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In a Hot, Thirsty Energy Business, Water Is Prized

By JIM WITKIN

WITH so much focus on carbon emitted from the nation's power plants, another environmental challenge related to electricity generation is sometimes overlooked: the enormous amount of water needed to cool the power-producing equipment.

In the United States almost all electric power plants, 90 percent, are thermoelectric plants, which essentially create steam to generate electricity. To cool the plants, power suppliers take 40 percent of the fresh water withdrawn nationally, 136 billion gallons daily, the United States Geological Survey estimates. This matches the amount withdrawn by the agricultural sector and is nearly four times the amount for households.

Battles for water among these competing interests are becoming more common, and power plants are not always winning. A recent analysis by the Union of Concerned Scientists revealed many examples from 2006 to 2012 of plants that had temporarily cut back or shut down because local water supplies were too low or too warm to cool the plant efficiently.

Proposals to build new plants are also under increased scrutiny, especially in water-stretched regions. The proposed White Stallion coal plant in Texas drew opposition in part because of the plant's water demands. The project was abandoned this year.

Making homes and buildings more energy efficient and using more renewable energy would reduce some of the strain on freshwater supplies. Still, about 84 percent of the nation's electricity will most likely come from thermoelectric plants by 2040, according to the Energy Information Administration. Ensuring that there is enough water for all competing needs will require better technology and better policy, industry watchers say.

Thermoelectric plants use a fuel source — coal, natural gas, nuclear and, in some cases, solar — to boil water to make steam. The steam spins a turbine connected to a generator to produce electricity. Some form of cooling is required to convert the steam back to a liquid that can be boiled again and sent back to the turbine. Three approaches to cooling power plants are prevalent today, each with drawbacks.

So-called once-through cooling withdraws water from a nearby river or lake, cycles it through the plant for cooling, then dumps most of it back, although warmer than when it came in. While once-through systems withdraw huge volumes of water, most is returned to the source. But drawing water into the plant harms fish and other aquatic life, as does the warm water discharged.

In recirculating systems, the water used for cooling is constantly recycled. Once used, it is sent to nearby cooling towers before returning for another run through the cycle. These systems withdraw less water, but consume more than once-through systems because water is lost to evaporation (the steam plumes you see wafting from the towers). An average 500-megawatt coal-fired plant with a recirculating system can gulp 5,000 gallons a minute to replace the water it consumes.

A third approach, dry cooling, is based on huge air-cooled condensers. These use no water for cooling, so such a system would seem to be a good solution to the problem. But they are costly, three to five times more than wet cooling systems. They are also less efficient, especially on hot days or in areas of high humidity, meaning dry-cooled plants will produce less electricity than those using wet cooling methods.

Only 1 to 2 percent of thermoelectric plants rely just on dry cooling. Hybrid systems combining recirculating wet methods and dry cooling are becoming more common, especially for new plants, said Mike Hightower, leader of the Water for Energy project at the Energy Department's Sandia National Laboratories. They can "switch between the two depending on the local weather conditions or water availability issues," Mr. Hightower said.

Newer combined-cycle natural gas plants can reduce water use by 60 to 70 percent, compared with older coal and nuclear counterparts, he said.

Researchers are busy working to make dry cooling techniques more economical, while also looking at alternative water sources like municipal wastewater, said Sean Bushart, who manages the water use innovation program with the Electric Power Research Institute, a nonprofit. Begun in 2011, the program has financed five test projects, including one by Johnson Controls, an energy and automotive products company.

Johnson Controls' Thermosyphon cooler technology is borrowed from the company's industrial refrigeration units, like those used in meat and beverage processing plants. It draws heat from the water in the cooling cycle.

"Every degree of heat we can remove from the cooling water means less evaporation in the cooling

towers," said Jim Furlong, vice president in the company's industrial refrigeration group. Initial results from a test system show water savings of up to 75 percent, he said.

While water-saving technologies are evolving, less certain are regulation or policy decisions that might push power plant operators to adopt them.

"From a policy perspective, it's a really tricky issue, given that energy and water are regulated at different scales and in different ways," said John Rogers, a senior energy analyst with the Union of Concerned Scientists. "Even how water is valued and how it figures into our economic math is very different in different parts of the country, which has made it very challenging for getting a handle on this."

At the federal level, a report last year from the Government Accountability Office noted that energy planning and water planning were generally "stove-piped, with decisions about one resource made without considering impacts to the other."

Energy analysts like Mr. Rogers of the Union of Concerned Scientists want policy makers to recognize that low carbon does not always mean low water.

For example, carbon capture, which stores carbon emissions from fossil-fueled plants, adds about 20 percent to a plant's water needs. And some forms of renewable energy, like geothermal and concentrating solar thermal, which focuses sunlight on tubes to heat a fluid, also depend on water for cooling.

What are needed are "policy decisions that link energy and water," Mr. Rogers said.