

+++ Heating and Cooling

++ The warm box model

First it is worth noting that the current model of comfort in buildings is that the internal spaces should be kept at a temperatures of around 20 degrees:

For example, the ideal temperature of a living room should be around 20 to 22 degrees. This is a room for relaxing in, and where you sit for long periods of time, meaning it should be on the warmer side. Meanwhile, the best temperature for a bathroom or child's bedroom should be warmer too at 22 to 24 degrees.

The ideal room temperature of a kitchen is between 18 and 20 degrees due to the fluctuation in heat and humidity, and this is also the best temperature for a bedroom for optimum sleep.

What is the ideal room temperature?

This could be called the warm box model: Rooms are kept at uniform fixed temperatures to keep the people in them comfortable. The warm box model keeps people, who occupy a cubic metre or two in comfort in houses that have, say, 250 cubic metres of interior space, so different to sitting near an blazing fire, as I did in my childhood, with burning hot legs and a freezing back.

++ Modern inglenooks and warming furniture

Another approach is to have spaces where temperatures are warmer (or colder) than the main 'box' - modern versions of old fashioned inglenooks - heating or cooling people-sized spaces. It is also what some poorer people do now. For example ...

One person might come in from work to their flat on a cold day, put the kettle on and sit in an armchair in front of the television. She does not turn on the 26 Kw gas central heating, which has an "energy-saving" gas condensing boiler, newly installed by her housing association because this takes an hour or so to heat the flat. Instead she switches on a 600 watt electric halogen heater, which is pointing at the armchair. When she has warmed up a bit, she goes to the colder kitchen to make a cup of tea and get something to eat and goes back to the warm armchair.

Other people might live in caravans using bottled gas for heating. The heated main room in a caravan may be one tenth of the volume of a typical house and have a quarter of the surface area. If the caravan (or park home) were insulated to a decent standard, heating load could be a quarter of that of the house and have a much faster heating response: turn on the heat for almost instant warmth. The caravan dwellers may also be lucky and have windows that look out onto pleasant green wooded surroundings. As one caravan dweller put it:

"There's nothing more life affirming than waking up surrounded by nature- woods, birds, the occasional deer and falling to sleep to the sound of hooting owls. The space and the fresh air put a bounce in your step!"

The carbon emissions for keeping flat, pub and caravan dweller warm are a small fraction of that necessary to heat a dwelling to the “fuel poverty” level.

These examples are not typical. They do not have children living with them and one could afford to stay in the pub for the evening – trying to drink slowly, of course. However three messages shout out. First, people find ways to keep warm by creating micro-climates in their homes (e.g. halogen heater and armchair). Second, the slightly more affluent can enjoy the communal warmth of the pub. Third, living in a small space can be economically warm and need not feel horrible and cramped.

And importantly they all have small carbon footprints.

Modern inglenooks and warming furniture

Warming furniture causes variations in temperature and getting up from a warm armchair into cooler air can be a pleasant experience.

++ Heating and cooling with air source heat pumps

Heat pumps - using electricity from renewable sources - seems to be the preferred option for heating houses in cool weather - and even cooling them in weather that is too hot. See [How to Cool Your Space with a Heat Pump](#). However, Homebuilding and Renovation says Britain is lagging behind in heat pump installation:

[D]ue to a shortage of skilled engineers with only 3,000 trained heat pump engineers available in the UK, households that can afford to implement a heat pump may be placed onto a waiting list, with Octopus Energy claiming to have a waiting list of about 50,000 households interested in having air source heat pump installation.

Why is Britain lagging behind in its heat pump uptake while the rest of the world steams ahead?

BRE Ltd have done polling to assess UK public attitudes to heat pumps:

Three-quarters (76%) of owner occupiers we polled in October 2022 said they would consider installing a heat pump if running costs were the same as a gas boiler. Half of households would install it if the purchase cost were the same as a new gas boiler; a quarter of households would consider installing it even if purchase costs were higher. [Changing the way we heat our homes to meet net zero: putting households at the centre.](#)

BRE has also called on the UK Government to do more on heat pumps:

BRE is calling on the Government to do more including extending its campaign to include information on heat pumps specifically. Improving public understanding of how low carbon heating technologies work will go a long way

towards increasing consumer take-up and helping people make the transition to clean energy.

BRE calls on UK government to improve the energy efficiency of Britain's homes.

More from BRE Group:

The UK has one of the oldest and least energy efficient building stocks in Europe, and some 88% of homes are still heated by natural gas. Changing the way we use energy in our buildings, particularly decarbonising heating, is an essential part of the UK's transition to a secure, sustainable energy system.

[Decarbonising heat in Britain's buildings](#), Dec 2022

++ Hydrogen

Hydrogen is another possibility, which is being seriously investigated. It has some advantages for the replacement of gas boilers. At present much hydrogen is produced using methane and is not a low carbon source. Low carbon hydrogen produced by electrolysis of water is intensive in its use of electricity.

Even if the hydrogen is produced from low carbon sources, when it is burnt it may produce high levels of Nitrogen Oxides, which are damaging to health:

In a letter to the leading scientific journal Nature, professor Ally Lewis, chair of the DEFRA's Air Quality Expert Group and a director of the National Centre for Atmospheric Science, while acknowledging hydrogen's promise "as a clean, low carbon fuel", warned that it would be "mostly burnt in engines and boilers rather than being used in fuel cells. The burning of hydrogen generates toxic nitrogen oxides (NOx) as well as steam. This pollution could disproportionately impact the urban poor."

Scientist warns of NOx urban pollution from hydrogen boilers

The burning of hydrogen with its polluting side effects can be avoided by oxidation in a fuel cell. This produces electricity as well as heat:

Essentially, hydrogen fuel cells use hydrogens natural gravitation toward oxygen to generate an electrical differential. When the hydrogen comes in to contact with oxygen it also generates heat and water as a byproduct.

A hydrogen Fuel cell Boiler is a home unit that utilizes this waste heat for hot water and heating, while also generating electricity for the home.

(Japan now has 300,000 fuel cell appliances in homes producing hot water and electricity and the demand is increasing by the day.)

[Hydrogen Fuel Cell Boiler in your home! The Vitovalor 300-P](#)

Unfortunately, the best hydrogen fuel cell boiler currently uses methane as a source of hydrogen and extra heating capacity but shows an interesting possibility for future research.

++ Ground source heat pumps

The ground below our feet has very large heat capacity and (undisturbed) has a constant temperature. Ground source heat pumps can extract this heat:

At depths of 2m and more, the ground temperature does not deviate very much from the average summer/winter surface temperatures (around 8° to 12°C in the UK depending on location). At this depth, there is an enormous store of heat that can be usefully tapped for heating in the winter.

Ground source heat pumps

Ground source heat pumps need a reasonably sized garden to lay pipes (filled with water and anti-freeze) that transfer the heat that the heat pump extracts from the ground.

++ Further research

BREgroup does building research. It was formed by a privatisation of the Building Research Establishment in 1997. It is now a "purpose-for-profit" organisation:

BRE is a profit-for-purpose organisation. Any profits from BRE's work go to the BRE Trust, which invests in research projects for the public benefit, or are invested in upgrading our research facilities at the BRE Science Park.

[About us, BRE Group website](#)

BRE's income comes from client fees, commissions & etc

BRE is funded with income from commissioned research, commercial programmes and by a number of digital tools for use in the construction sector.

[Building Research Establishment, Wikipedia](#)

Some, including myself, consider this makes BRE too close to commercial interests. For example, when developers ask for a rating with the BRE's environmental accreditation scheme, BREEAM, the fees become part of BRE's income.

The assessment of embodied carbon in building was one example of my concerns. In 2008, I raised concerns about embodied carbon in new buildings with York Council. I also contacted BRE and received a reply including:

BREEAM does not put an absolute value on the embodied carbon, it's true.

Partly because the science behind the process is still open to debate.

[Email from BRE Group, 2008](#)

I had been concerned with the lack of attention given to the greenhouse gases created by building construction for several years before that and wondered if BRE's tardiness was influenced by considerations of the interest of clients. Embodied carbon costs the developer and clients nothing - use of concrete and steel in buildings is not penalised for the greenhouse gases they cause but the creation of greenhouse gases when buildings are in use are accompanied by gas

or electricity bills.