MILESTONES in hydroelectric power

Hydropower—harnessing the kinetic energy of rivers to generate electricity—has been used for centuries to turn wooden water wheels for milling grain. The first industrial uses of hydropower began in the United States in the late 1880s. Today, hydroelectric power supplies twenty percent of the world's electricity.

UNITED STATES AMES PLANT TELLURIDE, COLORADO

The Ames Hydroelectric Plant in Telluride, Colorado, was the site of the world's first use of alternating current electric power that was generated, transmitted and sold for industrial purposes.

At the time of the plant's construction in 1891, the gold mining industry in the region was suffering under the depletion of cheap steam power. Meanwhile Thomas Edison and George Westinghouse were engaged in a "current war" over the superiority of direct current (DC) or alternating current (AC) electric power.

DC power had proven to be ineffective for the 2.6 mile distance of transmission from the Ames plant to the motor-driven mill at the Gold King Mine. The distance limitations were overcome with the decision to use single-phase alternating current.

In the winter of 1890, a generator and a motor from the Westinghouse Company—the largest manufactured at the time—were installed at the Ames plant. Two turbines powered the generator; each supplied from separate diversions of the San Miguel River. The project spurred many innovations in electrical generation and lightning protection; its success is seen by many as having spawned the contemporary use of alternating current electricity.

UNITED STATES MILL CREEK PLANT REDLANDS, CALIFORNIA

Built by the Redlands Electric Light and Power Company, the Mill Creek No. 1 plant was the first commercial use of three-phase alternating current generators in the United States when it began generating electricity on September 7, 1893. This achievement is owed to the work of Nikola Tesla, another foe of Edison's in the "war of currents." Tesla built the first motors using polyphase AC, or current with two or more alternating currents with the same frequency in different phases, a technology first demonstrated to the American Institute of Electrical Engineers (AIEE) in 1888.

The plant generated its power at Mill Creek, seven and a half miles from the city of Redlands. Three Pelton water wheels* turned two 250 kW generators that transmitted 2400 Volts to provide lighting for the town and power to a nearby ice house.

The success of the Mill Creek station greatly influenced the adoption of three-phase AC power systems. More than one hundred years after Mill Creek, three-phase generators remain the primary form of power generation around the world.

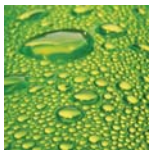
***What is a Pelton water wheel?**
See page 22 for more details.

UNITED STATES ADAMS POWER-HOUSE AT NIAGARA FALLS

In August 1895 the Adams No. 1 generating station of the Niagara Falls Power Company first supplied electric power to local industries in Niagara Falls, New York. This station was the first large-scale multiphase power station with commercial operations at Niagara Falls. Edward Dean Adams, the president of the Niagara Falls Power Company, designed the new powerhouse, which was built 1.5 miles above the falls.

The Niagara Falls Power Company contracted with the Westinghouse Company for long distance electric transmission development and implementation, including transformers that could handle 1,250 horsepower and overhead wires capable of transmitting 11,000 volts. Eventually, the falls were home to giant underground conduits leading to turbines generating upwards of 100,000 horsepower (75 MW). By 1896, the Adams Powerhouse was sending power as far as Buffalo, New York, twenty miles (32 km) away.

Niagara Falls became established internationally as the birthplace of a new electric utility industry that brought the benefits of large-scale power developments to users spread over vast areas.



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With the help of the Institute of Electrical and Electronics Engineers (IEEE) and its Milestones in Electrical Engineering and Computing program, the *ANSI Reporter* looks back into man's history of harnessing the power of water to supply electricity for industry and society.

GLOBAL
CHIVILINGO POWER STATION LOTA, CHILE

The Chivilingo power station, inaugurated in 1897, was the first hydroelectric power plant in Chile and the second in South America. Taking advantage of the water falls of the Chivilingo river, the plant provided power to the Lota undersea coal mines. At the beginning of the twentieth century, Lota was a significant port at the southern tip of South America for coal exports to North America and Europe.

Chivilingo had two Pelton turbines* transmitting power through a 10 kilometers line that led to the coal mines. The plant also provided essential power to the railway that transported the minerals that went underground up to a depth of 12 kilometers under the sea. Chivilingo demonstrated the advantages of hydro-based electricity generation in a region with important hydro resources and made possible the development of other industries in the region.

GLOBAL
DECEW FALLS PLANT ONTARIO, CANADA

The Decew Falls Hydro-Electric Development built by the Cataract Power Company was a pioneering project in the generation and transmission of electrical energy at higher voltages and at greater distances in Canada.

The plant began operation in August 1898, transmitting power at 22,500 Volts, 66 2/3 Hz, two-phase, over a distance of 35 miles to Hamilton, Ontario. Using the higher voltage permitted efficient transmission over that distance. It supplied power to Hamilton several years before Niagara power reached Toronto.

Drawing water from Lake Erie through the Welland Canal, the station originally contained two 1,500 horsepower units; two 3,000 horsepower units were added in 1900. The plant was completed in 1912 with a total output of 44,600 KVA at 66 2/3 cycles.

GLOBAL
VUCJE PLANT LESKOVAC, SERBIA

The Leskovac Electric Society was formed in 1901 in southern Serbia to raise capital to finance the building of a hydroelectric plant on the Vucjanka River. The Vucje hydroelectric plant began operation in 1903. It was the first in southern Serbia and the largest in the broader region.

One of the most unusual features of the hydroelectric plant was its water delivery method. A pipeline was constructed during 1902 and 1903, carving out a stone canal more than 3000 feet in length and averaging a little more than three feet in width along the side of the river. The plant's German-made turbines powered two generators that were each capable of producing 139 kW.

By transmitting alternating current of 50 Hz at 7000 volts over a distance of 16 km, the Vucje hydroelectric plant helped to transform the regional economy.

100 years of the IEC

The **International Electrotechnical Commission (IEC)** began preparing standards for hydroelectric power in 1913. IEC Technical Committee 4 (Hydraulic turbines) has the lead role in the development and maintenance of standards and technical reports for designing, manufacturing, commissioning, evaluating, testing and operating a wide range of hydraulic machines, including turbines, storage pumps and pump-turbines of all types. Standardization helps these alternative energy technologies to become marketable by providing a foundation for certification systems, promoting international trade of uniform high-quality products and supporting transfer of expertise from traditional energy systems.