

Water Heating

HIGHLIGHTS

■ **PROCESS AND TECHNOLOGY STATUS** – In developed countries, modest efficiency improvements in water heating have occurred in recent years. Water heating is typically the third largest domestic energy end-use after space heating/cooling and lighting. For example, in 2010 water heating accounted for 13.2% of energy consumption in US buildings. Demand for domestic hot water averages at 24 litres per person per day across the EU, although substantial national variations are observed. This demand can be serviced by dedicated water heating systems or by combination systems that also perform a primary space heating role; such devices are considered in the ETSAP Technology Brief R02 (Space Heating and Cooling). Dedicated systems can be broadly characterised as **storage** systems, **instantaneous** devices or alternative systems, including **heat pumps** and **solar** systems. Fuel splits vary substantially; most countries rely chiefly on **gas** and **electricity**, although oil and biomass use can be significant. Sales and stock shares by device differ significantly between countries: in the EU, electric storage systems dominate the market with approximately 55% of dedicated water heater sales, whilst renewables contribute a small portion. Solar devices are popular in China and heat pumps are widespread in Japan. In the commercial sector, water heating consumption contributes a smaller proportion of total consumption and is concentrated in limited building types. In the US, 4.3% of total energy consumption in the commercial sector is attributed to water heating functions, with hotels, hospitals and food service buildings accounting for over 75% of this. Commercial water heating equipment is typically scaled up compared to domestic equipment, in terms of power and storage capacity or flow rate, with significant overlap between smaller commercial units and the upper end of the domestic market. **Booster** heaters are also utilised to deliver higher temperature flows, although the market for such devices is small.

■ **PERFORMANCE AND COSTS** – A variety of metrics can be used to characterise and compare the performance of water heating systems. The key determinant of price and efficiency is size, in terms of storage capacity or power/flow, with a wide range of systems servicing the market. Domestic storage devices in the EU can provide capacities of over 250L but suffer significant standby losses, with overall efficiencies in the range of 27-41% for gas systems and 27-30% for electric devices. Large commercial devices are increasingly subject to more stringent efficiency limits in the US. Typical gas systems provide thermal efficiencies in the range of 76-79% while average electrical devices offer thermal efficiencies of 97-99%. Alternative systems are better characterised by the energy factor (the ratio of useful energy output to the input energy, which can be greater than one), with commercial heat pumps offering values of 2.3-2.4, while solar systems can attain a wide range from 0.8-4.8, depending on size, technology and irradiation levels. Prices vary significantly with size, system type and technology level: average domestic prices fall within the range €80-450 for conventional EU devices and \$4,000-8,000 for US solar thermal systems. Commercial device costs range more broadly from €150-5,800, with gas systems being most expensive. In both sectors user behaviour is important; values are quoted for typical tapping patterns, which encompass the frequency and duration of cycles as well as flow and temperature demands.

■ **POTENTIAL AND BARRIERS** – There is potential for significant energy savings in the domestic water heating sector, with EU reports suggesting a potential for 60% per unit energy savings with the adoption of best available technology. The Energy Star scheme in the US is designed to promote the uptake of more efficient devices, including a focus on instantaneous systems, gas devices, and in particular heat pumps and solar systems. The US market for heat pumps is growing rapidly, having risen from 0.4% to 1.6% of total sales over 2009-10, but overall the stock share of the most efficient systems remains very small in both the domestic and commercial markets. Focus by nation varies: in the US, instantaneous gas systems are strongly promoted; solar systems are heavily endorsed in China and the EU; Japan leads the way with heat pump technology, and their gas utilities are strongly promoting high efficiency condensing units. Reports also identify opportunities for the development of new systems with higher efficiencies, which may be necessary to bring about full market transformation. In the commercial sector, US studies identify unit energy savings of up to 50% with switches to solar systems or heat pumps, relative to the currently prevalent gas storage systems. However, a number of barriers exist to slow the spread of more efficient water heating systems across domestic and commercial markets: high capital costs, market acceptance issues, constraints associated with emergency replacement, split incentives, and fuel availability are all significant factors.

PROCESS AND TECHNOLOGY STATUS

A water heater is a device or set of devices which is equipped with a heat generator and connected to an external supply of sanitary water, and can deliver

desired water temperatures at desired rates. It may or may not be equipped with a storage tank.

This brief deals with dedicated water heaters which provide hot water directly. Combination boilers (which provide both hot water and space heating) are