WATER HEATING

Energy-efficient strategies for supplying hot water in the home

Buildings for the 21st Century

Buildings that are more energy efficient, comfortable, and affordable...that's the goal of DOE's Office of Building Technology, State and Community Programs (BTS). To accelerate the development and wide application of energy efficiency measures, BTS:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings
- Works with state and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use
- Provides support and grants to states and communities for deployment of energy-efficient technologies and practices

ENERGY-EFFICIENT WATER HEATING

Domestic water heating accounts for between 15 and 25 percent of the energy consumed in homes. Water-heating energy costs can be managed by selecting the appropriate fuel and water heater type, using efficient system design, and reducing hot water consumption.

TYPES OF WATER HEATERS

Storage-type water heaters, the primary focus within this fact sheet, are the most common domestic hot water (DHW) heating system selected today. However, other types of water heaters may be very cost effective.

Storage water heaters—heat and store water in a tank ranging in size from 20 to 80 gallons. They offer a ready reservoir of hot water, although "standby" energy losses are higher than with some other types. Conventional fuel sources include natural gas, electricity, propane, and fuel oil.

Heat pump water heaters are electric storage water heaters that are two to three times as efficient as conventional electric resistance units. Because they remove heat from the surrounding air, they are most effective in warm climates.

Combination space and water heating systems—are storage water heating systems providing space heating plus DHW. Separate water heaters and forced-air or hydronic systems may be combined, or a single-source system may be purchased. Because heating needs of small, well-insulated homes often are low, combination systems can be an excellent choice.

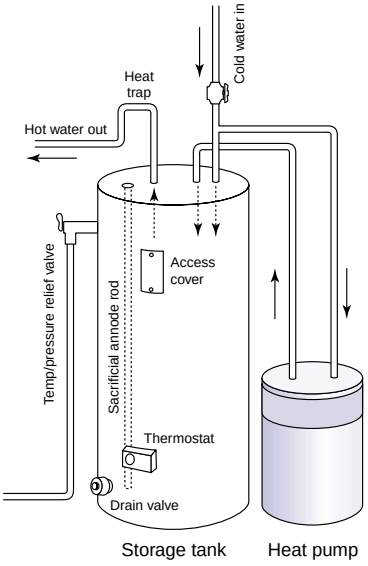
Demand (tankless or instantaneous) water heaters—heat water directly without use of a storage tank. Demand systems produce a limited amount of hot water—a 70°F water temperature rise is possible at a flow rate of five gallons per minute through gas water heaters and two gallons per minute through electric water heaters. These are best suited for low-demand or remote applications.

Tankless coil water heaters—use a heat exchanger integrated with a space-heating boiler to heat water instantaneously. These are generally recommended for use only in an extremely cold climate.

An indirect water heater is a tankless coil water heater with a separate storage tank to reduce boiler cycling. When matched with a high-efficiency boiler, this becomes a most efficient hot water system.

HEAT PUMP WATER HEATER

Heat pump technology can provide cost-effective water heating in mild climates.



STORAGE TANK WATER HEATER SELECTION

The lowest-priced water heater may be the most expensive to operate and maintain over its lifetime. And while an oversized unit may be alluring, it carries a higher purchase price and increased energy costs due to increased stand-by losses. Consider the following factors when buying a water heater:

- Fuel availability, including natural gas, electricity, oil, and propane
- Cost—equipment, installation, and expected annual fuel cost
- Capability—system capacity, including first hour rating (FHR)
- Longevity—expected equipment life
- Safety, including possible combustion gas backdrafting concerns

The FHR is the amount of hot water the heater can supply per hour (starting with the tank full of hot water). The FHR depends on the tank capacity, source of heat (burner or element), and size of the burner or element. To select the correct size water heater, use the FHR—not tank capacity. Using the table provided, first estimate the daily peak one-hour hot water demand for the house. Then try to choose a model with a FHR within about 2 gallons of this peak demand.

The energy factor (EF) indicates overall unit efficiency based on the amount of hot water produced per unit of fuel consumed over a typical day. While higher EF values generally equate with higher efficiency, they do not always mean lowered operating cost, especially when fuel sources are compared.

Information on annual energy use and average operating cost can be found on the EnergyGuide label on new water heaters.

To determine the local cost, multiply the annual energy use (in kWh or therms) found on the EnergyGuide label by local energy rates. Based on local utility rates, one type of water heater may operate much more cheaply than another.

FIRST HOUR RATING/PEAK HOUR DEMANDS

Hot water use	Avg. gal. hot water per usage		Times used in hour		Gal. used in hour
showering	15	x		=	
bathing	20	x		=	
shaving	2	x		=	
washing hands & face	2	x		=	
shampooing hair	4	x		=	
hand dishwashing	2	x		=	
automatic dishwashing	14	x		=	
preparing food	5	x		=	
clothes washing	32	x		=	
PEAK HOUR DEMAND (total gal used in hour)				=	

EXAMPLE
A typical household's peak hour of hot water usage might entail:

2 showers	15	x	2	=	30
2 shampoos	4	x	2	=	8
1 shaving	2	x	1	=	2
2 hand/face washing	2	x	2	=	4
1 food prep	5	x	1	=	5
PEAK HOUR DEMAND (total gal used in hour)				=	49

Source: Gas Appliance Manufacturers Association
**The above chart assumes no water conservation measures.*

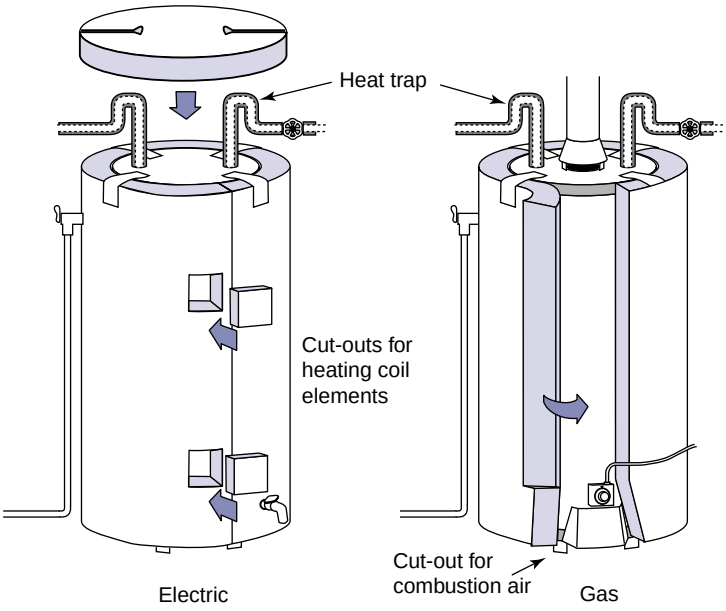
STORAGE WATER HEATER COMPARISON

Storage Water Heater Type	Range			Notes
	Energy Factor (EF)	Annual Cost	First Hour Rating (FHR)	
Electric tank type (50 gallon)	0.86 to 0.95	$410 to $370	50 to 70 gallons	Lowest initial cost, highest lifetime costs
Natural gas tank type (40 gallon)	0.54 to 0.63	$165 to $140	60 to 85 gallons	Higher initial cost than tank-type electric units due to gas lines and venting; sealed combustion and power-vented units reduce backdrafting potential at costs of $50 to $100 and $300 to $600, respectively
Propane tank type (40 gallon)	0.54 to 0.63	$305 to $261	55 to 75 gallons	Similar installation issues as natural gas; additional fuel tank required
Electric heat pump (80 gallon)	2.10 to 2.50	$170 to $140	50 to 65 gallons	Highest initial cost; must be surrounded by at least 1,000 cubic feet of air space and installed in locations that remain between 40˚ and 90˚F year round

Based on a family of four, electricity at $0.08 per kWh, natural gas at $0.60 per therm, and propane at $1.00 per gallon (prices often vary seasonally).

WATER HEATER INSULATING JACKETS

Insulating the water heater is one of the best dollar-for-dollar energy-saving measures.



IMPROVING WATER HEATER EFFICIENCY

With any DHW system, methods for reducing hot water cost start with lowering the thermostat. Set the thermostat low enough to minimize safety concerns (scalding) yet high enough for washing (dishes, clothes) and bathing. A setting of 120°F generally meets most household needs.

Installing water heater insulating "jackets" of R-11 or higher can be cost effective in reducing standby losses on storage-type units, especially older or poorly insulated ones. Greater benefit is achieved when the hot water tank is installed outside of conditioned space (e.g., garage). For safety, however, never block any controls, valves, or airways for combustion or exhaust.

Pipe insulation is inexpensive and easy to install. Add it to hot and cold water pipes in unconditioned spaces such as garages, attics, and crawlspaces and for a distance of at least six feet from the tank.

Heat traps prevent heated water in a storage tank from mixing with cooled water in pipes, a process called thermosiphoning. Some new water heaters have built-in heat traps, although they can be added to new or existing water heaters. Flexible connectors with a loop in the vertical line offer an effective, inexpensive, do-it-yourself alternative to plumber-installed heat traps.

Drainwater heat recovery devices improve efficiency by warming incoming cold water with heat absorbed from draining warm water. Recovery systems reclaim energy and can enhance hot water system performance by increasing effective FHR and capacity. Benefits ultimately depend on many variables including installation, fuel type, system geometry, exchanger characteristics, and usage patterns.

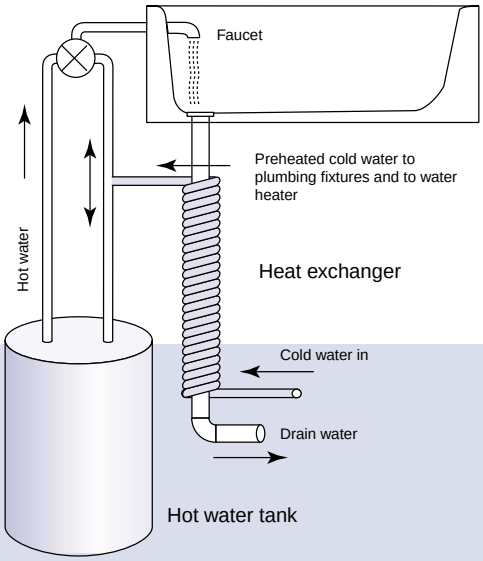
Flue dampers seal off the flues of naturally drafted gas water heaters when there is no exhaust to reduce heat loss up the flue.

Timers can shut off electric water heaters for a set time period, such as when time-of-use electric rates are highest or when occupants normally do not use hot water. Depending on shutoff time, setpoint, and tank insulation level, timers may or may not be cost-effective. In addition, they may be inconvenient when much hot water is needed while the water heater is turned off.

Load management devices enable utilities to turn off electric water heaters remotely during periods of heavy electrical demand. Allowing this option to be installed, where available, typically results in a monthly credit from the utility.

DRAINWATER HEAT RECOVERY

This system captures waste heat through heat exchange from the wastewater drains.



WATER HEATING

For more information, contact:

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Or visit the BTS Web site at www.eren.doe.gov/buildings

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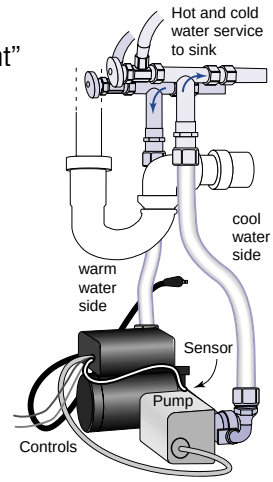
HOT WATER RECIRCULATION SYSTEMS

These devices provide "instant" hot water at point sources and provide water conservation benefits.



REDUCING CONSUMPTION

Simple use of water-saving appliances such as high-efficiency washing machines and dishwashers (look for the ENERGY STAR® label), combined with flow-restricting devices such as faucet aerators and low-flow showerheads, lowers household hot water consumption. A recirculation system powers a pump to cycle water through the plumbing loop between water heater and faucet. This lessens the amount of tepid water wasted down the drain while waiting for hot water. On-demand DHW systems recirculate water when a user trips a switch at the faucet. Once water of the desired temperature reaches the faucet, the pump shuts off.

WATER HEATING SYSTEM SAFETY

Backdrafting—the pressure-induced spillage of exhaust gases into interior living space—is a health and safety concern where combustion water heaters are employed. To reduce such risk, employ one of the systems described below, install a hardwired carbon monoxide (CO) detector nearby, and annually inspect (clean, adjust, or repair if necessary) the burners, combustion chamber, and flue.

When a combustion-type hot water storage tank system is used, placing the tank in the following places may improve resistance to backdrafting:

- Outside of the home's conditioned space (e.g., in garage).
- In a sealed, indoor mechanical room having adequate exterior ventilation.
- Inside the conditioned space when a power venting system using a fan is incorporated to expel combustion gases through the flue, and/or a sealed combustion system separately ducts in outside air for combustion and ducts out combustion gas exhaust.

INSTALLATION AND MAINTENANCE

Always meet the minimum applicable mechanical, plumbing, electrical, and/or other code requirements when installing a water heating system. Initial installation improvements include installing a second anode rod (combination anode/hot outlet nipple) and replacement drain valve (full-port ¾-inch threaded brass ball valve with hose adapter).

Water heater placement can impact operating cost, especially if the unit is poorly insulated. Unit placement to facilitate short, insulated piping runs to bathrooms and kitchens is most effective. To improve energy efficiency, storage-type water heaters are best located in conditioned space, except in extremely hot climates where tank heat loss increases the cooling load.

Periodic water heater maintenance can significantly extend water heater life and minimize loss of efficiency over time. Routine maintenance involves flushing a quart of water from the storage tank every three months, checking the temperature and pressure relief valve every six months, and inspecting the anode rod every three to four years.

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