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Water for Energy

By Lou Ellen Ruesink, Editor, Texas Water Resources
Recent national concerns over future energy supplies have raised serious questions about the availability of water needed to keep up with energy demands.

- Will water be a limiting factor for production of energy in the future?
- Will water demands of energy production exceed regional water supplies?
- What effects will energy production have on ground and surface water?

It is especially important for Texans to carefully answer these questions, for Texas is rich in energy sources and limited in water resources.

Fuel Rich

Texas leads the Nation in the production of oil and natural gas. The state is also one of the leading petroleum refining areas of the world.

Since oil was discovered here in 1902, Texas alone has produced over 31 billion barrels of crude oil--36 percent of the total U.S. production. Currently, 40-50 percent of all the oil produced in the U.S. is pumped in Texas. However, oil and gas reserves are limited and production of both is beginning to decline.

Another abundant fuel resource in the state is lignite, a low-grade coal. Lignite could become as important to the state's future as oil and gas have been to its past. To get an idea of the potential of Texas' vast lignite deposits, consider that more than 110 billion short tons of lignite have been mapped in Texas. This is the energy equivalent of 300 billion barrels of oil-- more than twice the amount ever located in Texas.

Neither all of the known oil nor lignite reserves can be recovered, however. The technology simply does not exist for recovering every barrel of oil or every ton of lignite. By 2020, it is estimated that 95 percent of all oil produced in Texas will involve enhanced recovery techniques such as pumping large quantities of water into an underground reservoir to force oil closer to the surface.

Lignite can be considered in two categories-- near-surface and deep-basin. Near-surface lignite is within 200 feet of the earth's surface and can be recovered by traditional strip mining methods. Total near-surface deposits are estimated at 10 billion short tons.

Deep-basin deposits--at depths of 200 to 5,000 feet--are estimated at more than 100 billion tons. A real challenge lies in discovering economically feasible and environmentally acceptable methods for recovering the deep-basin deposits. Research efforts are concentrating on two possible methods.

1. Underground liquefaction is any method for turning the lignite into a liquid form and bringing it to the surface.

2. Underground gasification involves burning the coal in its natural setting, bringing the gas products to an above-ground setting, and using them to produce energy.

Limited Water

Water is necessary in every phase of energy production: recovery, generation of electricity, and refining. It takes water--lots of water--to recover fuel and produce energy.

In most of Texas today, there is little excess water storage capacity in reservoirs to meet water demands during critical periods of drought. Further, in many areas of the state where water is obtained from wells, the annual withdrawal of water is greater than the annual recharge. The effect is net depletion--or mining--of underground storage reservoirs.

According to a recent study published by the Texas Water Development Board, now a division of the Texas Department of Water Resources, the amount of water which can be withdrawn from existing surface reservoirs and aquifers without exceeding the firm and safe yields is 14.9 million acre feet per year. The present annual usage, approximately 23 million acre feet per year, is well above this safe yield.

Bill Hoffman, an engineer with the Texas Department of Water Resources (TDWR), is careful to define and distinguish between consumption and use. "Water use is the total amount of water withdrawn to supply a process. Water consumption refers to that amount of the water intake which is depleted or lost through evaporation, chemical conversion or other means."

This distinction is important when analyzing water demands of an industry such as electric generation.

Steam Electric Generation

Steam electric generation is one of the major consumers of water in Texas today. Basically two types of water are used in steam electric plants:

1. All plants heat very pure water in boilers to produce steam. The steam drives turbines which generate electricity and must then be cooled and condensed to water before it is reheated to become steam again.

2. Steam-electric power plants must circulate large volumes of water through their condensers to remove waste heat. The water evaporated in this cooling process now accounts for over 90 percent of the water consumed by the electric utility industry.

The amount of water consumed at a power plant varies with the type of cooling system employed. The "once through" system is the most common and least expensive system. Water is simply pumped from lake or river through the condenser cooling tubes and returned to the lake or river 15 to 25 degrees warmer than when it entered. This rise in temperature causes evaporation over and above normal evaporation.

Closed cooling systems such as wet cooling towers, cooling ponds, or spray ponds recirculate the water and return very little to the stream. Weather conditions determine which of these systems is most efficient in terms of water conservation. However, wet cooling towers consume some 50-95 percent more water by evaporation than once-through cooling systems.

In general, wet cooling towers are used where the available water supply is underground water and no other cooling alternative exists. When surface water supplies are used for cooling, the least consumption of water is accomplished when the power plant is situated on a multipurpose reservoir which is used for other water supply purposes as well. This multipurpose approach minimizes the amount of water lost through evaporation.

Dry towers are another type of cooling system, and consume little or no water, but they are very costly to construct and operate.

Future Demands

Several factors will have a profound impact on future water requirements for steam electric power plants in Texas. The most important of these is the future demand for electricity. Another major factor is the type of cooling modes (towers, ponds, or once-through systems) that future power plants will use. Increased use of saline surface water in coastal areas could also have a significant effect by reducing fresh water consumption.

Air-quality regulations now require all power plants using high sulfur coal and lignite to use stack gas scrubbers--increasing water consumption by about ten percent. Most Texas lignite contains just enough sulfur to require this air emission control, according to Howard Drew, Environmental and Research Consultant for Texas Utilities Company.

Scrubbers are something new to the electric generation industry. The scrubber system is designed to reduce the sulfur dioxide content of air emissions to within the standards set by EPA.

The principal agent used in the scrubber is limestone. It is ground to a powdery consistency and mixed with water to form a scrubber slurry. Gases produced by the burning of the lignite are sent into the scrubbers where about 70 percent of the sulfur dioxide is removed. The slurry is piped to holding ponds, dewatered, and then buried.

Environmental Effects

Major environmental concerns associated with increased energy production are thermal pollution from electric generating plants and refineries, and contamination of water resources from underground gasification of lignite and strip mining. Another potential effect is the build up of solids in rivers due to evaporation.

Withdrawal of water from lakes or rivers to condense the steam in the power plant raises the temperature of the withdrawal water. When this cooling water is returned, the temperature of the source water also rises. Added heat in a lake or river can interfere with the life cycles of aquatic life, can increase production of undesirable algae, and can alter oxygen content of the water.

Heat can also improve fish production under certain conditions according to environmentalist Drew. He stresses that there have never been any reports of damage to fish or aquatic life from power plant heat discharges into Texas reservoirs. On the contrary, a number of studies by universities and the Texas Parks and Wildlife Department have shown that the heat and water movement produced by the power plants can be beneficial by extending the growing season of the game fish in the reservoirs. However, heat is considered a potential water pollutant and its disposal is regulated by the Texas Water Quality Board (now a division of the Texas Department of Water Resources) and the Environmental Protection Agency (EPA). Cooling water may be pumped directly into a river or multipurpose lake if it does not raise the temperature of that above the limits established in the power plant permit.

According to Hoffman, waste heat regulations will have a significant impact on fresh water consumption in steam electric power generation in Texas. If EPA cooling mode regulations were implemented in their most stringent form, they would require all future power plants to use the more water consumptive systems such as towers and ponds rather than once-through cooling. Recent court action, however, has determined that total water consumption must also be a consideration in determining cooling methods.

Strip Mining

Researchers in private utility companies as well as in the public universities and state agencies are studying the potential effects of lignite recovery on water resources.

Research is currently underway to determine if strip mining affects the quality or quantity of runoff or groundwater recharge in strip mining areas.

Another area of study involves the possible effects of burning lignite without bringing it to the surface. Groundwater pollution and land subsidence are two potential problems.

Protection of water quality in lignite surface mining areas is the responsibility of the Surface Mining and Reclamation Division of the Railroad Commission of Texas. Since January 1976 the Texas Surface Mining and Reclamation Act has required all new surface mining operations to obtain a permit from the Railroad Commission.

The Texas Department of Water Resources is one of ten state agencies to which the Railroad Commission is required to submit copies of each permit application for review. The TDWR must review and make any comments it cares to make within 30 days of the receipt of the application. Reviews are primarily concerned with the protection and minimization of any potential hazards to water resources that may result from the mining operations.

Threefold Increase

By the year 2000, the capacity of power plants in Texas is expected to increase by over threefold. Fresh water consumption of power plants is projected by the TWDB to increase by over one million acre feet per year. In addition, recovery of oil and lignite will require more water than present methods.

Some parts of Texas are experiencing water supply difficulties at the present time, and increasing water supplies will be required to support the environment and supply the economy to satisfy the needs of a growing population.

Perhaps the water requirements of energy production will be the most convincing argument for Texans to conserve energy. In other words: Help conserve water--turn off a light.

Energy for Water

There is another side to the relationship between water and energy.

Energy is necessary to bring water from underground reservoirs to the earth's surface. In Texas, where two-thirds of all fresh water used is pumped from underground sources, water availability for many purposes is directly affected by energy availability.

Irrigation farmers are acutely aware of their dependence on energy for water. Irrigation presently constitutes the greatest single use of groundwater in the state. Sixty percent of the value of agricultural crops in Texas is produced on irrigated land; and more than one-third of all food produced in Texas comes from irrigation farming.

In many areas of Texas, farmers are caught in a squeeze between upward spiraling fuel costs and declining water levels due to depletion of underground reservoirs.

Presently 76 percent of irrigation energy is provided by natural gas. Dramatic impacts on Texas agriculture related to price increases or curtailments of supply of natural gas is forecast by a study recently published by a team of Texas A&M University agricultural economists and agricultural engineers. The study was partially funded by the Texas Water Resources Institute.

The research analyzed the impact of the proposed National Energy Plan on Texas agriculture. They conclude that the irrigation farmer in Texas is much more vulnerable to curtailment of natural gas than he is to price increases.

The Plan as proposed by President Carter calls for the establishment of a federal interstate and intrastate price ceiling of approximately $1.75 per thousand cubic feet (mcf) on all gas. However, irrigation farmers in South Texas and the Trans-Pecos region are already paying prices for gas which exceed the maximum $1.75 mcf for natural gas.

The National Energy Plan provides incentives for industry to convert to coal, but in analyzing the impact of the Plan, agricultural researchers conclude that the Plan fails to offer incentives to assist agricultural sectors in adopting alternate fuels.

Electricity generated from coal is one way coal could be substituted for natural gas used to pump irrigation water. According to the research team, electricity must be available at rates near $.02 per kilowatt hour to be equivalent to natural gas, priced at $1.75 per thousand cubic feet for pumping irrigation water. The cost of equipment conversion to electricity must also be considered for each individual farmer.

"Wind, solar, and geothermal energy are nonconventional energy sources suggested for agricultural use. Although wind and solar-powered irrigation pumps are being tested, much more research is needed to develop units economically competitive with conventional energy sources.... These sources do not appear to be viable alternatives for agricultural uses with projected energy prices in the near future," the Texas A&M University researchers conclude.

The days of abundant cheap natural gas are past. The future of irrigated agriculture in Texas will be determined primarily by efficiency in the use of water and fuel, prices of agricultural products, and eventually the ability to convert to alternate sources of energy.