U.S. Water Supply and Distribution

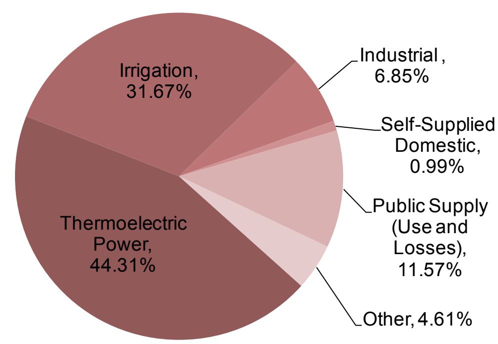
Patterns of Use

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 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, appealing to consumers, and non-corrosive and non-scaling.

Water Uses

- In 2010, total U.S. water use was approximately 355 billion gallons per day (Bgal/d). Thermoelectric power (161 Bgal/d) and irrigation (115 Bgal/d) accounted for the largest withdrawals.[1]
- Per capita use was roughly 41% higher in western states than in eastern states in 2010, primarily due to the volume of water used for crop irrigation in the west.[1]
- In 2010, California and Texas accounted for 18% of all U.S. freshwater withdrawals, even after reducing total water use by 26% and 16%, respectively, from 2000 levels.[1,2] Florida and California accounted for 32% of saline water withdrawals.[1]

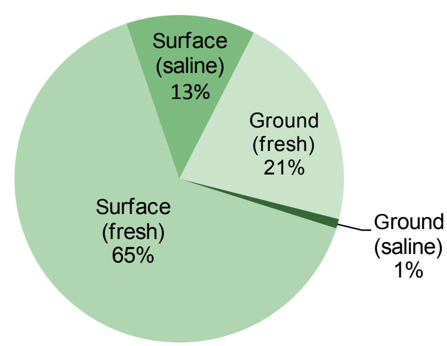
Estimated Uses of Water, 2010[1]



Sources of Water

- Approximately 86% of the U.S. population relied on public water supply in 2010; the remainder relies on water from domestic wells.[1]
- Surface sources account for 78% of all water withdrawals.[1]
- About 153,000 publicly owned water systems provide piped water for human consumption, of which roughly 51,000 (34%) are community water systems (CWSs).[3] 8% of all CWSs provide water to 82% of the population served.[4]
- In 2006, CWSs delivered an average of 96,000 gallons per year to each residential connection and 797,000 gallons per year to non-residential connections.[5]

Sources of Water Withdrawals[1]



Energy Consumption

- 2% of total U.S. electricity use goes towards moving and treating water and wastewater, a 52% increase in electricity use since 1996.[4] Electricity use accounts for around 80% of municipal water processing and distribution costs.[6]
- Groundwater supply from public sources requires 2,100 kilowatt-hours per million gallons—about 31% more electricity than surface water supply, mainly due to higher raw water pumping requirements for groundwater systems.[4]
- The California State Water Project is the largest single user of energy in California, consuming 5 billion kWh per year, on average—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.[7]

Water Treatment

- The Safe Drinking Water Act (SDWA), 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 regulations.[8]
- Typical parameters that the U.S. Environmental Protection Agency monitors for violations of drinking water standards include: microorganism, disinfectants, radionuclides, organics (e.g., volatile organic compounds and synthetic organic chemicals), and inorganics (e.g., nitrates, arsenic, radionuclides, lead, and copper).[9]
- Of all CWSs, 91% are designed to disinfect water, 23% are designed to remove or sequester iron, 13% are designed to remove or sequester manganese, and 21% are designed for corrosion control.[5]

Size Categories of Community Water Systems[3]

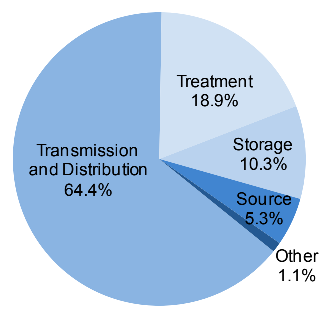
System Size (population served)	Number of CWSs	Population Served (millions)	% of CWSs	% of U.S. Population Served by CWSs
Very Small (25-500)	28,462	4.8	55%	2%
Small (501-3,300)	13,737	19.7	27%	7%
Medium (3,301-10,000)	4,936	28.7	10%	10%
Large (10,001-100,000)	3,802	108.8	7%	36%
Very Large (>100,000)	419	137.3	1%	46%
Total	**51,356**	**299.2**	**100%**	**100%**

Life Cycle Impacts

Infrastructure Requirements

- The 2011 Drinking Water Infrastructure Needs Survey and Assessment found that U.S. water systems need to invest $384.2 billion over the next 20 years to continue providing clean safe drinking water.[10]
- 64% ($247.5 billion) of the total national investment need is for transmission and distribution. The remaining 36% of need is for treatment ($72.5 billion), storage ($39.5 billion), source development ($20.5 billion), and other systems ($4.2 billion).[10]
- Water systems maintain more than 2 million miles of distribution mains.[11] In 2000, nearly 80% of systems were less than 40 years old, while 4% were more than 80 years old.[12] From 2001 to 2006, over 56,000 miles of distribution mains were replaced and 225,000 miles were newly added.[5]

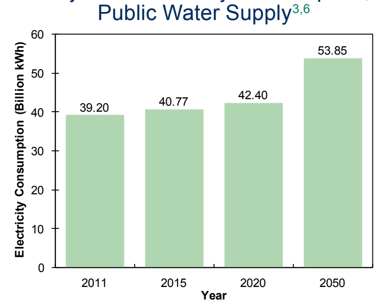
Total 20-Year Need, by Project Type[10]



Electricity Requirements

- Supplying fresh water to public agencies required about 31 billion kWh of electricity in 2000.[6]
- One study projects electricity consumption to exceed 36 billion kWh by 2020 and 46 billion kWh by 2050. This increased production of electricity may result in environmental burdens, whose magnitude will depend directly on the fuel mix at generating facilities—fossil, nuclear, hydropower, solar, wind, and biomass.[6]
- Household appliances contribute greatly to the energy burden. Dishwashers, showers, and faucets require 0.312 kWh/gallon, 0.143 kWh/gallon, and 0.139 kWh/gallon, respectively.[13]

Projected Electricity Consumption, Public Water Supply[3,6]



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 might have been lost to evaporation, incorporated into a product such as a beverage and shipped out of the basin, or transpired into the atmosphere through the natural action of plants and leaves.[1]
- Agriculture accounts for the largest loss of water (80-90% of total U.S. consumptive water use).[14] Of the 115 Bgal/d freshwater withdrawn for irrigation, over half is lost as a consequence of consumptive use.[1,15]
- Consumptive use for the remaining sectors — industry, thermoelectric, domestic, livestock, aquaculture, and mining — and public uses and losses total only 19%.[15] Of the 129 Bgal/d of water withdrawn for thermoelectric power in the U.S., 3% is consumed (3.5 Bgal/d).[16]
- Total freshwater consumptive use in the United States has been reported at around 100 Bgal/day.[15]

Solutions and Sustainable Alternatives

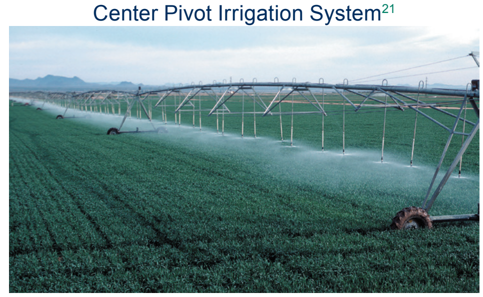
Supply Side

- Major components that offer significant energy efficiency improvement opportunities include pumping systems, pumps, and motors.[17]
- Periodic rehabilitation, repair, and replacement of water distribution infrastructure would help improve water quality and avoid leaks.[10]
- 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 and sludge disposal by efficient process design, recycling of sludge, and recovery and reuse of chemicals.
- On-site energy generation from renewable sources such as solar and wind.[18]
- Effective watershed management plans to protect source water are 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.[19]
- Less than 4% of U.S. freshwater comes from brackish or saltwater, though this segment is growing. Desalination technology, such as reverse osmosis membrane filtering, unlocks large resources, but more research is needed to lower costs, energy use, and environmental impacts.[4]

Demand Side

- Better engineering practices:
    - Plumbing fixtures to reduce water consumption, e.g., high-efficiency toilets, low-flow showerheads, and faucet aerators.[20]
    - Water reuse and recycling, e.g., graywater systems and rain barrels.[20]
    - Efficient landscape irrigation practices.[20]
- Better planning and management practices:
    - Pricing and retrofit programs.[20]
    - Proper leak detection and metering.[20]
    - Residential water audit programs and public education programs.[20]

Center Pivot Irrigation System[21]



1. Maupin, M., et al. (2014) Estimated Use of Water in the United States in 2010. U.S.G.S.
2. Hutson, S., et al. (2004) Estimated Use of Water in the United States in 2000. U.S.G.S.
3. U.S. Environmental Protection Agency (EPA) (2013) Fiscal Year 2011 Drinking Water and Ground Water Statistics Report.
4. Electric Power Research Institute (2013) Electricity Use and Management in the Municipal Water Supply and Wastewater Industries.
5. U.S. EPA (2009) 2006 Community Water System Survey.
6. Electric Power Research Institute, Inc. (2002) Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment – The Next Half Century. Technical Report.
7. Natural Resources Defense Council (2004) Energy Down the Drain: The Hidden Costs of California's Water Supply.
8. Tiemann, M. (2014) Safe Drinking Water Act: A Summary of the Act and Its Major Requirements. Congressional Research Service.
9. U.S. EPA (2016) "Table of Regulated Drinking Water Contaminants."
10. U.S. EPA (2013) Drinking Water Infrastructure Needs Survey and Assessment –Fifth Report.
11. American Water Works Association (2016) "Disinfection and Distribution."
12. U.S. EPA (2002) Community Water System Survey 2000.
13. Abdallah, A. and D. Rosenberg (2014) Heterogeneous Residential Water and Energy Linkages and Implications for Conservation and Management. Journal of Water Resources Planning and Management, 140(3): 288-297.
14. USDA ERS (2015) "Irrigation & Water Use Background."
15. Solley, W., et al. (1993) Estimated Use of Water in the United States in 1990. U.S. Geological Survey.
16. Diehl, T. and M. Harris (2014) Withdrawal and consumption of water by thermoelectric power plants in the United States, 2010: U.S. Geological Survey Scientific Investigations Report 2014–5184.
17. Water Research Foundation (2011) Energy Efficiency Best Practices for North American Drinking Water Utilities.
18. U.S. EPA (2016) "Energy Efficiency for Water Utilities."
19. Chichilnisky, G. and G. Heal (1998) Economic returns from the biosphere. Nature, 391: 629-630.
20. U.S. EPA (2012) "How to conserve water and use it efficiently."
21. Photo courtesy of U.S. Department of Agriculture, Natural Resources Conservation Service.

Cite as: Center for Sustainable Systems, University of Michigan. 2016. "U.S. Water Supply and Distribution Factsheet." Pub. No. CSS05-17. **August 2016**