



Residential Water Heating

Every day, we count on hot water to be at our fingertips – for washing hands, cleaning clothes and dishes, waking up to a hot shower, or soaking in a warm bath before bed. Unfortunately, the delivery of this wonderful convenience comes at a high price, as gas water heating accounts for about 16 percent of the average California home utility bill, and electric water heating about 28 percent. Which water heating system can deliver the water your household needs, when it is needed, in an energy-efficient and cost-effective manner? If you're in the market for a new water heating system, or just want to improve the efficiency of your existing system, keep reading to learn how different water heating options compare in cost, performance, and energy efficiency.

Water heating systems generally require only three elements:

1. An energy source (solar, heat from the air or ground, natural gas, propane, oil, electricity, wood, etc)
2. An appliance for using the energy source to generate hot water (solar collectors, heat pumps, storage tank units, or tankless units)
3. A distribution method for delivering the water to faucets and showerheads

Some systems might combine energy sources: for example, on average, a solar water heating system can cover about 2/3 of typical domestic hot water needs but requires a backup energy source. Here is an overview of typical water heating options:

Facts at a Glance

System	Initial Cost ¹	Annual Energy Cost ²	Lifespan (years)	Annualized Cost ³
Gas storage tank	\$380-525	\$290-330	10-15	\$320-372
Electric storage tank	\$350-440	\$715-792	10-15	\$743-827
Heat pump storage tank	\$1200	\$271	10-15	\$367
Gas tankless (1 unit)	\$650-1200	\$166-295	20+	\$199-355
Electric tankless (2 units)	\$600	\$800	20+	\$830
Combo gas boiler system	\$600	\$185	30	\$205

Source: [American Council for an Energy-Efficient Economy](#) (ACEEE)

¹ Includes equipment and installation. High-efficiency units are at upper end of cost range. Retrofit installations of tankless units can further increase cost due to larger gas line or amperage requirements.

² Based on hot water needs for typical family of four. ACEEE numbers adjusted for average PG&E rates as of 10/06 (16¢/kWh and 1.27/therm). Future operation costs are neither discounted nor adjusted for inflation.

³ Annualized cost = Initial cost/ Lifespan + Annual Energy Cost



The key decision for many households is whether to go with a gas or electric storage or tankless unit. However, you might also consider a combo system, heat pump water heater, or solar water heating system. While most people avoid heating with electricity as it is generally much more expensive than other fuel sources, heat pumps use electricity very efficiently and can be competitive with gas appliances.

Whichever system you decide on, choose a high-efficiency product. Most likely, you'll use less energy and lower your water heating bills. And as fuel prices continue to rise, the payback time for covering additional costs of more efficient systems continues to decrease.

Efficiency is often expressed differently for different types of water heating systems. For example, storage types use the Energy Factor, which is the ratio of energy delivered in heated water to the total daily energy consumption of the heater. Energy Factors are useful in comparing water heaters of the same type, but beware of comparing the Energy Factors of heaters that use different fuel sources. Different ratings are used to assess efficiency of heat pumps and combo units.

Before Choosing Your Water Heating System

Reducing consumption is the first step in optimizing your water heating system. Consider these simple steps to save both energy and water:

- Insulate [accessible hot water pipes](#)
- Install low flow showerheads and faucets
- Lower the [water heating temperature](#) on your unit to 120 degrees
- Use cold or warm water to wash clothes and cold water to rinse
- Install an [ENERGY STAR](#) rated clothes washer
- Run the dishwasher with full loads only
- Install an [ENERGY STAR](#) rated dishwasher
- Install a [drainwater heat recovery](#) (DHR or GFX) system

Storage/Tank-Type Water Heaters

The most common type used in the US, storage tank water heaters may be fueled by natural gas, propane, oil, or electricity and typically range in size from 20-80 gallons depending on a household's needs. Water is kept hot at all times, whether it's 2PM when you're at work, 2AM when you're sleeping, or 7AM when you actually need hot water for your shower. Unfortunately, substantial energy can be lost due to standby heat losses. Purchasing a high-efficiency, well-insulated tank can help to reduce those losses.

Proper sizing of storage types is essential, as over-sized units cost more initially and then use more energy due to excessive cycling and higher standby losses. To properly size a water heater, calculate the amount of water used during the most water intensive hour of the day. Match this to the First-Hour Rating (FHR) of the heater, which does not necessarily correlate to tank size. Learn more with ACEEE's [Water Heating Consumer Guide](#).

Green Tips:

- Install a sealed combustion natural gas water heater with EF > .62



- Install an electric water heater with EF > .92
- Install a water heater blanket around your existing storage tank
- Insulate all inlet and outlet pipes within at least 3 feet from the tank
- Install heat traps

Heat Pump Water Heaters

More commonly used for space heating, heat pumps can also be very effective for water heating or combination space and water heating. Rather than using electricity to heat water directly, heat pump water heaters extract heat from the air and transfer it to the water. They are ideally suited for locations where air conditioning is also needed since they cool the air as they heat water. But regardless of potential energy savings from cooling capabilities, heat pump water heaters are typically two to three times more efficient than standard electric resistance storage types.

These systems can have a built-in tank or be installed as an add-on to conventional resistance heaters. They must be provided a minimum 1000 cubic feet of surrounding airspace and are best suited for warmer climates in which the year round temperature ranges from 40° to 90°. Heat pump water heaters can be noisy.

For more information, see the US Department of Energy's page on [Heat Pump Water Heaters](#).

Green Tips:

- Install a unit with an efficiency rating (COP) of at least 2.2

Tankless Water Heaters

Since tankless units heat water only as needed, they are also referred to as Demand, Instantaneous, or Flash heaters. While they've historically been popular in Japan and Europe, the market for tankless units in the US is now heating up. People like tankless water heaters because they take up less space, should last at least 20 years, and can truly provide "endless hot water" if they are specified properly. Because tankless units do not have the standby heat losses of storage tank heaters, their energy consumption is expected to be lower. However, studies do not always support this expectation.

According to the [US Department of Energy](#), "for homes that use 41 gallons or less of hot water daily, demand water heaters can be 24%–34% more energy efficient than conventional storage tank water heaters. They can be 8%–14% more energy efficient for homes that use a lot of hot water—around 86 gallons per day. You can achieve even greater energy savings of 27%–50% if you install a demand water heater at each hot water outlet."

The term "Instantaneous" can be misleading. Tankless water heaters can take up to 10 seconds to completely fire up and fully raise the water temperature. This can cause a longer wait for hot water and contribute to more cold water wasted down the drain. An [on-demand hot water circulation pump](#) can help to address this issue. For tankless water heaters to perform as expected, users must understand that a unit is limited by its minimum and maximum flow rates.



All but the smallest tankless units are very gas intensive and require 3-4 times the gas flow rate of typical gas appliances. Ensure your gas line and metering can provide the required flow rates, and keep in mind most tankless retrofits will require installation of larger gas line. Tankless units are typically more expensive than conventional storage tank type units. Smallest gas units, which have small flow rates and are appropriate for single points of use, start around \$200. Larger gas units with flow rates of 3-5 gallons per minute range from \$550-1000.

Green Tips:

- Purchase a unit with an electronic ignition
- Don't lengthen your showers since you have "endless" hot water

Combination/Combo Space and Water Heating Systems

Under the radar for most consumers, combination space and water heating systems can be an excellent choice for many households. With these systems, a home's forced-air or hydronic space heating system is used to heat water with a heating coil or heat exchanger. Various configurations are available, and the type best suited to a home will depend on climate and heating demand. For many situations, however, the most efficient combo system will utilize a high-efficiency gas boiler and well-insulated tank.

Combo systems generally cost more than a separate water heater and furnace or boiler, but they take up less space, and installation and maintenance costs are often lower. Efficiency of combination systems is expressed with CAE (Combined Appliance Efficiency) and can range from .59 to .90. Since the sizing of a combo system involves some different calculations than those used for individual water and space heating systems, it's important to find a qualified contractor with knowledge of both HVAC and plumbing systems, or else two trade professionals willing to work together.

For more information, see the US Department of Energy's page on [Tankless Coil and Indirect Water Heaters](#).

Green Tips:

- Install a unit with a CAE at the top of its class

Solar Water Heating

Solar water heaters, sometimes called solar domestic hot water or thermal systems, use the sun to heat either water or a heat-transfer fluid in collectors. They are generally used as pre-heaters for one of the other water heating options and typically reduce the need for conventional energy sources for water heating by about two-thirds. Although the initial cost of solar water systems is higher than that of conventional systems, the fuel (sunshine) is free, and through the federal [Energy Policy Act of 2005](#) a tax credit up to \$2000 is now available for installation of a solar water system. They can be cost competitive in many applications when you account for the total energy costs over the life of the system. And when the environmental benefits are factored in, they are often a worthwhile investment.

After being heated in the collector, the water or fluid is stored in a tank similar to a conventional gas or electric water tank. Some systems are active, using an electric pump



to circulate the fluid through the collectors, while others are passive, using natural convection to circulate the fluid.

One requirement of solar water heaters is to have space available in a relatively unshaded, southerly facing location. Solar water heaters will operate in any climate, but a solar site analysis should be performed to assess whether solar can meet your needs effectively. One of the most popular applications for solar water heaters is to heat pools. For more detailed information, see our [Solar Water Heaters](#) fact sheet.

Green Building Guidelines References

Efficient water heating systems may correspond to specific measures, points, or credits in various Green Building Guidelines and Rating Systems:

New Home Construction Green Building Guidelines (Build It Green)

- F1 – Distribute Domestic Hot Water Efficiently
- K1 – Pre-Plumb for Solar Water Heating
- K2 – Install Solar Water Heating System

Home Remodeling Green Building Guidelines (Build It Green)

- E1 – Install Water Heater Jacket
- E2 – Insulate Hot and Cold Water Pipes
- K1 – Pre-Plumb for Solar Water Heating
- K2 – Install Solar Water Heating System

Multifamily Green Building Guidelines (Build It Green)

- D3 – Solar Water Heating

LEED-H Rating System (U.S. Green Building Council)

- IE2 – Combustion Venting
- EA7 – Water Heating

To learn more about these [Green Building Guidelines & Rating Systems](#), visit: www.builditgreen.org/guidelines

Resources

Energy Cost Calculators (U.S. Department of Energy) - estimate the energy cost savings from buying a more efficient product:

www1.eere.energy.gov/femp/procurement/eep_eccalculators.html

Rebates (PG&E) - save money on high-efficiency products:

<http://www.pge.com/res/rebates>

Federal tax credits - save money on high-efficiency products:

www.energytaxincentives.org/consumers

For current product, manufacturer, and supplier information, search the Green Product Directory: www.builditgreen.org/products.



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