Center for Sustainable Systems

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U.S. Water Supply and Distribution

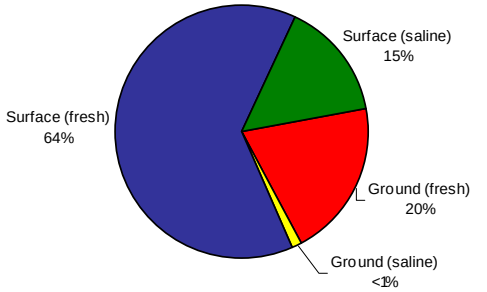
Patterns of Use

All life on Earth depends on water. Human uses include drinking, bathing, crop irrigation, electricity generation, and industrial activity. For some of these uses the available water is not clean enough and requires treatment prior to use. Over the last century, the primary goals of water treatment have remained the same – to produce water that is biologically and chemically safe, is appealing to consumers, and is non-corrosive and non-scaling.

Sources of Water

- 85% of the U.S. population obtains its water from a privately or publicly owned water source, the remainder obtain water from domestic wells.[1]
- Surface sources account for 79% of all water withdrawls.[1]
- About 158,000 privately and publicly owned water systems provide piped water for human consumption – of these, roughly 53,000 (33%) are community water systems (CWSs). Nearly 8% of all CWSs provide water to 81% of the population served.[2]
- CWSs deliver an average of 119,000 gallons/year to each residential connection and 618,000 gallons/year to non-residential connections.[3]

Percentage of Water Withdrawals by Source[1]



*96% of saline withdrawals were for thermoelectric-power use

Water Treatment

- The Safe Drinking Water Act (SDWA), first enacted in 1974 and amended in 1986 and 1996, regulates contaminants in public water supplies, provides funding for infrastructure projects, protects sources of drinking water, and promotes the capacity of water systems to comply with SDWA.[4]
- Typical water quality parameters that are monitored for violations of drinking water standards by EPA include: microbials; organics – volatile organic compounds and synthetic organic chemicals, and inorganics – nitrates, arsenic, radionuclides, lead, and copper.[2]
- Of all CWSs, 98% are designed to disinfect water, 43% are designed to either remove or sequester iron or manganese, 31% are designed for corrosion control and 25% add fluoride.[3]

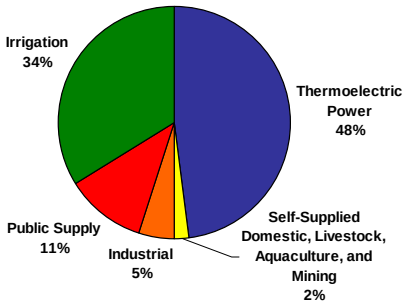
Size Categories of Community Water Systems[3]

System Size (population served)	Number of CWSs	Population Served (millions)	Percent of CWSs	Percent of U.S. Population Served by CWSs
Very small (25-500)	29,666	4.93	56%	2%
Small (501-3,300)	14,389	20.9	27%	7%
Medium (3,301-10,000)	4,748	27.5	9%	10%
Large (10,001-100,000)	3,648	103	7%	36%
Very large (>100,000)	386	126	1%	45%
Total	52,837	282	100%	100%

Uses[1]

- In 2000, total water use in the U.S. was estimated to be 408 billion gallons per day (Bgal/d). Thermoelectric power (195 Bgal/d) and irrigation (137 Bgal/d) accounted for the largest withdrawals.
- Per capita use was roughly 60% higher in the western states than in the eastern states, primarily due to the volume of water used for crop irrigation in the west.
- In 2000, California and Texas accounted for 18% of all freshwater withdrawals; California and Florida accounted for 40% of saline-water withdrawals in the U.S.

Estimated Use of Water (2000)[1]



Energy Consumption

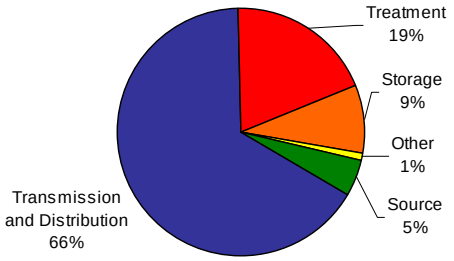
- 4% of the nation's electricity use goes towards moving and treating water and wastewater. Approximately 80% of municipal water processing and distribution costs are for electricity.[5]
- Groundwater supply from public sources requires 1,824 kilowatt-hours per million gallons – about 30% more electricity on a unit basis than supply from surface water, primarily due to a higher requirement of raw water pumping from groundwater systems.[5]
- The California State Water Project is the largest single user of energy in California. It consumes an average of 5 billion kWh/yr, more than 25% of the total electricity consumption for the entire state of New Mexico. In the process of delivering water from the San Francisco Bay-Delta to Southern California, the project uses 2-3% of all electricity consumed in the state.[6]
- To reach universal coverage by 2025, nearly 3 billion people need to be linked with a water supply and more than 4 billion with sanitation, thereby increasing the electricity consumption of the water and wastewater sectors by 33%.[7, 8]

Life Cycle Impacts

Infrastructure Requirements

- The 2003 Drinking Water Infrastructure Needs Survey and Assessment found that the nation's water systems need to invest $276.8 billion over the next 20 years in order to continue to provide clean and safe drinking water to their customers.[9]
- 60% ($165 billion) of the total national need is current need and 40% ($111.8 billion) is estimated as future need: $183.6 billion for transmission and distribution, $53.2 billion for treatment, $24.8 billion for storage, and the remainder for other systems.[9]
- Water systems maintain more than 1.8 million miles of distribution mains. Nearly 80% are less than 40 years old, while 4% are more than 80 years old. Over 50,000 miles of pipe have been replaced in the past 5 years at a cost of over $4 billion.[3]

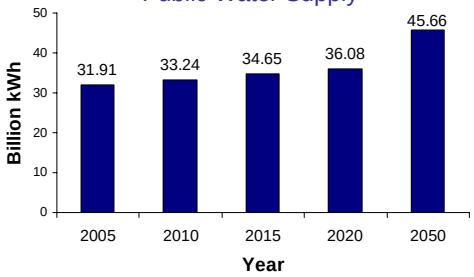
Total 20-Year Need by Project Type[9]



Electricity Requirements

The baseline electricity consumption projection for supply of fresh water by public agencies is shown graphically. Electricity consumption was about 32 billion kWh for the year 2005. This is expected to reach about 36 billion kWh by the year 2020 and 46 billion kWh by the year 2050 with subsequent increases in environmental burdens due to the production of electricity necessary to treat the water properly.[5] The magnitude of these impacts depends directly on the fuel mix at generating facilities – fossil, nuclear, hydro, solar, wind, biomass.

Projected Electricity Consumption
Public Water Supply[5]



Consumptive Use

- Consumptive use is an activity that draws water from a source within a basin and returns only a portion or none of the withdrawn water to the basin. The water withdrawn that is not returned to the basin may evaporate into the atmosphere, be incorporated into a product such as soft drinks or beer and shipped out of the basin, and/or be transpired into the atmosphere through the natural action of plants and leaves.
- Of the 137 Bgal/d freshwater withdrawn for irrigation, 76.2 Bgal/d is lost as a consequence of consumptive use, e.g., losses through evaporation and transpiration. The irrigation sector accounts for 81% of the total freshwater loss through consumptive use. Consumptive use for each of the other sectors including industry, thermoelectric, domestic, livestock, aquaculture and mining, and public uses and losses total only 19%. The total freshwater consumptive use in the United States has been reported as 94 Bgal/d.[1, 10]

Solutions and Sustainable Alternatives

Supply Side:

- Major systems that offer significant energy efficiency improvement opportunities include pumping systems, pumps, and motors.
- Periodic rehabilitation, repair and replacement of water mains infrastructure would help improve water quality and avoid leaks.
- Achieve on-site energy and chemical usage efficiency to minimize the life cycle environmental impacts related to the production and distribution of energy and chemicals used in the treatment and distribution process.
- Reduce chemical usage for treatment & sludge disposal by efficient process design, recycling of sludge, recovery & reuse of chemicals.
- On-site energy generation from renewable sources.
- Effective watershed management plans to protect source water; this is often more cost-effective and environmentally sound than treating contaminated water. For example, NYC chose to invest between $1-1.5 billion in a watershed protection project to improve the water quality in the Catskill/Delaware watershed rather than construct a new filtration plant at a capital cost of $6-8 billion.[11]

Demand Side:

- Better engineering practices:
  - plumbing fixtures to reduce water consumption – high-efficiency toilets, low-flow showerheads and faucet aerators
  - water reuse and recycling – greywater systems and rain barrels
  - efficient landscape irrigation practices
- Better planning and management practices:
  - pricing
  - retrofit programs
  - proper leak detection and metering
  - residential water audit programs and public education programs

Source: http://www.twdb.state.tx.us/assistance/financial/fin_infrastructure/awcfund.asp

[1] Hutson, S.S. et al. (2004) *Estimated Use of Water in the United States in 2000*. U.S. Geological Survey. Circular 1268.
[2] EPA (2006) *Factoids: Drinking Water and Ground Water Statistics for 2005*. EPA 816-K-03-001.
[3] EPA (2002) *Community Water System Survey 2000 Volume 1: Overview*. EPA 815-R-02-005A.
[4] Tiemann, M. (2006) *Safe Drinking Water Act: Implementation and Issues*. Congressional Research Service. Resources, Science, and Industry Division. IB10118.
[5] Electric Power Research Institute, Inc. (2002) *Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment – The Next Half Century*. Technical Report. 1006787.
[6] Natural Resources Defense Council (2004) "Energy Down the Drain. The Hidden Costs of California's Water Supply."
[7] World Health Organization and UNICEF (2000) *Global Water Supply and Sanitation Assessment 2000*. Joint Monitoring Programme for Water Supply and Sanitation.
[8] Alliance to Save Energy (2002) *Watergy: Taking Advantage of Untapped Energy and Water Efficiency Opportunities in Municipal Water Systems*.
[9] EPA (2005) *Drinking Water Infrastructure Needs Survey and Assessment – Third Report to Congress*. EPA 816-R-05-001.
[10] Solley, W.B. et al. (1993) *Estimated Use of Water in the United States in 1990*. U.S. Geological Survey. Circular 1081.
[11] Chichilnisky G. and G. Heal (1998) "Economic returns from the biosphere." *Nature*. Volume 391, 629-630.