WATER HEATING

Energy-efficient strategies for supplying hot water in the home

WATER HEATING

For more information, contact:
Energy Efficiency and Renewable Energy
Clearinghouse (ERECC) 1-800-DOE-3732
www.eren.doe.gov
Or visit the BTS Web site at
www.eren.doe.gov/buildings
Written and prepared for the U.S. Department of Energy by:
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U.S. Department of Energy’s National Renewable Energy Laboratory
(303) 275-3000
www.nrel.gov/building_thermal

REDUCING CONSUMPTION

Energy efficiency in hot water systems can be achieved through simple steps such as:

- Installing a tankless water heater or a condensing water heater.
- Replacing old, inefficient water heaters with energy-efficient models.
- Using water-saving appliances and fixtures.
- Lowering water temperature for hot water use.
- Insulating water pipes to reduce heat loss.

Energy savings can be significant. For instance, switching from a 55°F to 40°F water temperature can cut hot water expenses by 10%.

ENERGY-EFFICIENT WATER HEATING

Different types of water heaters are available, each with its own advantages and disadvantages:

- Storage water heaters:
  - Traditional water heaters that store hot water in a tank.
  - Suitable for homes with moderate to high hot water demand.
  - May be more energy-efficient when used in concert with energy-efficient appliances.

- Tankless water heaters:
  - Heat water on demand, providing instant hot water.
  - Can be more cost-effective in homes with low hot water usage.

- Demand water heaters:
  - Produce hot water only when needed, similar to tankless water heaters.
  - Ideal for small spaces and low hot water usage.

- Heat pump water heaters:
  - Use heat pumps to heat water, which can be more energy-efficient than electric resistance heaters.
  - Suitable for warm climates.

- Solar water heaters:
  - Use solar collectors to heat water using the sun's energy.
  - Most appropriate for homes with a high solar resource.

When choosing a water heating system, consider factors such as energy efficiency, cost, and the specific needs of your home.

WATER HEATING SYSTEM SAFETY

Backdrafting—the pressure-induced spillage of exhaust gases into interior living space—is a health and safety concern. To prevent backdrafting:

- Install a combustion air intake and an exhaust vent to the outside of the building.
- Ensure that the water heater is properly vented to the outside to prevent carbon monoxide buildup.
- Use a carbon monoxide detector in the home to alert you to potential problems.

ENERGY STAR-QUALIFIED WATER HEATERS

Water heaters labeled with the ENERGY STAR® logo are designed to meet energy efficiency guidelines set by the U.S. Environmental Protection Agency (EPA). These water heaters can help you save money on your energy bills and reduce your carbon footprint.

Heat pump water heaters and tankless electric water heaters are ENERGY STAR-qualified options. These systems can significantly reduce water heating costs and emissions when compared to traditional electric resistance water heaters.

Heat pump water heaters:
- Use heat pumps to heat water, which can be more energy-efficient than electric resistance heaters.
- Suitable for warm climates.
- Can be more cost-effective in homes with low hot water usage.

Tankless electric water heaters:
- Heat water on demand, providing instant hot water.
- Suitable for small spaces and low hot water usage.

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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.

STORAGE WATER HEATER COMPARISON

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.

<table>
<thead>
<tr>
<th>Energy Factor (EF)</th>
<th>Annual Cost</th>
<th>First Hour Rating (FHR)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.86 to 0.92</td>
<td>$410 to $570</td>
<td>50 to 70 gallons</td>
<td>Lowest initial cost, highest lifetime costs</td>
</tr>
<tr>
<td>0.54 to 0.63</td>
<td>$145 to $140</td>
<td>60 to 95 gallons</td>
<td>Higher initial cost than tank-type electric units due to gas lines and venting; includes combusted and power-vented units; reduce backdrafting potential at costs of $50 to $150 and $300 to $800, respectively.</td>
</tr>
<tr>
<td>0.54 to 0.63</td>
<td>$105 to $267</td>
<td>60 to 95 gallons</td>
<td>Similar installation issues on natural gas; additional fuel tank required</td>
</tr>
<tr>
<td>2.50 to 3.50</td>
<td>$170 to $140</td>
<td>60 to 65 gallons</td>
<td>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 80°F year-round.</td>
</tr>
</tbody>
</table>

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.

WATER HEATING

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

This system captures waste heat through heat exchange from the wastewater drains.
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STORAGE WATER HEATER COMPARISON

<table>
<thead>
<tr>
<th>Storage Water Heater Type</th>
<th>Energy Factor (EF)</th>
<th>Annual Cost</th>
<th>First Hour Rating (FHR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric tank type (50 gallon)</td>
<td>0.86 to 0.90</td>
<td>$410 to $370</td>
<td>50 to 70 gallons</td>
</tr>
<tr>
<td>Natural gas tank type (40 gallon)</td>
<td>0.54 to 0.63</td>
<td>$145 to $140</td>
<td>60 to 85 gallons</td>
</tr>
<tr>
<td>Propane tank type (40 gallon)</td>
<td>0.54 to 0.63</td>
<td>$190 to $205</td>
<td>65 to 75 gallons</td>
</tr>
<tr>
<td>Electric heat pump (90 gallon)</td>
<td>2.50 to 2.50</td>
<td>$170 to $140</td>
<td>60 to 85 gallons</td>
</tr>
</tbody>
</table>

Notes:
- Lowest initial cost, highest lifetime costs
- Higher initial cost than tank-type electric units due to gas lines and venting; insulated combustion and power-vented units reduce backdrafting potential at costs of $50 to $150 and $300 to $600, respectively
- Similar installation issues on natural gas; additional fuel tank required
- 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 80°F year-round

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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.

DRAINWATER HEAT RECOVERY

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

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.

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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.

DIAGRAM 1. WATER HEATING SYSTEM SAFETY

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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