# Hydropower in Minnesota's Future

*Editor's Note: Water power as a source of energy in Minnesota has many champions, and rightly so. Plans to increase the output of electricity from dams existing in our state are moving ahead.*

*In the following two articles, two Department of Natural Resources specialists — dam safety engineer Craig Regalia and aquatic biologist Joseph Geis — report on two aspects of increasing our hydropower resources. Regalia surveys the field and recounts what is necessary to increase our energy supplies from water power. Geis describes the impact on fish and other aquatic life of one type of hydropower operation, then suggests ways to protect aquatic life by an alternative method.*

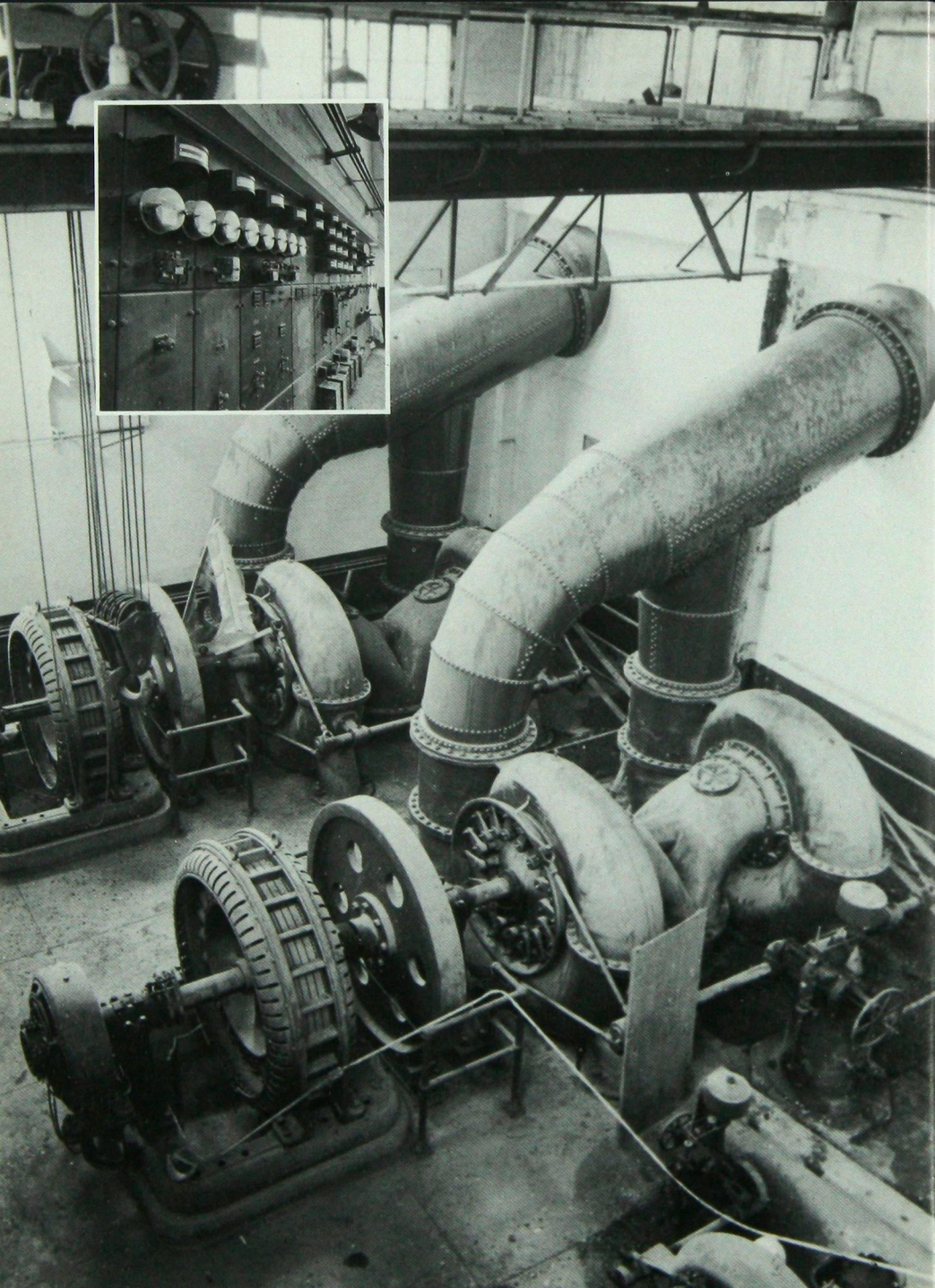
## 1. Cranking Up Our Hydropower Resource

Craig Regalia

THE HIGH COSTS and environmental issues associated with generating electricity by fossil and nuclear fuel have caused widespread public debate and concern. Consequently, optional energy sources are being evaluated and developed. One such option available in Minnesota is water power.

Most of the good hydroelectric sites in Minnesota, however, are already occupied by dams. The good news, though, is that many of these dams are sitting idle. Over their crests flows unharnessed energy. Some were built to generate power and did so for many years until it

**High water rushes over Lake Byllesby Dam at Cannon Falls on Cannon River. Power plant, idle since 1966, is in right background. Dam was completed in 1911 and operated 55 years.**



became more economical to substitute fossil fuel or nuclear facilities. Many small hydropower plants were then either dismantled or left to deteriorate. Using these existing dams is the most probable means of hydroelectric expansion in Minnesota.

Some of the advantages of hydroelectric generation are as follows:

- Dependability — down time is very low
- Nonpolluting operation
- Conventional fuels are not required
- Low operation and maintenance costs
- Long life of dam and generating equipment — 50 to 100 years
- Existing electric transmission lines can be used
- High plant efficiency — 85%
- Dams would be maintained in good condition, thus enhancing public safety
- Independence from commercial power suppliers.

Despite these advantages, however, plans for new dams in Minnesota have progressed more slowly than expected. The primary reasons are:

- High initial costs
- Necessity for engineering and feasibility studies
- Gaining the right to develop a site
- High interest rates for new construction and equipment
- Difficulties in arranging favorable power sales agreements
- Difficulty developing economical operating plans compatible with the fisheries of the watercourse involved. (See "Hydropower's Unexpected Side Effect," page 59.)

Existing dams may be used by rehabilitating idle equipment, installing new or used equipment, or by upgrading equipment operating today. Although each hydro site has unique hydraulic characteristics, standardized turbine/generator packages are available from equipment manufacturers.

**Cost Per Kilowatt.** Costs for reopening an existing small dam vary widely from site to site. A typical redevelopment project using new equipment might have the following cost breakdown:

Project design and management — 10 percent; construction and equipment installation — 40 percent; equipment manufacture and delivery — 50 percent.

A representative total project cost would be $1,200 per kilowatt of capacity, but the cost might vary from $800/KW to $1,600/KW, depending on the specifics of the site and the capacity of the installation. In a recent feasibility study for the Mississippi River Dam in St. Cloud, the project cost estimate was $9,200,000 for a 7,200 KW installation. (A kilowatt is 1,000 watts.)

In Minnesota, water power provides about 172 megawatts of electrical capacity at 28 hydro plants. (A megawatt is 1,000 kilowatts.) Minnesota Power Company is the leader with about 109 megawatts of hydro-

**In Byllesby Dam power plant, water flows through large pipes — penstocks — circles turbines (center) which turn generators (left). Water continues through penstocks into river below dam. Inset: Idle control panel.**

power generating capacity at 10 generating stations. This represents about six percent of that utility's power capacity.

In the near future, MPC plans to add about six megawatts of hydroelectric capacity and is evaluating the possibility of another 20 megawatts for the long term. Another 20 to 50 megawatts of capacity could be added by upgrading dams owned and operated by other private companies. Retired sites, now owned by counties, municipalities, and the state, could add 30 megawatts.

The amount of hydroelectric expansion in Minnesota will depend upon the economic feasibility of each site as determined by owner or developer. Improved economic conditions in terms of lower interest rates could result in an additional 150 megawatts of hydroelectric capacity within 10 years. (Minnesota's electrical generating capacity, all forms of energy, is about 8,000 MW.)

It's unlikely, however, that additional hydroelectric development in Minnesota will have a significant impact on the state's electrical energy needs. However, a small hydroelectric installation could significantly reduce energy costs for a municipal utility or private company. A one megawatt hydro station, for example, could provide most electricity for a community of 1,000 people.

**Permits.** In Minnesota, state law requires that a permit be obtained from the DNR for hydropower construction or reconstruction. The primary issues addressed during the permit review process relate to dam safety and engineering feasibility, water appropriation in terms of low-flow regulation, and impacts on wildlife, fisheries, recreation, navigation, flood control, water supply, and water quality.

The permit review also includes input from all levels of government, including counties, federal agencies, municipalities, watershed districts, and Soil and Water Conservation Districts.

Federal regulations require that hydroelectric projects larger than 5.0 megawatts be licensed by the Federal Energy Regulatory Commission. Projects smaller than 5.0 megawatts may apply for exemption from this federal licensing.

Most redevelopment projects in Minnesota will probably have a modified run-of-river mode of turbine operation. This type of operation would primarily use the normal stream flow rather than a store-and-release peaking cycle to generate electricity. Therefore, run-of-river operations are more environmentally acceptable because of the smaller streamflow fluctuations caused by turbine operation. (These hydropower operations are discussed in the article by Joseph Geis. — *Ed.*)

**Expansion.** The Minnesota State Legislature has provided funds to the DNR for cost sharing with local units of government on hydroelec-

tric feasibility studies. Under this program the St. Anthony Falls Hydraulic Laboratory is preparing feasibility analyses for dams located at St. Cloud, Granite Falls, Kettle River, Anoka, Lanesboro, Park Rapids, and Thief River Falls. These dams were selected from a hydropower site screening study of publicly owned dams that was prepared for the Minnesota Department of Energy, Planning and Development.

The Legislature has also provided for the long term leasing of publicly owned dams for hydropower and for hydropower expansion by limiting local taxes for the first five years after development. The Minnesota Public Utilities Commission is developing rules to encourage small power production — for dams, windmills, and solar facilities, for example — consistent with the protection of rate payers and the public.

Federal laws encourage hydropower by requiring electric utilities to purchase power generated by small producers. Also, changes in federal tax laws provide significant advantages to hydropower developers in terms of investment credits and depreciation.

Based on this generally favorable government climate and the need to develop additional sources of energy, it is likely that Minnesota can look forward to hydroelectric expansion in coming years.

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# 2. Hydropower's Unexpected Side Effect

## Joseph Geis

PEOPLE VIEW hydropower as a clean source of energy — no smoke, no ash, no radiation, no environmental side effects. But fish and other aquatic life see hydropower in a different light. There is one way of operating a hydro facility that threatens aquatic life. Most people are unfamiliar with this aspect of hydropower.

The driving force of hydropower is gravity. Gravity causes water to flow from a higher to a lower level. The difference in the water elevation between the pool above the dam and the water below the dam is called "head." The higher the head, the greater the waterpower.

Dams are generally classified as either low head or high head. Heads under 60 feet are generally called low head. Most dams in Minnesota being considered for hydropower are low head dams.

The most efficient turbine design for low head dams is a propeller turbine. The propeller looks like the prop on an outboard motor, except that it is larger. The propeller is inside a tube through which water flows and is connected to a generator