

Energy Consumption Overview

Residential Water Heating

Market Characterization

Technologies

Economics

Energy Savings

Market Potential

Market Characterization

Technologies

Economics

Energy Savings

Market Potential

Appendices

**Residential water heaters are defined by rated storage volume and heat-input rate.**

Type	Criteria: Storage Volume and Heat-Input Rate
Residential, Electric	Up to 120 gallons; not more than 12 kW (40,940 Btuh)
Residential, Gas-Fired	Not more than 75,000 Btuh
Residential, Oil-Fired	Not more than 105,000 Btuh

Source: Code of Federal Regulations [DOE, 1992].

**Residential water heaters, regardless of fuel type, often have these attributes.**

- Stand-alone residential storage water heaters heat water in an insulated tank.
- Tank water is stratified by temperature: cold water is added at the bottom, and the hottest water rises to the top.
- Typically, storage water heaters operate at the same pressure as the incoming water supply (up to 125 psi; typically 40 to 80 psi).
- Storage water heaters usually have glass-lined or cement-lined steel tanks. Some premium models have stainless-steel tanks or polybutylene-lined fiberglass tanks.
- The most popular size of residential gas-fired water heater is 40 gallons.
- The most popular size of electric water heaters is 50 gallons, with a significant number in the 80-gallon size as well.

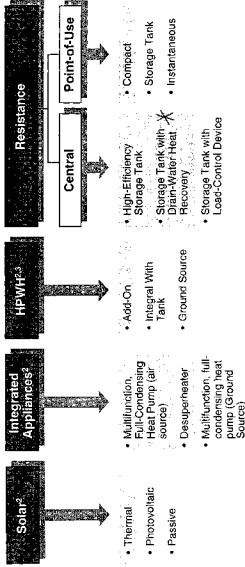
**For a given hot-water draw, a higher heat input rate can compensate for a lower stored volume.**

Storage Volume, gallons	Gas			Electric		
	First-Hour Rating <sup>1</sup> , Gallons	Energy Factor	First-Hour Rating <sup>1</sup> , Gallons	Energy Factor	First-Hour Rating <sup>1</sup> , Gallons	Energy Factor
19-20	42-44	0.58-0.60	23-32	0.89-0.94		
29-30	46-64	0.56-0.64	35-46	0.91-0.97		
38-40	54-88	0.54-0.64	42-50	0.90-0.96		
50-52	69-99	0.52-0.62	53-66	0.86-0.95		
60-65	78-98	0.50-0.53	67-73	0.96-0.95		
75-77	109-144	0.47-0.51	N/A	0.89-0.94		
80-82	N/A	N/A	80-89	0.89-0.94		
103	165	0.42	N/A	0.89-0.94		
119-120	N/A	N/A	109-120	0.89-0.94		

Source: GAMA Consumer's Directory of Certified Efficiency Ratings (GAMA, 1995).

<sup>1</sup> Water-heating capacity is expressed as First-Hour Rating, or gallons of hot water that can be drawn over the course of one hour, starting with a full tank.

## Seven high-efficiency electric technologies were investigated for residential applications<sup>1</sup>.



<sup>1</sup> Shaded technologies were evaluated. Baseline technologies are standard-efficiency electric resistance and gas-fired water heaters.

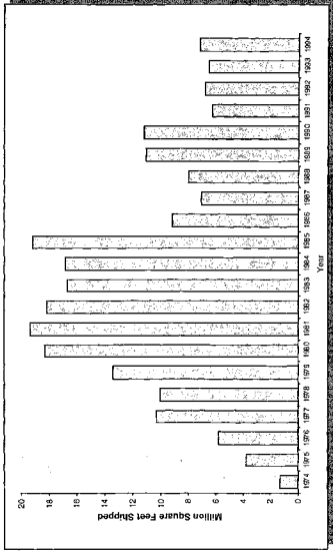
<sup>2</sup> Generally use electric resistance for supplemental heating.

<sup>3</sup> Heat pump water heater.

**An active solar thermal water heating system consists of a number of components.**

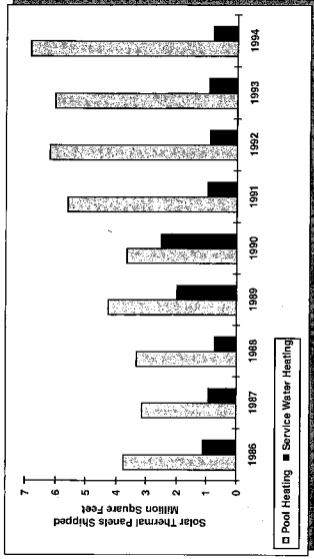
- The solar collector (most commonly a flat-plate collector).
- A thermal reservoir, (typically an insulated hot-water storage tank).
- An auxiliary heat source, (typically a conventional electric water heater).
- The necessary piping, controls, valves, and pumps required to
  - a) transport heat from the collector to the hot-water storage tank and
  - b) integrate all the individual elements into a working system.

Shipments of solar thermal collectors peaked in the first half of the eighties.



Source: EIA Renewable Energy Annual, 1995.

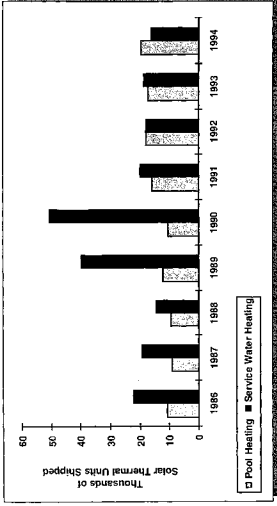
## Shipments of solar panels for service water heating peaked in 1990.



Source: EIA Renewable Energy Annual, 1995.



An estimated 50,000 solar service-water-heating systems were shipped in 1990, dropping to about 15,000 by 1994.



Source: EIA Renewable Energy Annual, 1995.

Note: The average pool heating solar thermal system was estimated to be 350 ft<sup>2</sup>.

The national average water heating solar thermal unit was estimated to be 50 ft<sup>2</sup>.

Estimates from ADL and Les Nelson of the California Solar Energy Industries Association.

**Most manufacturers are guardedly optimistic about future growth. This cautious optimism is strongest in the Sunbelt and weakest in the Northeast and Midwest. Three indications of growth have been identified.**

- Actions by State and regional environmental authorities to enact even more stringent environmental legislation than the Clean Air Act.
- A trend by local authorities towards reform in local building codes that facilitate or mandate the use of solar hot water systems in new construction.
- A growing trend among public utilities to consider solar hot water as a resource in meeting Demand Side Management goals. Utility sale, lease, and rebate programs are also gathering momentum.

**Manufacturers cite several growth areas for solar water heating.**

- Continued strong sales of low-temperature swimming pool systems (outside the scope of this assignment).
- Residential and commercial system growth fostered by utility-sponsored solar hot-water programs.
- Expanded use of solar hot-water systems by the Department of Defense and other federal agencies.
- An increase in export sales of solar hot-water equipment. Growth is anticipated by those manufacturers active in the export market. The strong technical position of the U.S. solar thermal industry, more stringent foreign environmental regulations, higher international fuel costs, and a relatively low U.S. dollar will all contribute to this expected export growth.

**Seven current manufacturers of HPWHs have been identified.**

- **Air-Source HPWHs:**
  - DEC
  - FHP
  - Crispaire
  - Econar
  - Water Furnace
- **Closed-loop, ground-source HPWHs:**
  - Florida Heat Pump
  - Water Furnace
  - Econar
  - Hydro Delta
- **Rheem and State stopped offering HPWHs in 1990-1992**

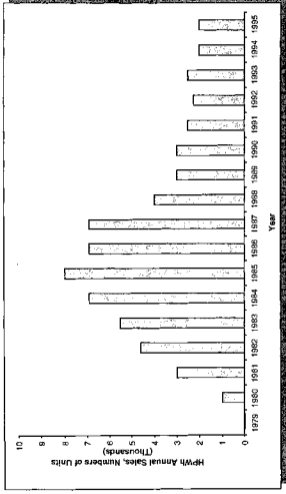
**A new product is the dedicated ground-source HPWH.**

- Ground loop can be stand alone, or combined with a space-conditioning heat-pump ground loop.
- No adverse cooling effect in the winter and no need for ventilation in confined spaces.
- Typically cost prohibitive unless combined with ground-source heat pump.
- For commercial applications having high hot-water consumptions, installation of the system without co-existing ground-source heat pump could be justified.

**A range of residential air-source heat pump water heaters is available today.**

- Energy factors range from 1.8 to 2.6, compared to 0.86 to 0.95 for conventional electric water heaters.
- Recovery rates range from 10 to 24 gallons per hour.
- Heating capacities from 6,000 to 13,000 Btu/h.
- Cooling capacities from 4,000 to 9,500 Btu/h.
- Retail prices range from \$575 to \$1,750.

## Heat pump water heater sales peaked in the mid 1980s.



Source: Oak Ridge National Laboratory (Oak Ridge, 1999), GAMA, and manufacturers. Does not include pool heaters or desuperheaters.

**Multifunction, full-condensing heat pumps provide heat pump water heating even when there is no demand for space conditioning.**

- Provide a significantly larger fraction of water heating relative to a desuperheater,
- Provide greater utilization of a single vapor-cycle system than a stand-alone space-conditioning heat pump or HPWH.



**Three manufacturers of residential multifunction, full-condensing heat pumps have been identified.**

- DEC (air source)
- Nordyne (air source)
- Hydro Delta (ground source)

**The water-heater industry sold approximately 8-10,000 compact water heaters last year. These units are generally used as point-of-use water heaters.**

- Typically range from 10 to 30 gallons.
- Commonly are used in gas stations although small offices, apartment complexes, and hotels are other possible applications
- This analysis examined a 20-gallon compact water heater with a retail value of approximately \$200.