Chapter III. Supplying Water Requires Energy

Satisfying the Nation's water needs requires energy for supply, purification, distribution, and treatment of water and wastewater. Nationwide, about 4 percent of U.S. power generation is used for water supply and treatment, which, as shown in Figure III-1, is comparable to several other industrial sectors (EPRI, 2002b). Electricity represents approximately 75 percent of the cost of municipal water processing and distribution (Powicki, 2002).

A recent study funded by the Electric Power Research Institute (EPRI) looked at energy requirements for water supply and treatment across the country. The results are examined in terms of per capita use of energy for water supply and treatment in Figure III-2.

The biggest difference among regions is the amount of energy used to supply water for agriculture. In general, per capita non-agricultural use of energy for water is similar region to region.

However, within regions, there can be substantial variation in energy requirements for water supply and treatment, depending upon the source, the distance water is conveyed, and the local topography. California is an interesting case study in electrical consumption and illustrates the cost of long-distance water conveyance. California uses about 5 percent of its electricity consumption for water supply and treatment (CEC, 2005). This is substantially above the national average. As shown in Table III-1, a study by the California Energy Commission (CEC) illustrates how energy use can vary among water systems.

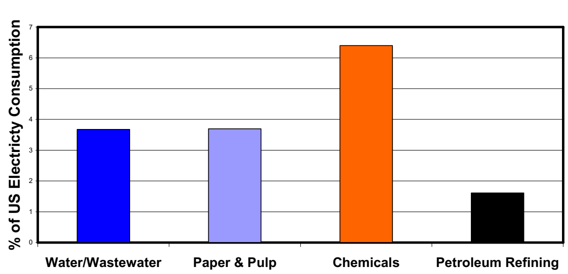

Figure III-1. Percent of U.S. Electricity Consumption by Sector (EPRI, 2002b; EIA, 1998)

SUPPLY AND CONVEYANCE

Supply and conveyance can be the most energy-intensive portion of the water delivery chain. If the water source is groundwater, pumping requirements for supply of freshwater from aquifers vary with depth: 540 kWh per million gallons from a depth of 120 feet, 2000 kWh per million gallons from 400 feet (Cohen et al., 2004). These energy needs will increase in areas where groundwater levels are declining.

Table III-1. Energy Requirements for Water Supply and Treatment in California (CEC, 2005)

	kWh/Million gallons	
Water Cycle Segments	**Low**	**High**
Supply and Conveyance	0	16,000
Treatment	100	1,500
Distribution	700	1,200
Wastewater Collection and Treatment	1,100	4,600
Wastewater Discharge	0	400
TOTAL	**1,900**	**23,700**
Recycled Water Treatment and Distribution for Non-potable Uses	400	1,200

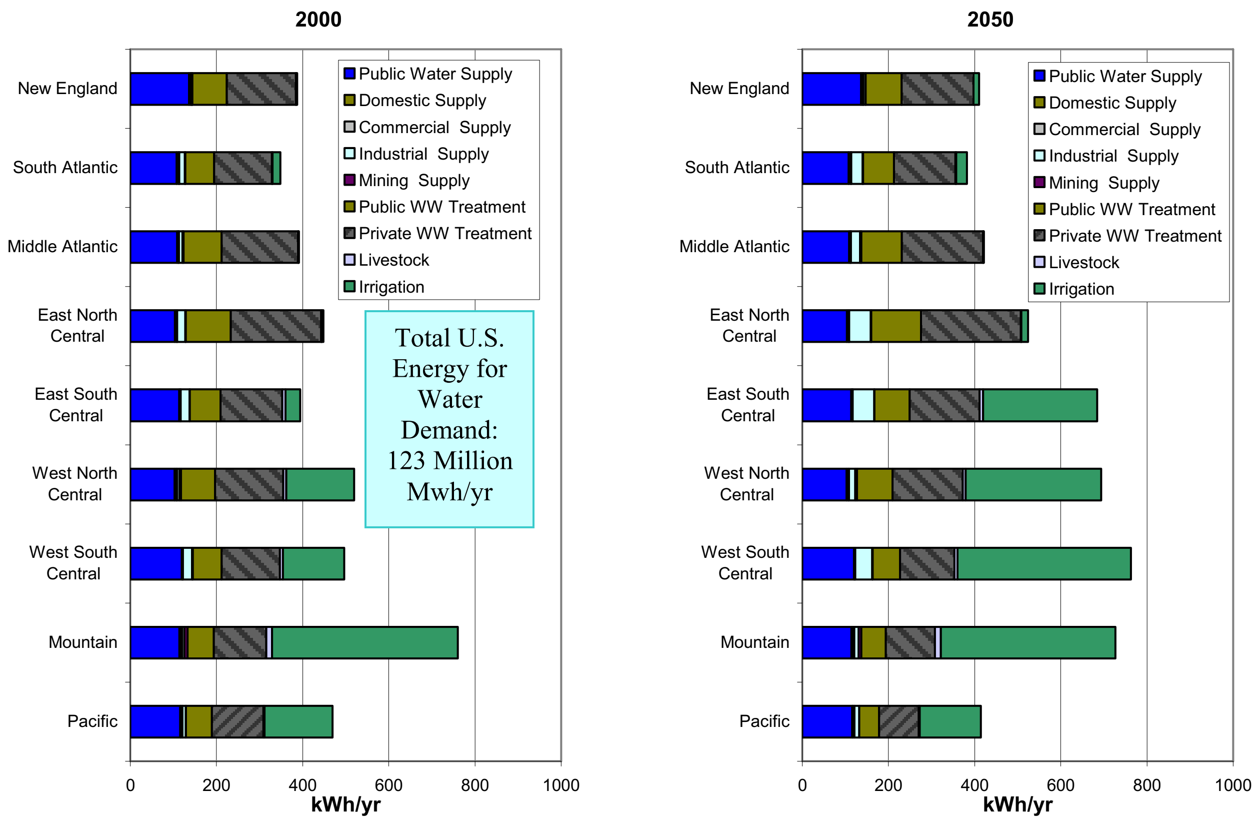

Figure III-2. Per Capita Energy Use for Water Supply and Wastewater Treatment in 2000 and Projected for 2050 (EPRI, 2002b).

Energy requirements to pump water from surface waters can be negligible if users are located close to the source. But if water must be pumped long distances, then the energy requirement is much higher. In California, water is conveyed from Northern California up to 400 miles via the State Water Project to the cities of Southern California. Energy requirements for long-distance conveyance are indicated by the upper range in Table III-1. The table also illustrates that energy savings can be realized when wastewater streams are made available for reuse, rather than having to pump and convey freshwater over long distances.

TREATMENT AND DISTRIBUTION

Groundwater, if not brackish, can require minimal energy for purification. Surface waters generally require more treatment, and energy requirements for surface water treatment are at the upper end of the range in Table III-1. Energy requirements for distribution and collection vary depending on system size, topography, and age. Older systems often require more energy because of older infrastructure and less efficient equipment.

END USE OF WATER

One of the more interesting results that the California study noted is that energy consumption associated with using water is greater than the energy consumption for supply and treatment. Activities such as water heating, clothes washing, and clothes drying require 14 percent of California's electricity consumption and 31 percent of its natural gas consumption. Most of that use is in the residential sector. These data illustrate that both water and energy can be conserved through the use of appliances and fixtures that reduce hot water use.

FUTURE ENERGY DEMAND FOR WATER SUPPLY AND TREATMENT

Population growth will create an increased demand for water. As freshwater supplies become more limited, pumping water from greater distances or greater depths and treating water to access alternative sources will increase energy consumption to meet future water demands. Additionally, emerging water treatment requirements (e.g., standards for arsenic removal) are becoming more stringent, which will increase energy consumption for both purification and wastewater treatment. In agriculture, gravity-driven flood irrigation may be replaced with more water-efficient but more energy-intensive spray irrigation and micro-irrigation.

An increased demand for water and water treatment could provide incentives to improve the efficiency of the water infrastructure. Aging supply, treatment, and distribution equipment may be replaced by newer, more energy-efficient equipment, and water conservation measures, including improved irrigation practices, could reduce water use.

The EPRI study estimated future energy demands for water supply and treatment in 2050. The results are presented on a per capita basis in Figure III-2. Compared to 2000, per capita energy requirements are expected to be largely unchanged, except in the industrial and agricultural sectors. Energy for public and commercial water supply and treatment are expected to grow with population, with an average increase for the Nation of almost 50 percent between 2000 and 2050. According to the EPRI study, energy use for water supply and treatment in the industrial sector is expected to triple because of growth projected in industrial activity, with strong growth in per capita use in the East North Central region. The study also projects that energy use for irrigation will triple based on projections of land use, with strong growth in per capita use in the South Central, West North Central, and West South Central regions. The study cites EPRI projections on industrial activity and U.S. Department of Agriculture (USDA) projections on land use (EPRI, 2002b).