Written evidence submitted by Daikin UK

UK House of Commons Environmental Audit Committee inquiry into "Heat resilience and sustainable cooling"

Definitions are provided at the end of the document for terms highlighted in blue

Who are Daikin UK

Daikin UK is an award-winning low carbon heating and cooling business. We are the UK's leading provider of commercial heating and ventilation solutions, and we have a significant presence in the residential air source heat pump market. In the UK, Daikin employs over 420 people across seven offices and training centres.
With nearly 100 years of experience, Daikin has built a well-deserved worldwide reputation for quality and technology, selling more than one million heat pumps across Europe.
Daikin fully supports the 2016 Kigali Amendment to the Montreal Protocol for a global phase-down of hydrofluorocarbons (HFCs) in total global warming potential (GWP) volume. The main tenet of our policy is "diversity of refrigerants" and reducing impacts through a lifecycle approach.

Daikin is also a manufacturer of refrigerant , which is an investment made due to the importance of refrigerants within the operation of a Heat Pump. In this way Daikin can innovate with different refrigerants exploring which ones are the most sustainable, safe, efficient and cost effective. Daikin can then design compressor technology to match the characteristics of the chosen refrigerant.

The reason that Daikin is responding to this call for evidence is that as a leading Global, European and UK manufacturer of HVACR solutions, with nearly 100 years of experience, we believe that we can bring significant experience to the discussion of what could be a suitable long term solution to support the drive towards net zero.

- **What can be done to protect the UK's existing public and private sector housing stock from the impacts of extreme heat while ensuring that homes are sufficiently warm in the winter months ?**

The balance between increased insulation and internal comfort needs to be redressed in our warmer climate

Over recent decades, the Building Regulations have focused on increasing insulation and air-tightness in new-build homes. We know that even 10 years ago some people living in new build homes and apartments were suffering from "overheating" within their home during periods of warmer weather. With record-breaking high temperatures, (40°c) in the UK this June, it is likely that large parts of the UK housing stock will overheat.

The World Health Organisation states[1] " Exposure to excessive heat has wide ranging physiological impacts for all humans, often amplifying existing conditions and resulting in premature death and disability…… exposure to hotter than average conditions compromises the body's ability to regulate temperature and can result in a cascade of illnesses, including heat cramps, heat exhaustion, heatstroke, and hyperthermia. It continues stating "Heat also has important indirect health effects. Heat conditions can alter human behaviour, the transmission of diseases, health service delivery, air quality, and critical social infrastructure such as energy, transport, and water."

The solution for this approach is contained within Part O of the building regulations where Heat Pumps can be used to overcome over Heating in Buildings. However In the current regulations it is stated that this option should only be considered when natural or mechanical ventilation cannot meet the requirements. The regulations should be considered using these technologies together where Heat Recovery is used and the ability to cool, heat and ventilate depending on the ambient conditions – ie – what time of year. The requirement should consider a balanced approach and to look at all these options together. Heat Pumps can pre-heat or pre-cool incoming fresh air and load adjusted depending on the temperature of the incoming air and the internal requirement. In periods of high temperatures where the home needs to be cooled then this excess energy could be used to heat hot water for sanatory requirements- for example. These sorts of integrated solutions should be positively favoured within the building regulations.

The role of reversible heat pumps in meeting future cooling demands *and* decarbonisation targets

Both Air-to-air and air-to-water reversible heat pumps provide a flexible renewable energy solution which can:

- Provide both heating and cooling in a single system enabling the occupier(s) to achieve comfortable internal conditions whatever the outside temperature.
- Works in a complementary way with well insulated homes
- Deliver energy efficiency savings of 3-4 x compared with a gas boiler
- Deliver carbon savings of over a gas boiler
- Can be applied to residential houses, apartments and commercial buildings

Reversible Air to Air Heat Pump provide Cooling or Heating of the Air in a property through convection. Units similar to radiators can be used or wall units or even units that can be built into the fabric of the property with the Air being distributed through a grill.

Reversible Air to Water Heat Pumps provide sanatory Hot water all year round however they all provide space Heating or Cooling depending non the season and external conditions. This means that Underfloor Heating becomes underfloor cooling and Heat Pump convectors [which are similar to radiators] can either Heat or Cool the room. Some additional installation considerations need to be made compared with a standard Heating only Heat Pump however these are quite straight forward.

The UK Government has set an ambition for 600,000 heat pumps/year to be installed from 2028. In response to this, the heat pump sector has invested in innovation, upskilling the workforce needed to install them and increasing production capacity. The supply-chain is gearing up to provide heat pumps at a mass scale to meet heating and hot water demands, and with additional policy changes (see section: Action for Government), these renewable technologies can be used to provide comfort cooling.

When sized correctly, heat pumps enable compliance with the Building Regulations overheating requirements (Part-O) in those cases where natural or mechanical ventilation cannot meet these requirements, as well as provide high levels of energy-efficiency.

Air-to-air heat pumps can play a significant role in reducing gas consumption for the UK. Consider this example:

Scenario:	Working from home during the winter in a 3-bed home	
Requirement:	To feel warm in the home-office	
Gas Central Heating	**Vs.**	**Air-to-air heat pump**
The boiler is fired on circulating heat around the whole home, operating at an **average efficiency of 80%**		Can provide heat to a single room achieving an **average efficiency of 600%*.** In addition, the system can work in reverse during warmer weather to provide cooling to a single room.

**The efficiency of these systems at ~600%+ are higher than a Air to Water Heat Pump [typically 300-400% efficiency] do to the fact that the systems are designed solely for Heating. Air to water Heat Pumps have to carry out the dual function of heating sanatory Hot water as well as space Heating.*

It is important to consider the application and combination of heat pumps and other technologies in different housing types. For example, for apartment buildings a combination of air-to-air heat pump and a hot water cylinder can provide the central heating/cooling and hot water.

On air conditioning specifically, the Committee cites a rising demand for air conditioning in coming years both in the UK and globally as a "vicious cycle", whereby "more ACs lead to higher energy consumption, leading to higher CO2 emissions", causing further rises in temperature.

If solutions are considered as a complete Heating, ventilation and Hot water solution rather than just a 'knee jerk' response to over heating then we will avoid a vicious circle. Many house holds purchase Air Conditioning in these circumstances when they already have a gas Boiler. This does not make sense ; they need to reflect that the 'Air conditioning' unit is in fact a reversible Air to Air Heat Pump and can also Heat in the winter. If this was considered as part of a complete decarbonisation strategy then a home owner would remove their Boiler. Install Air to Air to Heating or Cooling in the rooms where over heating is an issue then supplement this with a Air to Water Heat Pump [or a reduced capacity] for the Hot water and any other spaces where Heating only would be required. In these instances the Heat Pump would be much smaller than if one Heat Pump was selected for the complete residence AND the home owner would overcome their immediate over heating requirements. Motivating a home owner to make these holistic decisions through incentives or market mechanisms would lead to faster decarbonisation in the short and medium term.

The load on the grid for these 2 x units would also be lower as they would often be working in a complementary manner rather than together at maximum current draw.

Optimising a reduction in UK GHG emissions: the interplay between refrigerants and energy efficiency

"How can cleaner refrigerants with low or zero global warming potential support the UK's cooling needs while contributing to the national emission reduction targets?

The first thing to say here is that, if the refrigerant gas stays within the system, there is no impact on the environment. It is only where there is leakage that it has an impact. It is therefore crucial that we understand the root-cause of refrigerant leakage and that, across the sector, we put measures in

place to mitigate leakage. This requires particular action from manufacturers, installers, service engineers and those who decommission and dispose of the equipment.

When looking at how to reduce the emissions associated with cooling equipment that uses refrigerants, it is important to consider both the Global Warming Potential (GWP) *and* the thermal conductivity of the refrigerant. The thermal conductivity is a measure of its ability to conduct heat, and is measured in Watts per meter Kelvin or W/(m.K). It is an important characteristic that can reduce the quantity of refrigerant required, and allow more compact equipment design.

The current refrigerants solutions with a low GWP are generally less thermally efficient and therefore use more energy. A "low" GWP refrigerant can be up to 15-20% less energy efficient than one with a higher GWP. See table 1 below.

Refrigerant code	Atmospheric lifetime (years)	Global Warming Potential (GWP)	Safety Group	Thermal conductivity of liquid @ 25C [W/(m.K)] – (the higher the better)
R-32	4	677	A2L	0.135
R-290	13 days	3.3	A3	0.094
R-410A	17	2,088	A1	0.098
R-454C	-	148	A2L	0.0756
R-744	29,300-36,100	1	A1	0.0168

Table 1: safety and environmental characteristics of refrigerants

Other environmental considerations include the impact of the refrigerant production process and a refrigerant's potential to be recycled and reused.

A whole-product and lifecycle approach

At Daikin, we assess four key factors to decide on the 'best' refrigerant choice for the different applications: safety, environmental impact, energy efficiency and cost-effectiveness.

A refrigerant must be safe to use through the entire lifecycle of the equipment. This includes transport, storage, installation, use, servicing, recovery and recycling. This means that possible hazards such as toxicity or flammability characteristics, as well as the risk of human error, must be evaluated for each type of application. While non-flammable and low-toxicity refrigerants may have safety benefits, they may not be ideal from an environmental point of view. In addition, some refrigerants may be acceptably safe for one type of equipment but not sufficiently safe for others. Thorough risk assessments are therefore needed for each application.

To reduce the environmental impact of a refrigerant throughout its lifecycle, we also evaluate the impact of the refrigeration production process and a refrigerants potential to be recycled and reused.

The future of clean refrigerants

Daikin has identified R-32 as a very beneficial refrigerant for some of our air conditioning and heat pump products.

We believe that the transition to R-32 will help to meet both the HFC phase down schedule and the HCFC phase out schedule. We are now in the process of evaluating and identifying suitable refrigerants for other applications. As soon as the most balanced and feasible solution for an application is found, Daikin will commercialize and disseminate the technology to contribute to the efforts to mitigate global climate change.

R32 is an interesting refrigerant as it is low cost , readily available globally, has a relative low GWP, and is a single component chemical. This single component aspect is important as it means it is easy to reclaim and recycle so it can be used over and over again. So at the end of a systems 15 years life the refrigerant can be recovered , cleaned and used in a new system- there is no degradation. This continuing the drive for other refrigerants has significant risks as we will need to ultimately destroy the current refrigerants which can only be achieved through burning – with the associated carbon release.

Incorrect installation of heat Pumps poses a major risk to the achievement of carbon reduction and internal comfort

In the previous paragraph we highlighted that minimising leakage of refrigerant gases is crucial. We know from our own data and training centres that the vast majority of leakages are as a result of the heat pump being installed incorrectly. Incorrect installation also shortens the lifespan of the system, increases the running costs and reduces efficiency.

The domestic heating engineer sector is predominantly made up of people who have previously been installing gas boilers and are moving into heat pumps. The skills and knowledge needed to correctly install a heat pump is very different to those required for gas boilers. The skills are not transferrable and it requires a fundamental re-train. This means that awareness of what they installers are dealing with and correct Training in the installation, commissioning , service and maintenance is critical for the successful growth of Heat Pumps.

Actions for Government

We strongly urge the government to engage with us, and other parts of the heating and cooling sector who understand the technology and its environmental impact in-depth to ensure the feasibility and applicability of any future policy and plans. The environmental impact of cooling equipment using refrigerant is multi-dimensional. Moving towards a low GWP has knock-on effects on energy efficiency and if the transition is not done properly, the problem effectively moves up the chain.

The German government bought in new rules in January of this year which grant rebates of up to 40% to help homeowners to buy and install heat pumps. The current BUS grant of £5000 does not go far enough to encourage mass conversion, strong measures are required.

With the efficiency different between Gas Boiler and Heat Pumps [~90% vs 300-400%] and the gas to electricity price [spark gap] has to be <3.9 x for there to be a saving for the home owner and a consequent return on investment. The difference has to be < 3 x in reality to work for all conditions and Heat Pump capacities where as currently this is at ~4 x. Market mechanisms to reduce the gap would need to be consider at the same time as the incentive grant otherwise the motivation to change will be considerable less.

To support this change Air-to-air heat pumps need to be recognised and incorporated within the SAP calculation which is used to demonstrate compliance with Part L of the Building Regulations. This would allow them to be used as a solution for new-build homes.

Air to water Heat Pumps also need to have a greater impact within the SAP methodology as currently they have little impact relative to other measures that can take place such as insulation.

Definitions

Air-to-air heat pump	Transfers heat from the air outside to the air inside or, for cooling, it extracts heat from the inside and removes to outside the building.
Air-to-water heat pump	Takes heat from the outside air and transfers it to a wet central heating system, usually through radiators or underfloor heating.

1 Heat and Health (who.int)

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