found, licensing by the various municipal, state and federal boards can take 16 months or more. Lack of technology can lock up a project. Over the years, as the hydroelectric industry geared up for larger and larger production, innovations in small-hydro technology came to a halt. Outdated technology now threatens to keep many small-hydro projects from becoming economically competitive. Moreover, hooking small, decentralized hydro units into the utility grid is technically complex and in many areas is hindered by legal barriers.

The Corps, however, in its final report to President Carter concluded that "none of the identifiable constraints to the development of hydroelectric power at existing dams are insurmountable and that the national potential is of such significance to warrant the rapid selection and development of small-scale hydro demonstration projects."

Taking up the challenge, DOE has allotted $10 million for establishing a small-scale hydro division, under the direction of Richard McDonald. It will deal with the recent flood of hydro interest and eventually set up demonstration projects. To speed development, the agency plans to streamline its regulatory process for small-hydro projects, cutting the application period to three to six months for plants smaller than 1,500 kw and to less than a year for larger units. The group also plans to assess regional resources and recommend development of certain sites, set up an information clearing house and evaluate new hydro technology. The first major push came last April when DOE

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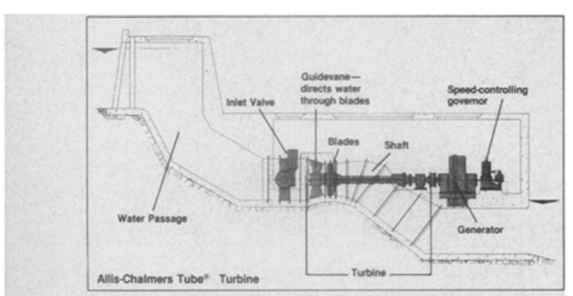
awarded 50 grants for feasibility studies of small (up to 15,000-kw) hydroplants at existing dams. While development is the goal, feasibility studies are an expensive but necessary first step. Says DOE hydro director McDonald: "Often the cost of the study just to assess the plant's feasibility is an impediment. We hope to help with some of the front-end costs and then choose maybe two or three of the best sites for construction funds."

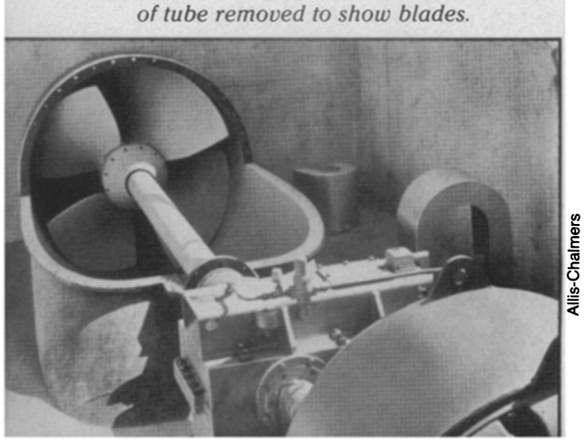
One site has already been picked. DOE will award $7.3 million over a four-year period to the city of Idaho Falls, Idaho, to help triple the output of three small dams on the Snake River and to test the efficiency of bulb turbines at small generating sites. Total cost will run $43.8 million.

The bulb turbines at the Idaho Falls project will be the first of their type to produce power in the United States. More than 350 bulb systems have been installed throughout the world, but they are just getting a toehold in the United States, with three or four turbine facilities under construction or in the planning stages. At Idaho Falls, the plant will consist of a generator enclosed in a metal bulb that can be placed underwater along with the turbine. This eliminates the cost in conventional systems of housing the generator separately. Because of their small size, bulbs are ideal for dams of less than 20 feet — about 34 percent of the existing dams in the United States. Helping to further close the technology gap are a line of small turbines just brought on the market by Allis-Chalmers's Hydro-Turbine Division in York, Pa. Called Tube Turbines, they range in size from 50 kw to 5,000 kw and can handle up to 50 foot heads. Unlike the custom-designed units that Allis-Chalmers builds for large dams, Tube Turbines are standarized and often cost less than conventional designs.

Even when built for one purpose, a dam



New for small hydro: Tube Turbines. Top of tube removed to show blades.



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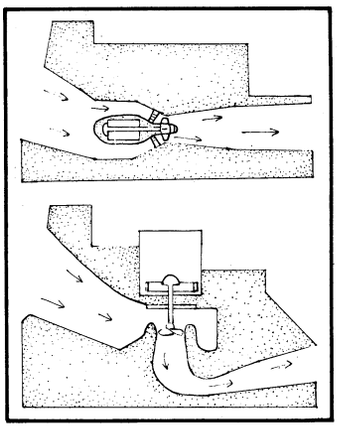

For small dams, the bulb turbine (top) is more efficient and easier to install than the Kaplan turbine (bottom), the most popular turbine in the United States.

can serve another. Take the Mount Morris dam on the Genesee River in west central New York. When the Army Corps of Engineers built it as a flood control dam, they prudently built in penstocks as well. If powerhouse and turbines were added, the dam could produce 40,000 kw of much-needed electricity. And the city of Vanceburg, Ky., is taking steps to install 210,000 kw in three navigation dams on the Ohio River to which it has access.

Another double-duty dam was among the more unusual recipients of DOE funds for the feasibility study. The Turlock Irrigation District in central California supplies irrigation for 300,000 acres of the U.S. "salad bowl." Originating high in the Sierras, irrigation water flows by gravity through man-made canals to the farmlands. Most of the district's power comes from high-head hydro, abundant in the great Sierras. But the district also plans to tap some of the power flowing through the canals. There are 19 places where the canal level drops—some places 6 feet to 8 feet, others as much as 26 feet. Turlock plans to install two generating systems this winter, one at a 17-foot drop, and another at a 26-foot drop. The two hydroelectric systems are expected to generate about 4,500 kw of power for the district at a cost of $4 million to $5 million. According to general manager Ernie Geddes, small-scale hydro and irrigation make a great match: "We can only supply power when irrigation water flows — which is also our peak load period because we only supply electricity for irrigation."

The Northeast, which has the highest fuel bills in the country and also has a healthy share of the small-hydro potential, is showing big interest. New York State's Energy Research and Development Authority funded a study by the Polytechnic Institute of New York to assess the state's small-scale hydro potential. They counted more than 1,400 dams in New York. If small dams were developed, they might furnish one million kw for the state. New York ERDA will provide funds to assess and develop some of the sites. PINY will pick 18 sites spanning the spectrum from 50 kw to 1,500 kw, from prime to not-so-good sites. Consulting engineers will do cost assessments of renovations. Finally, New York ERDA will provide the sites' owners with information on how to develop their power source—and offer grants for those projects that will best benefit hydro development in the state.

The New England states are embarking on a coordinated study of small-scale hydro potential. The New England River Basins Commission, a federally funded mix of state and federal personnel, is assessing the region's potential — and the potential problems if hydropower were extensively developed. They plan to look at environmental considerations — effects on fish breeding, muddying of river bottoms and restriction of recreational facilities.

Geared for decision-makers, the two-year study will also result in handbooks of case studies that explain how to develop hydropower at existing dams and how to build hydro facilities where there are no dams. The handbooks will also include what problems to expect — legal, engineering, institutional and financial.

Interest is not limited to the United States. While U.S. utilities were retiring small-hydro plants at a furious pace, Europe, China and Russia were setting up new ones right and left. The few bulb turbines used in U.S. projects came from Neyrpic Co., of France and a Canadian project bought a Russian bulb turbine.

A French company has also begun marketing a miniature hydroelectric power plant priced as low as $7,800 that can heat a country house indefinitely provided there is a small waterfall in the garden. Called Hydrolec, it was developed by Leroy-Somer, a respected motor building company based at Angoulême in western France. Hydrolec looks like a huge black top hat, operates on the siphon principle and comes in several sizes. The smallest, which weighs half a ton and stands four feet high, produces 5 kw. The biggest is about 12 feet high, weighs one and one-half tons and produces 40 kw. Ten kw is estimated to be sufficient for heating seven rooms in the average French climate.

China has also far surpassed the United States in small-hydro production. Since 1958, it is estimated that more than 60,000 small-hydro stations have been constructed with an average capacity of about 50 kw. The small generators produce most of the electricity for one-half of the production brigades and more than 70 percent of the communes.

Yankee ingenuity, however, is coming on strong. In the summer of 1977, for instance, the town of Bartlett, N.H., auctioned off two acres of land that held an old hydro plant. The town fathers figured the lovely view would sell the site. The high bidders, Edward Clark and Ted Larter, paid $52,000 for the property — but not for the view. They reworked the dam and power station, and now sell electricity back to the town. They've already recouped their investment. □