MARCH 1990

Oklahoma Water News

MONTHLY NEWSLETTER OF THE OKLAHOMA WATER RESOURCES BOARD

From Water Wheels to Turbines

Hydroelectric power lights homes, fuels economy

The thunderous roar of a waterfall hints at the energy hidden within; the ground rumbles under the awesome force. Undoubtedly, early man wondered if his kind might someday harness the consummate power of falling water. Although this dream would not be realized for centuries, when man at last developed the technology, he advanced quickly.

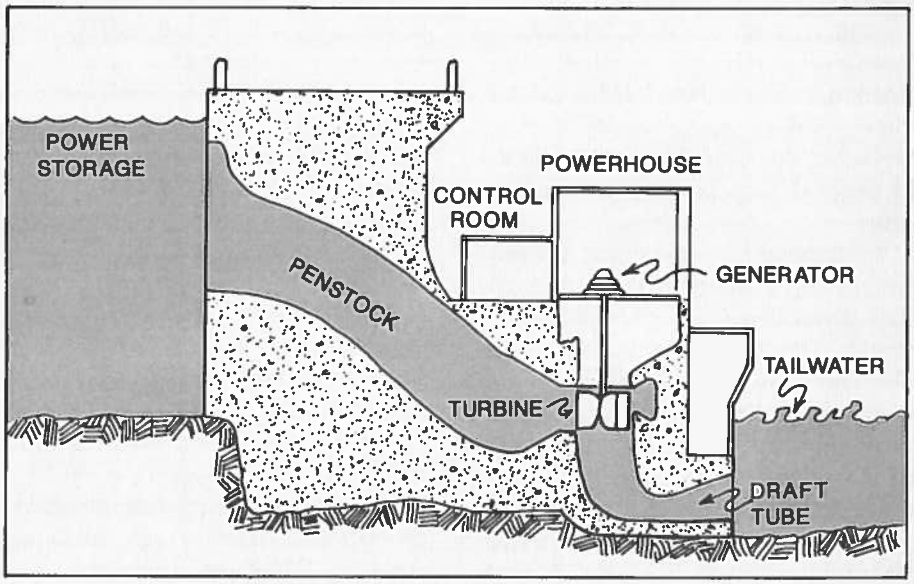
Today, hydropower is the source of one-quarter of the world's electricity and about five percent of the world's total energy consumption. A huge and still largely untapped source of energy, it is responsible for running factories and lighting cities throughout the globe. Hydropower provides more electricity for the world than does nuclear power—and it has clear environmental advantages, emitting no residue or pollutants.

Hydropower has brought electricity to the nation's rural areas and offers hope to some of the world's poorest regions. In South America, 73 percent of the electricity used comes from hydropower. Norway receives 99 percent of its electricity and half of all its energy from rich, flowing water.

Early Romans knew that the interaction of moving or falling water with a series of buckets, paddles or blades placed around the circumference of a wooden wheel could easily move the structure, thus converting the flow to mechanical power. But slave labor made water wheels unnecessary. Subsequent wars, famines and the Black Plague killed one-third of the European population in the 14th century and water-powered mills soon came into vogue; thousands were in use entering the 18th Century. The English colonies in America also utilized water mills and, by the end of the 1700s, about 10,000 water wheels were utilized by New Englanders. Golda's Mill, a water-powered grist mill established in 1836 near Stilwell, was one of Oklahoma's first industries. The important facility, fueled by the flow of spring-fed Bidding Creek, was equipped with machinery for grinding grain into flour or meal.

In 1820, hydropower finally became a source of electricity when French engineer Benoit Fourneyron invented the turbine—a submersible, compact and efficient machine for energy production. Turbines were connected to generators to produce electricity (200 kw) for the first time at Appleton, Wisconsin, in 1882—a few days after the first thermal plant began operation. The important discov-

Continued on page 2



Cross section of a dam illustrating a typical hydroelectric power generating structure

Hydropower, continued from page 1

ery and development of alternating current by George Westinghouse at Niagara Falls in 1901 allowed for economical transmission of power over relatively long distances. But due to the low cost of fuel, thermal plants dominated the energy scene in the early 1900s.

Hydropower received its biggest boost during the era of large dam construction and creation of the Tennessee Valley Authority by Congress in 1933. The TVA's development of massive hydroelectric projects brought vast quantities of affordable electricity to rural America. Electrification of the region led to rapid industrial growth which, in turn, led to even greater energy demands.

Congress passed 1936 Flood Control Act

The Flood Control Act recognized multipurpose development and increased factors used to determine the economic feasibility of large projects. Dams constructed to control floodwaters became profitable power facilities. Prime locations for these projects were soon occupied throughout the nation, especially in Oklahoma.

Today, there are 12 hydroelectric projects at major reservoirs in Oklahoma—Texoma (Denison Dam) on the Red River; Broken Bow on the Mountain Fork River; Kaw, Keystone, Webbers Falls and Robert S. Kerr on the Arkansas River; Grand (Pensacola Dam), Fort Gibson and Hudson (Markham Ferry Dam) on the Grand River; Hudson's sister facility at W.R. Holway Lake; Tenkiller on the Illinois River; and Eufaula on the Canadian River.

To generate hydroelectric power, water from a reservoir flows through gate-controlled pipelines, called penstocks. The flow rotates turbines in the dam's powerhouse, driving overhead generators, then discharges through draft tubes into the river channel below. The electric current from the generators is increased in voltage by large transformers for transmission away from the project and eventually to homes and industries. Because hydroelectric power production is a nonconsumptive use, many northeast Oklahoma facilities use the same water which drives turbines at upstream projects. Water which flows through facilities on the Arkansas, Grand, Illinois and Canadian Rivers also generates power at the farthest downstream project, Kerr Reservoir.

Interestingly, the most productive hydropower facility in Oklahoma does not exist at a major dam site, although it works in tandem with the Lake Hudson project. W.R. Holway Lake, adjacent to and above Lake Hudson, is part of a "pumped storage" project designed to receive water during off-peak periods, then generate power during times of peak demand.

The pumped storage system utilizes "reversible pump-turbines," each devised to operate as either a pump or turbine simply by reversing its direction of rotation. Water is diverted from Holway Lake through a canal to penstocks which release it to run down a 250-foot bluff to turbines in the powerhouse, generating electricity. During low demand, the reversible pump-turbines drive water from Lake Hudson back through the penstocks and uphill into Holway Lake to be reused. Pumping and power generation for the system are controlled at Hudson.

The Federal Energy Regulatory Commission (FERC) licenses water power projects developed by non-federal entities (including individuals, private entities, states, municipalities, electric cooperatives, etc.). Existing hydropower projects owned and operated by Oklahoma's Grand River Dam Authority (GRDA)—Grand Lake O' the Cherokees, Lake Hudson and W.R. Holway Lake—are also under FERC control. Federal dam projects which support hydropower facilities have obtained such authorization from Congress.

The Southwestern Power Administration (SWPA), an agency of the U.S. Department of Energy, markets power produced at federal dams, including eight in Oklahoma—Keystone, Fort Gibson, Webbers Falls, Kerr, Tenkiller, Eufaula, Broken Bow and Texoma. According to Fred Munsell, a planner with the SWPA, those eight projects alone have generated enough electricity to light three million homes for one year, or more than $3 billion worth of power, since the completion of Denison Dam 45 years ago.

Hydropower is reliable, environmentally clean

"Energy and operating costs of hydropower facilities are relatively low compared to thermal plants, and they are designed to last for the life of the host dam—100 years or more," Munsell pointed out. "And hydropower is readily available and can be put on line much faster than fossil fuel plants." Such flexibility is an important characteristic. Electricity demands are not constant throughout the day or year and users often require power sources that can be easily turned on or off.

Hydropower also offers stable prices in an era of inflation. When oil prices skyrocketed, the price of hydropower remained stable and tax incentives were offered to build hydroelectric facilities, Munsell said. Between 1970 and 1975, the price of coal quadrupled, uranium increased by eight times, and the price of oil tenfold, but the sudden plunge of fuel prices made hydropower less intriguing from an economic point of view. If projections hold true, rising energy prices in the 90s could once again spark interest in hydropower.

"Hydropower projects are good insurance against increasing fuel prices, although they require quite some time to earn financial return," he added. Economy and reliability can be ensured by combining water and thermal (steam) power. Systems served by hydropower alone are often at a disadvantage during drought episodes.

Political and environmental issues also factor into hydropower development. Political battles have long been waged over competing needs for water storage—such as flood control, power, recreation, fish and wildlife and navigation. Operation of a reservoir's power pool causes dramatic fluctuations in lake levels because of the tremendous quantities of water that must pass through the generating turbines at one time.

Pensacola Dam, on Grand Lake, was originally authorized only for hydropower but the Corps of Engineers soon determined that flood control was also needed at Grand, Hudson and Fort Gibson. Flood control and hydropower advocates met head on but, subsequently, Congress determined that development of the Arkansas River should combine navigation, hydropower, flood control and other uses.

According to James Barnett, OWRB Executive Director, current federal law states that hydropower, as well as navigation uses, are secondary to other beneficial uses of Oklahoma reservoirs.

"Of special concern to the Board is hydropower's impact on existing and future water rights from those projects, as well as present and future downstream diversions. Use of water for hydropower must be coordinated so that water is available to water right holders when they need it," he said.

Development of new hydropower units in Oklahoma seems to be moving at an even pace to keep up with the state's steady demand for electricity, according to Munsell.

"SWPA is currently working with GRDA and the Corps to construct two additional hydropower units at Fort Gibson," he pointed out, adding that future hydropower development will center around increased private involvement. "The Oklahoma Municipal Power Authority was responsible for adding hydropower at Kaw Lake and the Cherokee Nation has received permission to design, construct and finance hydropower facilities at W.D. Mayo Lock and Dam on the Arkansas River Navigation System.

"When hydropower facilities are added to existing projects, the penstocks and related structures are usually in place for future modification, such as at Fort Gibson. And while studies of Oklahoma's hydropower potential have identified many feasible sites, there are few existing large projects that can be readily expanded for hydropower.

"The key to expansion of hydropower projects rests with future legislation on fossil fuel plant development and restrictions on emissions. And if costs for power and fuel escalate, construction or modification of hydropower facilities will become more feasible," Munsell added. Currently, less than three percent of the country's dams produce electricity.

If interest in hydropower again booms, many experts agree that existing small dams will be targeted for modification—a practice once popular, according to Harold Springer, chief of OWRB's Engineering Division.

"There are several small lakes in the state which, at one time, supported minor hydropower projects. Unfortunately, falling fuel prices made them obsolete." Today, these structures sit in ruin, reminders of the fickle demand for hydropower and thermal power's strong hold on energy production. Regardless, hydropower is a proven, clean source of power vital to Oklahoma's economy—and it is poised to meet the state's future energy demands.

Coalition Solicits Support for New Lock, Dam Proposed on McClellan-Kerr System

The Arkansas Basin Development Association (ABDA), businesses and industries have formed a coalition to encourage the Congress to proceed with funding for a new lock and dam to be constructed in the entrance channel of the McClellan-Kerr Arkansas River Navigation System. The ABDA and other project backers united in the Arkansas River Basin Coalition for Montgomery Point Lock and Dam declare that the future of the navigation system is threatened.

According to coalition members, the Mississippi River elevation at the confluence of the navigation system has been dipping lower than designers ever believed possible. Planners intended the system to operate at 110 feet above sea level, the lowest predicted level at the confluence. However, over the years, the forces of nature combined with the impact of bank stabilization and other man-made changes along the river have caused an alarming drop in the water level at the entrance to the system. They predict that the Mississippi will continue to decline before stabilizing at 95 feet above sea level—15 feet lower than expected.

The low water level and increased sediment buildup at the confluence have required frequent dredging in the last 10 years just to keep this 10-mile section of the channel open.

Coalition members point out that an additional lock and low water dam close to the confluence would solve the problem. They say an environmental study by the U.S. Army Corps of Engineers shows that the river and wetlands close to the proposed construction would not be adversely affected. According to backers, construction of a low water dam would neither hold water above the existing river banks, create any lakes, nor flood surrounding natural habitat.

The Montgomery Point lock and low water dam designs are scheduled for final review in July, 1990. Results and an environmental impact statement will be included in a report due by September.

As the Corps of Engineers finalizes its study, the Arkansas River Basin Coalition for Montgomery Point Lock and Dam asks all who are interested to participate by allowing their names or their companies' names to be used to show support for the project. The Arkansas Basin Development Association requests that notes stating support be addressed to the Arkansas Basin Development Association, 440 South Houston, Room 505, Tulsa, OK 74127.

More information on the coalition and the proposed project is available by writing ABDA at that address or calling (918) 581-2806.

mainstream

Wetlands Given $26 Million

The 101st Congress voted during its first session to allocate $26 million for the preservation of wetland habitat.

The bill authorizes up to $26 million annually for the U.S. Department of the Interior to acquire wetlands in this country, Mexico and Canada. According to "U.S. Water News," $15 million will come from the federal budget, the remaining $11 million annually from a federal trust fund collected as excise taxes on hunting equipment.

The purpose of the legislation is to protect the habitats of migratory birds and perhaps double the wildfowl population by the year 2000.

ACTIVE CONSERVATION STORAGE IN SELECTED OKLAHOMA LAKES AND RESERVOIRS AS OF MARCH 5, 1990

PLANNING REGION LAKE/RESERVOIR	CONSERVATION STORAGE (AF)	PERCENT OF CAPACITY
SOUTHEAST		
Atoka	123,475	100.0
Broken Bow	918,100	100.0
Pine Creek	77,700	100.0[2]
Hugo	157,600	100.0[2]
McGee Creek	109,800	100.0
CENTRAL		
Thunderbird	105,925	100.0
Hefner	55,636	73.8
Overholser	15,935	100.0
Draper	79,703	79.7
Arcadia	27,390	100.0
SOUTH CENTRAL		
Arbuckle	62,571	100.0
Texoma	2,519,200	95.0
Waurika	203,100	100.0
SOUTHWEST		
Altus	125,693	94.5
Fort Cobb	78,423	100.0
Foss	171,178	70.4[1]
Tom Steed	75,294	84.6
EAST CENTRAL		
Eufaula	2,329,700	100.0
Tenkiller	627,500	100.0

PLANNING REGION LAKE/RESERVOIR	CONSERVATION STORAGE (AF)	PERCENT OF CAPACITY
Wister	63,250	100.0[2]
Sardis	302,500	100.0
NORTHEAST		
Eucha	79,567	100.0
Grand	1,483,980	99.0
Oologah	544,240	100.0
Hulah	30,594	100.0
Fort Gibson	365,200	100.0
Heyburn	6,600	100.0
Birch	19,200	100.0
Hudson	200,300	100.0
Spavinaw	30,000	100.0
Copan	43,400	100.0
Skiatook	319,400	100.0
NORTH CENTRAL		
Kaw	428,600	100.0[2]
Keystone	616,000	100.0
NORTHWEST		
Canton	97,500	100.0
Fort Supply	13,900	100.0
Great Salt Plains	31,400	100.0
STATE TOTALS	**12,110,954**	**94.6**

1. Conservation storage lowered for project modification
2. Seasonal pool operation

Data courtesy of U.S. Army Corps of Engineers, Bureau of Reclamation, Oklahoma City Water Resources Department, and City of Tulsa Water Superintendent's Office.

This monthly newsletter, printed by the Central Printing Division of the Office of Public Affairs, Oklahoma City, Oklahoma, is published by the Oklahoma Water Resources Board as authorized by James R. Barnett, executive director. Ten thousand copies are printed and distributed monthly at an approximate cost of 20 cents each.

MARY E. WHITLOW, Editor **BRIAN VANCE, Writer** **BARRY FOGERTY, Photographer** **BRAD NESOM, Layout Artist**

OKLAHOMA WATER NEWS

Monthly Newsletter of the
Oklahoma Water Resources Board
1000 N.E. Tenth, P.O. Box 53585
Oklahoma City, Okla. 73152

BULK RATE
U.S. POSTAGE
PAID
Oklahoma City, Okla.
Permit No. 310

March is Flood Awareness Month!

For information on the NATIONAL FLOOD INSURANCE PROGRAM call the OWRB at (405) 271-2531.