# THE *ENERGY* COSTS OF WATER (ECW) – U.S. units

| *How many kWh of energy are used to source & treat* **one gallon of water?*** | | *How many kWh of energy are used to source & treat* water for **one U.S. household** for one month?* | | *How many kWh of energy are used to source & treat* water for **100,000 U.S. households** for one month?* | |
|---|---|---|---|---|---|---|
| | | | *Average U.S. household water use: 7,716 gallons/month[1]* | | | |
| *Ranges of averages are shown from low (lighter) to high (darker). Overall means are not necessarily the means of the given extremes.* | | | | | | |
| **Origin** | **kWh/gal range** | | **kWh/month range** | | **kWh/month range** | |
| **On-site rainwater** [a] →+ | 0.0000 | 0.0007 | 0 | 5 | 0 | 540,120 |
| **On-site greywater** [b] →+ | 0.0000 | 0.0002 | 0 | 2 | 0 | 154,320 |
| **On-site blackwater** [c] →+ | 0.0000 | 0.0011 | 0 | 8 | 0 | 848,760 |
| **On-site AC condensate** [d] →+ | 0.0000 | 360.0000 | 0 | 2,777,760 | 0 | 277,776,000,000 |
| **Stormwater** [e] →+ | 0.0000 | 0.0034 | 0 | 26 | 0 | 2,623,440 |
| **Surface water** [2,3] →+ | 0.0002 | 0.0014 | 2 | 11 | 169,752 | 1,084,870 |
| **Central Arizona Project** [f] →+ | 0.0126 | 0.0152 | 97 | 117 | 9,738,209 | 11,745,049 |
| **Groundwater** [2,3] →+ | 0.0006 | 0.0020 | 5 | 15 | 478,392 | 1,543,200 |
| **Brackish groundwater** [g,2,3,4,5] →+ | 0.0032 | 0.0379 | 25 | 292 | 2,469,120 | 29,243,640 |
| **Desalinated seawater** [2,3,5] →+ | 0.0087 | 0.0882 | 67 | 681 | 6,712,920 | 68,055,120 |
| **Wastewater** [2,3] →+ | 0.0010 | 0.0030 | 8 | 23 | 771,600 | 2,314,800 |
| **Recycled water** [3,6] →+ | 0.0011 | 0.0041 | 8 | 31 | 848,760 | 3,144,642 |
| **Average utility water** [3] ⟳ | **0.0013** | **0.0065** | 10 | 50 | 964,500 | 5,015,400 |

Available at: HarvestingRainwater.com/water-energy-carbon-nexus

## ECW FACTS

The **average U.S. residential water usage** is 98 gallons per capita per day (gpcd).[7]

The **virtual water footprint** of each **U.S.** citizen is 1,146 gallons per day.[8]

The **virtual water footprint** of each **world** citizen is 366 gallons per day.[9]

**Democratic Republic of Congo**'s virtual gpcd is lowest: 9 | **Jordan**: 120 | **Germany & China** ~290
**France**: 371 | **Japan**: 517 | **Australia**: 834 | **Iraq**'s is highest: 1,894.[8]

Of **all water withdrawn** in 2005 for use in the U.S., **5% was for industry/mining, 12% for public supply, 34% for agriculture, 49% for thermoelectric power generation**.[h,7]

## ECW NOTES

*__Sourcing__ (➔) includes pumping from aquifer, surface source, ocean, wastewater facility, etc, to treatment plant only.
**Treatment** (**+**) includes raw-water treatment to potable standards, or wastewater to discharge standards.
**Lifecycle** (⟳) means ➔ plus **+** plus distribution to end-user & wastewater collection, treatment, & discharge.

Energy costs of infrastructure (tank & pump manufacture, canal & building construction, etc) relevant to water sources are beyond intended scope of this resource, & are not included herein.

Range in kWh/gal is due to pumping distance, depth, & quality of source water, &/or variations in equipment/processes (e.g., 0.0040–0.0080 kWh is used to lift 1 gallon of water 1,000 feet).[3]

**a.** Energy use is zero for gravity-fed untreated rainwater systems. High end is calculated with Flotec 3/4-HP shallow-well jet pump lifting water 0–5' at 14.4 gpm[10] & UV system treating to NSF/EPA standards using a Sterilight Silver S12Q-PA[11] or a Trojan UV Max IHS12-D4.[12]

**b.** Energy use is zero for gravity-fed greywater systems. High end was calculated based on EcoVort 650W dirty-water pump lifting water 5' at 56 gpm.[13]

**c.** Energy use is zero for gravity-fed & -discharged septic tanks & leachfields. The high end of range is for lagoons or ponds with oxidation.[14]

**d.** Energy use is zero for passive harvest (secondary to normal operation of air conditioner (AC)). Cost rises dramatically for active harvest (if AC is installed or run primarily to harvest condensate).

Energy intensity = energy use ÷ condensate yield. For 2- to 3-ton central AC system, energy use: 1.4–3.6 kW/hour;[15] condensate yield in dry air: 0.01–0.02 gal/hour; in humid air: 0.1–0.2 gal/hour.[16]

Range includes dry air: 7–36 kWh/gal, humid air: 70–360 kWh/gal. Values are for chemical-free AC, not cooling tower. Indoor & outdoor humidity & temperature, SEER rating, etc, affect kWh/gal.

**e.** Zero value is for gravity-fed stormwater in separated storm & sewer systems (MS4). High value is for combined storm & sewer overflow systems (CSO), where stormwater is treated at wastewater treatment plant & often pumped from deep underground storage. Values for MS4 in low-lying areas (prone to flooding & requiring stormwater pumping stations) would fall within given range.[17]

**f.** Central Arizona Project (CAP) diverts water from Colorado River near Lake Havasu to supply central & southern Arizona. The given statistics for southern Arizona are 4–5 times higher than energy intensity of water delivered to central Arizona, due to increased treatment & pumping.[18] Higher value includes proportionally small kWh usage to distribute treated water to end-users.[19]

**g.** Definition of brackish groundwater varies by source. Broadly, it is groundwater containing 500–30,000 mg/liter of TDS (total dissolved solids)—more salty than freshwater, less salty than seawater.[20]

**h.** A large percentage of water withdrawn for power generation is typically returned to its source, but the volume of withdrawal matters: If the quantity of water isn't available, the power plant will have to shut down. Also when water is withdrawn for one use, it is then unavailable for others, such as municipal water supply & environmental needs.[2]

**CREDITS: Brad Lancaster**, Resource concept, oversight | **LeeAnn Lane**, Research | **Megan Hartman**, Research, resource creation | **Brandy Lellou & Valerie Strassberg**, **NV-OC.org**, Research, peer review

## ECW REFERENCES


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**11.** Personal communication via email correspondence with Mark Ragel, Water Harvesting International, 7 Nov. 2011.

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**15.** LCEC.net, “Cooling and Heating,” LCEC.net/tips/brochures/heatcool.pdf (accessed 18 Jan. 2012).

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