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Addressing low heat pump heating system sales in the UK

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How will UK homes be heated in the future – by a combination of gas boiler and heat pump?

Photo: Adobe Stock

Perhaps it doesn’t have to be gas boilers versus electric heat pumps. Here, Ben Costelloe* proposes a temporary dual heat pump and boiler transition scheme as a way to see heat pumps gain widespread acceptance in the UK.

In order to address net zero obligations, many European states have a policy to replace fossil fuel-fired heating boilers with heat pumps. While this policy seems to be succeeding in Scandinavia and some Baltic countries, it is failing in many areas of Western Europe, particularly in the UK. A recent survey of heat pump sales as a percentage of total heating system sales showed Sweden at 92%, France at 32%, Ireland at 18% and the UK at 3%.

The UK government’s target is to install 600,000 heat pumps per annum by 2028. However just 43,000 were installed in 2022 – a very low number relative to the 1.6 million gas boilers fitted in the same period. Worn out gas boilers are being replaced with new gas boilers, not heat pumps. Fresh thinking is required if this serious situation is to be reversed.

Why are heat pump sales so low in the UK?
The standard answer to this question is that many UK buildings are unsuitable due to their low levels of insulation. Heat pumps generate water at typically 55°C compared with 75–85°C for boilers and therefore need very well insulated buildings to achieve the required room temperatures.

But is this the only issue? There are regular accounts in the UK media describing the public’s perception and experience of heat pumps. These give a much wider understanding of the problem and are summarised here:

- My building is too poorly insulated for heat pumps.

- Heat pumps are too expensive to run.
- The £5,000 grant and other subsidies are too low relative to the actual costs involved.
- They do not heat rooms as well as boilers, particularly when the temperature is below +5°C externally.
- Ground source heat pumps work best but I don’t have the space or funding to fit this type.
- They are too slow to heat up.
- There is a great need for independent advice and more training in design and installation.
- Heat pumps are hard to accommodate externally, often noisy, and come with many planning issues.
- Fitting a heat pump could reduce my energy performance certificate (EPC) rating as more energy can be consumed.
- Heat pumps are currently in a development phase – later models will be cheaper and better.

Many of these issues are real but readily addressed. Some, however, need time and much more funding to resolve.

> ***Worn out gas boilers are being replaced with new gas boilers, not heat pumps – fresh thinking is required if this serious situation is to be reversed.***

Addressing the issues

The accommodation issue and the slow heat up time can generally be resolved by better design and commissioning. Planning matters, the EPC problem and more realistic and better targeted grant support are all issues for willing government action. The noise issue requires a design and manufacturing input.

However, low insulation levels and the skills shortage are inherent and need considerable time and funding to address. Poor heating performance is also related to low insulation levels.

The state of UK housing stock

There are 28 million dwellings in the UK. The age profile is as follows, with the corresponding average figure for 28 European countries given in brackets. Almost two in five dwellings – 38% (23%) were built before 1946. In the period 1946–1980 a total of 40% (44%) were built and 22% (32%) are post-1980. The UK has one of the oldest housing stocks in Europe.

Furthermore, in 1980, new regulations requiring major increases in new building insulation levels were introduced, in response to the oil crisis. In the post-1980 dwellings cohort, the UK at 22% has the third lowest quantity of dwellings which came under the new insulation regulations, of all the 28 countries. However, by 2017, 70% of cavity walled dwellings had been fitted with cavity insulation. Nonetheless, solid wall insulation levels remain low, with just 12% insulated by 2017.

Upgrading insulation in pre-1980 dwellings is a greater task in the UK than elsewhere in Europe.

Prevalence of piped gas in UK heating systems.

The UK is very dependent on piped gas for heating, at 82% of homes. Germany (at 35%) and France (at 34%) are far less gas dependent. In the UK, the combination of the extent of the gas network and of older, often poorly insulated dwellings, has resulted in gas fired boilers predominating as a very effective means of heating in these circumstances.

Weaning the public off gas boilers is a greater task in the UK than elsewhere and therefore more radical policies are justified.

One crucial fact about air source heat pumps.

The coefficient of performance (COP) is the measure of heat pump energy efficiency. This is the quantity of energy delivered by the heat pump per unit of energy used by the compressor. This parameter depends on the temperature lift achieved – the difference between the water temperature generated and the temperature of the heat source. Water generated at 55°C when the external air is at +5°C has a lift of 50°C and a COP of approximately 3.

However, water generated at 65°C from an air source heat pump at 0°C has a COP of just 2. As the cost of electrical power per kWh is always approximately three times that of natural gas per useful kWh, a COP of at least 3 must be achieved, on average, if heat pumps are to be competitive with the gas boilers they replace. The great majority of heat pumps sold are air source.

Hence the temperature lift must be kept to an average of 50°C or less during the heating season.

Existing radiator heating system design

Most existing heating systems, using boilers and installed since 1997, have been designed to the EN442 standard with a supply water temperature of 75°C, a return temperature of 65°C and a typical room temperature of 20°C (75/65/20 design). The heat emission of a typical existing radiator heating system designed for 75/65/20 will be reduced to 50% when supplied by heating water from a heat pump at 55°C. In these circumstances three common strategies can be used to compensate for the lower heat pump temperature:

- fit additional or larger radiators;
- fit additional low temperature heat emitters such as underfloor heating or convectors; and
- upgrade building thermal fabric to compensate for the reduced heat output.

This last option is generally preferred on energy conservation grounds.

However, some of the most effective thermal upgrading measures, such as external wall insulation and new glazing are expensive. Crucially however, many cannot afford the cost of carrying out these measures while concurrently paying to supply and fit a new heat pump – often requiring civil, electrical and mechanical works and costing up to £14,000, excluding design fees.

An unrealistic subsidy of £5,000 is available but requires full boiler replacement to qualify.

Dual heat pump and boiler installation

One solution to this problem is to retain the existing boiler pending the completion of building fabric upgrading. In its simplest form, this dual installation arrangement would operate in two modes. During less cold weather the heat pump alone provides sufficient heat. In colder weather the boiler operates alone.

However, an interim mode is also possible whereby the heat pump is used to preheat the return water, while the boiler is used to raise the supply water to the required temperature.

Operating thresholds

While heating system external design temperatures vary with location, in the UK and Ireland a temperature of –2°C is typical, with room temperatures of 20°C being common. A heat pump, therefore, operating at 55°C and supplying 50% of the original heating system design output is capable of fully heating the building down to an external temperature of +9°C. In most buildings some thermal upgrading measures will have been implemented and this 9°C threshold will, therefore, reduce accordingly.

When the external temperature falls to a level whereby the heat pump maximum supply temperature of 55°C is insufficient to maintain 20°C in the rooms, the boiler would be called in by the control system.

When the external temperature falls to a level whereby a heating water supply temperature of 65°C is required, the heat output from the system will be 75% of its original design output. For a room temperature of 20°C and with an external design temperature of –2°C, this threshold occurs at +3.5°C. The boiler operates alone at the external temperature range +3.5 to –2°C. Where the third (interim) mode is deployed, with both heat pump and boiler in operation, this would occur between +9°C and +3.5°C externally.

Support measures and design guidance

As more fabric upgrading measures are implemented, the boiler operating time diminishes, CO_2 generation is further reduced and ultimately eliminated. Time is bought to implement all the fabric upgrading measures and costs are spread across the time limited transition period. The subsidy schemes, however, would need to be amended to recognise this dual option.

To support this proposal, the broader heating system industry would need to market bespoke equipment kits to facilitate standard and speedy dual installation. The proposed scheme would also benefit from a sponsored pilot project to refine the detail of the dual connection arrangement.

It is apparent that heat pump heating systems require a substantial design input to be successful. There is a pressing need for better official and independent design and installation guidance, case studies and demonstration projects which would show empirically that heat pumps can be effective across the spectrum of UK buildings, without compromising architectural integrity.

**Ben Costelloe is a mechanical design engineer and the current membership/education adviser for the Ireland branch of the Energy Institute. He taught engineering while a senior lecturer and head of department at Bolton Street Dublin Institute of Technology (now the Technical University Dublin). Previous to his academic career he gained design and contract administration experience in an HVAC consulting engineering practice. He holds a PhD in mechanical engineering from University College Dublin, is a corporate member of both the CIBSE and Energy Institute and is a registered chartered engineer. His research interest is in low-energy/low-carbon heating and cooling systems.*