Space Heating and Cooling

HIGHLIGHTS

PROCESS AND TECHNOLOGY STATUS – Heating and cooling technologies have a major influence on global energy consumption, and will continue to do so in the future. In temperate regions, space heating is the single largest energy demand for households. In the commercial sector cooling demand has grown significantly, and with increasing office space being rapidly constructed in developing countries it is projected to rise dramatically over the coming decade. Residential cooling technologies are more important in the US and in warmer world regions. China is already the largest market for residential air conditioners. The market for residential heating technologies is complicated, as different cultural, climatic and physical requirements mean no single style of technology is used globally. In North America, forced air furnaces are common whilst in parts of Europe combination boilers and district heating systems are particularly popular. In terms of fuel input a general theme of heating technologies globally is a shift away from oil and coal towards gas and electricity. This shift is driven by rising fossil fuel prices and legislation driving consumers towards less carbon-intensive technologies. Low-carbon technologies such as heat pumps are becoming increasingly common in domestic and commercial applications and this trend is expected to continue over the coming decade.

PERFORMANCE AND COSTS – Fossil fuel fired heating systems remain the lowest initial capital cost, however, low carbon alternatives are becoming increasingly competitive when viewed over a five to ten year time frame. Future cost reductions and efficiency improvements in gas boilers and furnaces are not expected as the technology can be regarded as mature. However, the efficiency of technologies currently installed has scope for improvement, particularly utilising technologies such as condensing boilers, which are now mandatory in some countries. Heat pumps and air conditioning systems could see efficiency and cost reduction improvements of at least 20% by 2030 according to the IEA. This guide also highlights a range of developing technologies such as CO_2 refrigerant heat pumps and micro-CHP where there is scope for efficiency and cost reductions that may influence the market in the future.

POTENTIAL AND BARRIERS – Fossil fuel fired heating systems are expected to remain dominant in the years to come with an increasing proportion of low carbon heating systems which have great potential. CHP, biomass and heat pumps are projected to be some of the key technologies of the future. Legislation is a key factor driving improvements in technology and driving a market shift towards more efficient appliances. The Energy Star label is widely used and the Eco-design requirements being introduced in the EU will become increasingly important in placing minimum performance requirements upon heating and cooling products. A key barrier to the uptake of more efficient technologies is the additional cost, which is being partially overcome through various financial incentives. Additional barriers include consumer awareness, principal-agent barriers, information, transaction cost and regulatory barriers.

PROCESS AND TECHNOLOGY STATUS

In most countries, the building sector accounts for at least 40% of primary energy use in residential and services sectors, and the absolute figure is increasing due to higher construction rates, particularly in China, India and South Mediterranean countries [1]. The residential buildings uses significantly more energy than commercial buildings (around 70% of total building sector energy consumption) Currently, around 39% of CO_2 emissions from the global residential sector are due to space heating and cooling needs. In the service sector's this share is around 35% [2]. In order to keep the average global temperature rise below the 2°C limit agreed at the United Nations climate negotiations, average building energy consumption per person will need to be cut by 60% by 2050 compared to levels in 2005 [3].

Building heating and cooling systems are used to maintain comfortable indoor temperatures through the generation and/or transfer of heat. There are three main technical approaches to reducing the heating or cooling load of a building: first, to reduce the temperature difference between indoors and outdoors by accepting an indoor temperature that is closer to the outdoor temperature (as far as possible); second, to improve the building envelope (see ETSAP R01); and finally to increase the efficiency of heating and cooling products. It is this final approach that is the main focus of this brief. The technologies covered are concerned with primary (main) space heating and cooling technologies. Secondary (localised) heating and cooling systems are not considered in detail as by definition they account for a smaller proportion of demand.

Over the full life cycle (from equipment manufacture to disposal), the main environmental impact from heating and cooling systems occurs during the operation phase, which is directly related to energy consumption [12]. A variety of energy sources are employed, including gas, oil, electricity, biomass and other renewable sources.

Residential Sector - Residential energy consumption for space heating and cooling varies depending on local climate conditions, season and user behaviour. Domestic energy use is dominated by space heating in colder climates such as in (Northern and Central) Europe, where it accounts for 60-70% of residential primary energy consumption (Figure 1).

Please send comments to Oliver.Edberg@aeat.co.uk, Andrew.Waddelove@aeat.co.uk, Gena.Gibson@aeat.co.uk, (Authors), and to Giorgio.Simbolotti@enea.it and Giancarlo Tosato (gct@etsap.org), Project Coordinators