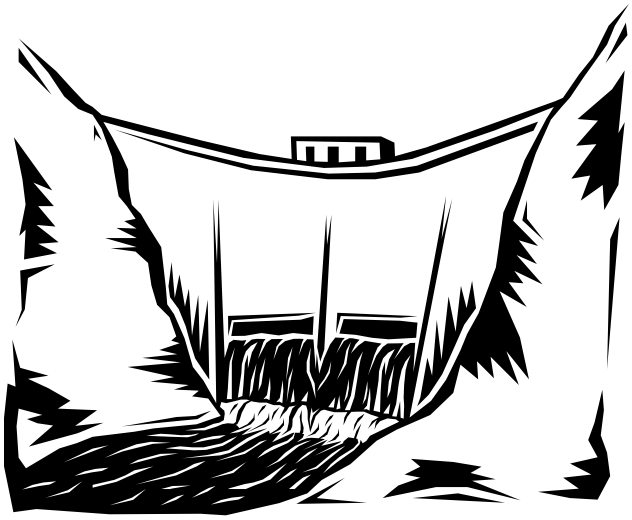
Facts about Hydropower

Introduction



Humans have used water as source of power for thousands of years. Civilization's earliest machines were waterwheels for grinding grain. The earliest reference to hydropower is in China between 202 BC and 9 AD. Later, waterwheels were adapted to drive sawmills, pumps, and bellows and to provide mechanical power for textile mills. Hydropower plants that produced electricity were developed in the late nineteenth century. Today, nearly all hydropower plants in the United States produce electricity. The term "hydroelectric power" is often used interchangeably with the term "hydropower."

A hydropower system converts the kinetic energy (energy of motion) in flowing water into other forms, such as electrical or mechanical energy. This conversion occurs when water flows past a waterwheel, propeller, or turbine. The farther the water falls the more kinetic energy it has. The kinetic energy of flowing water can be increased by building a dam across a river or stream.

Hydroelectric power is measured in kilowatt-hours, which is a measure of energy that calculates the power used over time. Kilowatt-hours is abbreviated as kWh. One kilowatt-hour of electrical energy is equal to 3,413 Btu (British thermal units). The power output of a hydroelectric power plant is measured in kilowatts (1,000 watts) or megawatts (1,000,000 watts).

Hydroelectric Power Plants

Hydroelectric power plants are generally located at places on rivers or streams that can be easily dammed to create a reservoir of water. Larger rivers with sufficient height for dams are ideal for providing electricity because the farther the water falls, the more kinetic energy there is to be harnessed. Penstocks channel flowing water into turbines which provide the mechanical energy to produce electricity in the generator. The amount of water released can be adjusted to meet the demand. Spillways divert excess water that builds up behind the dam. Most of the larger hydroelectric dams in the United States are on sizable rivers, such as the Colorado and Columbia in the West and those in the Tennessee Valley Authority region in the South.

One of the world's first hydroelectric power stations was built in Appleton, Wisconsin, in 1882, only three years after Thomas Edison's invention of the light bulb. This station's output was 12.5 kilowatts, which lit two paper mills and a house. The Wisconsin River, which runs the length of Wisconsin and spills into the Mississippi River, has been described as the "hardest working river in the nation." Most of the hydroelectric dams on the Wisconsin River are located on the upper two-thirds of the river. These dams have generating capacities between 700 kW and 29.5 MW (see ***Wisconsin Hydroelectric Sites***).

Electricity Production

In 2015, six percent of all electricity generated in the United States was generated using hydropower. Of the approximately 3,900 dams in Wisconsin, about 150 are used to generate hydroelectric power. These sites produced about 192,000 MWh (192,000,000 kWh) of electricity in 2015.

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Hydroelectric power provided 16.6 percent of the world's electricity, or 3,900 terawatt-hours (TWh) in 2014. The world's three largest producers are China, Brazil, and Canada. The relatively small country of Norway generates about 95 percent of its electricity from hydropower.

Although most large-scale hydropower sites in Wisconsin and the U.S. have already been developed, some potential exists for small-scale, local hydropower plants. The amount of hydropower being generated today is nearly five times the worldwide potential amount estimated in 2011 at 946,182 MW. There are also immense undeveloped hydropower resources in northeastern Canada.

A number of industries in Wisconsin and the United States are located near large hydroelectric sites so they can use the cheap, reliable electricity these plants provide. Examples include the paper industry in Wisconsin and the aluminum smelting industry in the Pacific Northwest.

Effects

Hydropower offers several benefits. Hydroelectric power plants have no fuel costs and low operating and maintenance costs. They last two to ten times longer than coal and nuclear plants, emit no carbon dioxide or other air pollutants, and generate no waste. In addition, hydroelectric dams help control downstream flooding, provide water for crop irrigation, and create reservoirs that provide recreation and fishing.
Large reservoirs behind hydroelectric dams also flood vast areas, harm wildlife habitats, move human settlements, and decrease fertilization of farmlands and fish harvests below the dam. A concern currently being researched and mitigated is dam impediment to fish migration. Migrating fish such as salmon can be blocked by dams to traditional spawning sites and their population can be severely harmed. Fish ladders and passages have been implemented on a number of large and small dams across the globe to avoid this issue.

Outlook

Hydropower will continue to be an important energy resource in the United States and the world. However, it is unlikely that enough new hydroelectric plants will take the place of fossil- and nuclear-fueled electric power plants. Most available sites for large-scale hydroelectric power production in the United States have already been developed. On the other hand, the potential for further development of hydropower on smaller rivers and streams still exists. However, water shortages have decreased electricity produced by hydropower by 14 percent over the past two decades globally.

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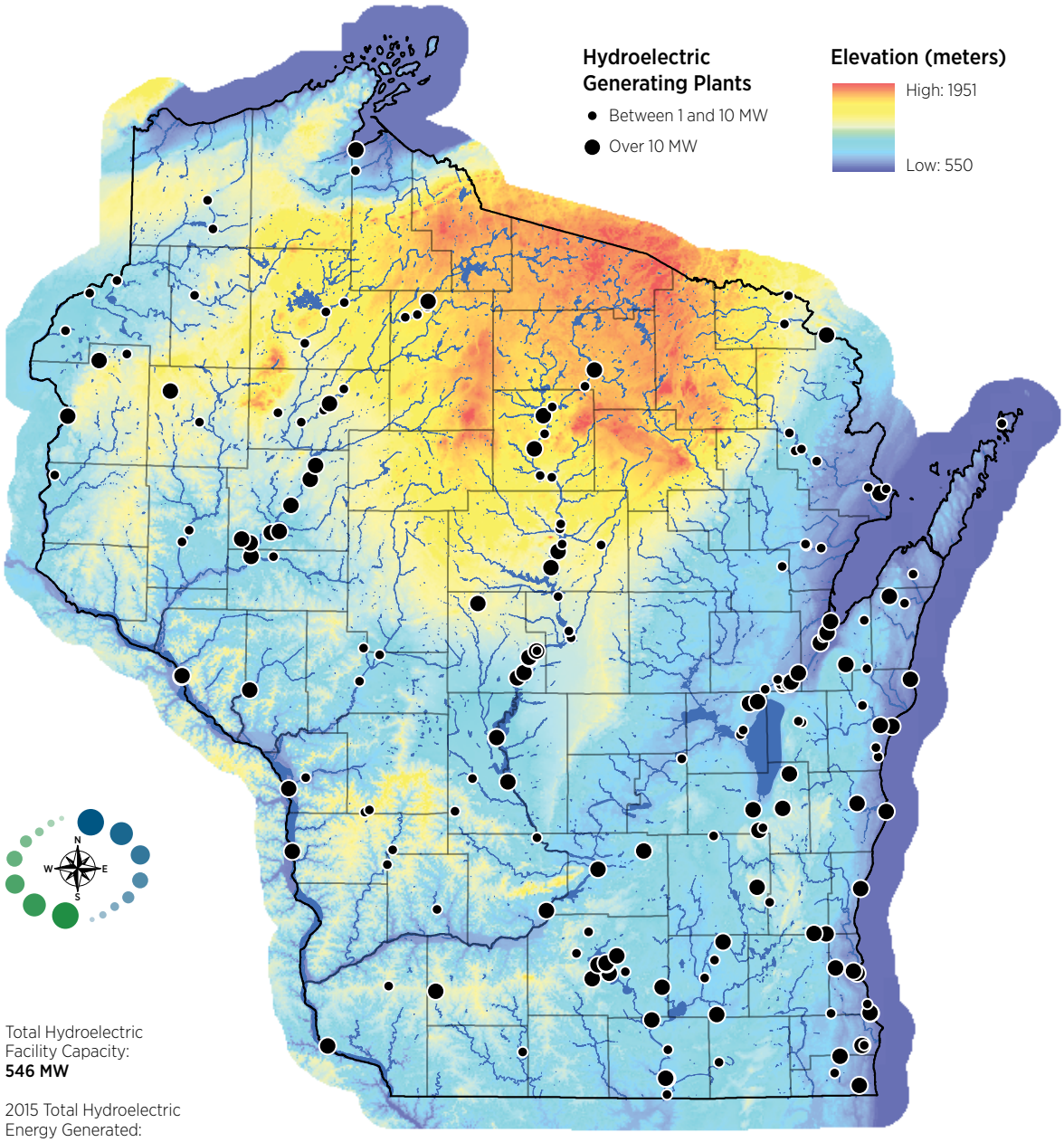
Wisconsin Hydroelectric Sites

Hydroelectric Generation Sites in Wisconsin

2015



Total Hydroelectric Facility Capacity:
546 MW

2015 Total Hydroelectric Energy Generated:
2,431,230 MWhs

(Capacity and energy generated include hydroelectric facilities owned by utilities, merchants, cooperatives, and other nonutilities.)

Source: Wisconsin Office of Energy Innovation. Wisconsin Energy Statistics Book.

Wisconsin Hydropower

Spillways at Wissota Hydro. Located on the Lower Chippewa River, this facility was completed in 1918 and produces 36.4 MW. Photo Courtesy of Xcel Energy.

Jim Falls Hydro auxiliary spillway adjacent to the power house. Located on the Lower Chippewa River, this facility was originally constructed in 1923. In 1984, a $92 million redevelopment project made it the largest hydro facility in the Midwest in terms of generating capacity (57.5 MW). Photo courtesy of Xcel Energy.