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Heat Pumps in the United Kingdom

- An Assessment of the Environmental Impact

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With its cool summers and ready supply of low-cost gas, the United Kingdom does not offer the most favourable economic conditions for the widespread application of heat pumps. However, environmental concerns have recently led to an increasing interest in heat pumps in this country. To find out more about this trend, the HPC asked EA Technology to report on the situation in the UK regarding CO₂ and CFC emissions, and on the impact this has on the application of heat pumps. As an independent R&D company whose major customers are the electricity supply companies of the UK, EA Technology Ltd is well placed to reflect the current UK situation. It should, however, be emphasized that the views expressed as to the future impact of heat pumps are, of course, entirely their own and do not necessarily reflect those of either the UK Government or the individual UK electricity supply companies.

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With CO₂ emissions from electricity generation set to reduce due to increasing efficiency and a shift in the fuel mix, the environmental case for using heat pumps is becoming stronger. Proposed building regulations could stimulate the use of heat pumps in new homes since they encourage mechanical (fan-assisted) ventilation by insisting on tighter insulation. Heat pumps are already finding increased application in commercial buildings, and are well established in some industrial sectors.

CO₂ Production and Fuel Mix

The CO₂ production rate for electricity generation in the UK, based on 1992 data for the annual average fuel mix, is 0.72 kg/kWh. For gas the accepted value is 0.21 kg/kWh of fuel delivered. These figures are those currently used by the UK's Building Research Establishment. If we take a seasonal efficiency of 85% for a gas condensing boiler then a heat pump with a seasonal COP in excess of 2.9 will give savings in CO₂ production rate. This value is achievable, with careful design, in a wide range of applications both in commercial and domestic premises and in industrial processes.

Since the electricity industry was sold into private ownership, there has been a rapid increase in the

building of new power plant, a very large proportion of these being gas-fired combined cycle plant with expected efficiencies of over 50%. When these new stations come on stream, the CO₂ production rate for electricity generation will fall, probably to less than 0.6 kg/kWh by the late 1990's, making the case for heat pumps even more attractive in terms of their potential for CO₂ reduction.

However there are a number of factors which make it likely that heat pumps will not achieve their full potential in the UK, the most important being firstly, the wide availability and low cost of gas (which makes an economic return difficult in many applications) and secondly an attitude to heat pumps which, in commercial and domestic buildings, equates them with unnecessary air-conditioning.

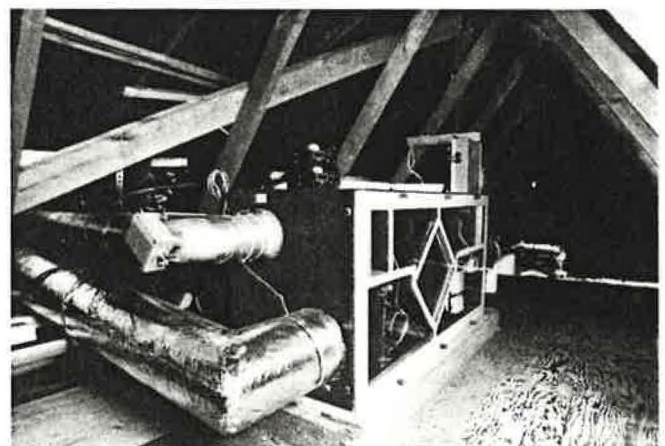
CO₂ Reduction

The UK Government committed itself at the Rio Earth Summit to returning CO₂ emissions to 1990 levels by the year 2000. The Government has produced a consultative document to outline ways and means of achieving this target. Heat pumps do not feature as an option to be promoted.

There are two major initiatives in the buildings sector.

- The Building Research Establishment Environmental Assessment Method (BREEAM) for commercial

Mechanical ventilation heat pump installed in an EA Technology test house.



buildings has been formalized as a method of assessing buildings on their environmental impact and energy performance.

- New building regulations will be imposed in 1994. A draft set has been published to allow comments from the building industry.

As well as increasing statutory insulation levels, the proposed new building regulations will introduce the requirement on the part of the architect/developer to demonstrate that there is a need for mechanical ventilation or air-conditioning (positive cooling) for buildings of over 500 m² floor space, prior to such systems being specified. Mechanical ventilation is allowed for domestic premises.

CFCs

The UK has accepted the European phase-out date of January the 1st 1995. On HCFCs, new European regulations are under discussion and we understand that the UK want the phase-out to be brought forward to 2015. EA Technology do not see the working fluids issue as being a hindrance to the development of heat pumps or to their application. New fluids are now widely available for CFC replacement. The major concern is with the replacement for HCFCs and in particular HCFC-22. Here again the evidence suggests that alternatives will be developed, with a return to ammonia or the use of flammable refrigerants being a possibility, with the draft European Standard on the use of flammable refrigerants expected to supersede the British Standard.

Heat Pump Applications

EA Technology believe that there will be a number of important applications for heat pumps in the UK which will help meet the target for returning CO₂ production levels to 1990 values.

Commercial Buildings

Mechanical ventilation will continue to be a viable option with clear advantages in control of indoor air quality. Heat pumps will be increasingly used as heat recovery options where mechanical ventilation has been selected.

Mechanically-driven air-conditioning will continue to be the best means of dealing with excessive heat generation within many offices and other commercial premises, but will come under increasing threat from gas absorption systems. Heat pumps will be increasingly used in such buildings to provide some or all of the winter heating as well as the summer cooling, as witnessed by the rapid uptake of heat pump VRV (Variable Refrigeration Volume) systems in recent years. In these multi-split systems, each indoor unit can be individually set to heating or cooling mode.

The current low cost of gas means that it is unlikely that there will be many heating-only applications of heat pumps unless they are in a locality with no access to natural gas. The vast majority of heat pumps will thus be linked to air-conditioning or mechanical ventilation and will be air-source.

Domestic Buildings

Tighter sealing of buildings against air infiltration means that mechanical ventilation is becoming an increasing requirement at a domestic level. Mechanical ventilation (exhaust air) heat pumps are being promoted as part of a low-energy strategy for new houses (see photograph). Air-conditioning heat pumps are now being actively marketed in the UK, but the mild climate means that a large uptake is unlikely. Air-to-water heat pumps are receiving attention and are seen to be more environmentally friendly than split-refrigerant systems since they confine all their refrigerants to a single factory-sealed unit.

Industrial Applications

While there is no UK policy for industrial heat pumps, it is understood that they have considerable potential for the reduction of CO₂ emissions. Applications include Mechanical Vapour Recompression (MVR) evaporation, heat pump assisted distillation and drying, and heat recovery schemes.

MVR, where COPs up to 40 are achievable, can give rise to 40 to 50% reductions in CO₂ compared with the best thermal practices. In addition to traditional evaporation applications, there is a growing potential for MVR evaporation in effluent treatment, giving additional environmental benefits of reduced disposal volume plus often a combustible final product.

Heat pump assisted distillation applications include solvent recovery and steam stripping, again offering environmental benefits. Drying applications include wood products, grains, textile products and, more topical from an environmental viewpoint, sewage and paper sludge drying. COPs of 4 to 6 are possible for these application areas.

Much work is being done by EA Technology to produce lower cost, packaged, small capacity plant, to open up the market for these technologies. This work is starting to generate interest.

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