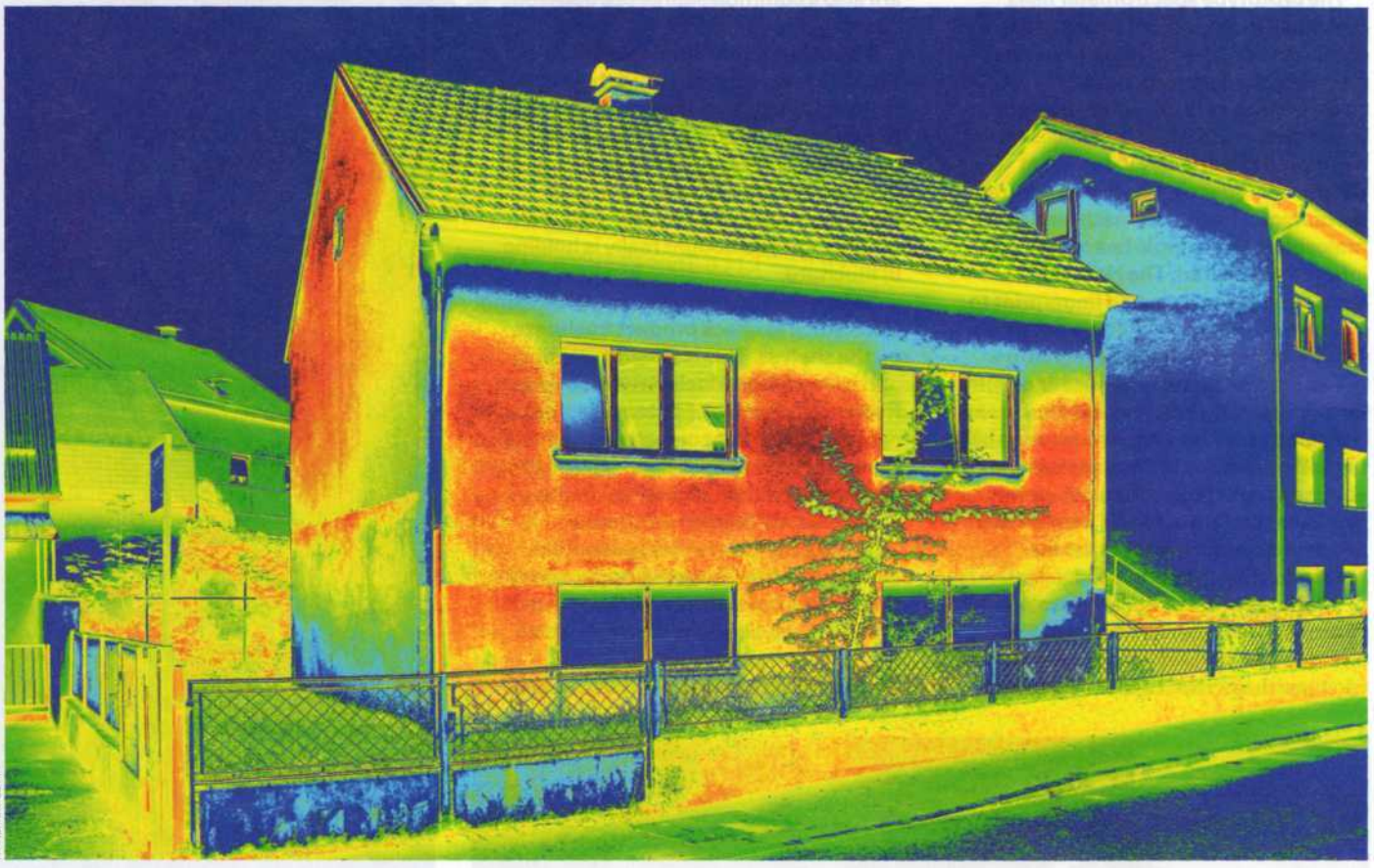

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Global cooling starts at home

Household heating systems are huge sources of carbon emissions – but we have the technologies to fix the problem, says **Michael Le Page**

WINTER is coming to the north. If you live in those climes, chances are you have already switched on your heating. Chances are, too, that your heating burns fossil fuels. If the world is to meet its climate goal of zero net carbon emissions by mid-century, that needs to change – and change fast. "We are two boiler replacements away from 2050," says researcher Lukas Bergmann of consultancy firm Delta Energy & Environment.

It is a huge challenge. In the UK, for example, 85 per cent of homes use natural gas for heating, and a third of the country's total greenhouse gas emissions are from heating. Across the world, hundreds of millions of homes, offices and factories will need major, often expensive, upgrades.

Many countries have only just begun to notice the problem. "It's a huge consumer issue," says Richard Lowes at the University of Exeter in the UK. "Yet if you asked the average person in the street about this, they would have no idea what you are talking about."

The good news is that heating can be greened with existing technology. But can it be greened fast enough?

While coal and oil are the worst offenders as heating fuels, even natural gas must go. To help meet the Paris target of limiting warming to well below 2°C, the use of natural gas must be entirely ditched across the European Union by around 2035, according to a study last year co-written by Kevin Anderson of the Tyndall Centre for Climate Change Research in the UK. "An urgent programme to phase out existing natural gas and other fossil fuel use across the EU is imperative," he says.

"The technology exists to green heating. The question is whether it can be greened fast enough"

The broad outline of the fix for heating is clear: heat pumps powered by clean electricity in rural and suburban areas, and district heating systems in more densely populated locations.

Heat pumps can produce up to five times as much heat energy as they consume in electrical energy. There is nothing magical about this: they use electricity to suck heat from the air, water or ground near a building, just as your fridge extracts the heat from its interior. Even in countries where most electricity is generated using fossil fuels, replacing a gas boiler with a heat pump will reduce

Thermal imaging shows where bad insulation hikes carbon emissions

carbon dioxide emissions.

District heating networks, which deliver heat to buildings as hot water or steam, already exist in many cities, from New York to Tokyo. In several European countries, including Denmark and Poland, they already warm more than half of all homes.

These networks can be converted to use clean sources of energy that are impractical for single homes, such as geothermal energy or waste heat from sewage, without householders having to do anything. The Bunhill project, a district heating network that already serves more than 700 homes in north London, will soon supply heat extracted from air coming from the London Underground.

"Putting a price on carbon that reflects its true cost would make green heating options more appealing"

Sweden shows what can be done to cut emissions. District heating networks using low-carbon energy sources are now common in its cities, and more than half of detached houses have a heat pump. Emissions from heating Swedish buildings have fallen by around 90 per cent since 1990.

It may be harder to achieve such change in other countries. In the UK, most houses leak lots of heat. Because electricity costs more than gas, if a heat pump replaces a gas boiler in a badly insulated house, energy bills can go up instead of down, upsetting householders.

Heat pumps are also not a straight swap for existing boilers. They warm water to temperatures around 20°C lower, meaning radiators may need to be bigger to keep houses warm, and storage tanks larger to supply enough hot water for showers and baths. On the plus side, though, heat pumps can cool your house in summer.

Then there is the question of where the low-carbon electricity to power the heat pumps will come from on cold, windless winter days. Sweden already generates most of the electricity it needs from dependable nuclear and hydropower. But for nations like the UK, where the peak demand for heat energy in the winter is already six times higher than the peak demand for electricity, this is a huge issue (see graph, below).

Two solutions have been proposed for cutting electricity use. One is to retrofit homes – for instance, with insulation – to make them zero emission for heating and cooling. That is costly. The other is to keep heating with gas, but make it lower carbon.

The simplest way to do this would be to generate methane from sources such as sewage. However, even using all available waste and all available crops to make biomethane would only meet a fraction of the demand – perhaps 5 per cent in the UK, according to an analysis by the Anaerobic Digestion and Bioresources Association.

Do what works

An alternative proposed by gas companies is to replace natural gas with hydrogen. It produces only water when burned, so it is zero carbon. In principle, huge quantities could be made by using electricity to split water, or by converting natural gas to hydrogen, and capturing and storing the resulting carbon.

But both processes waste a lot of energy, and neither has ever been done on anything like the scale required. Nor do we have electricity to spare, at least for now. Unlike with biomethane, switching to hydrogen would also require upgrades to gas networks and the replacement of home appliances.

According to a 2018 study for the UK's Committee on Climate Change, this wouldn't be much more expensive than installing heat pumps. But Lowes is sceptical. "No one else in the world is going down the hydrogen route," he says. "I don't think it will ever happen."

The best way forward may be to try everything and see what works: installing more heat pumps and district heating networks where that makes sense, insulating houses to cut energy demand and carrying out small-scale trials of hydrogen. Hybrid approaches, such as heat pumps that are powered by gas only on the coldest days, could take us a long way.

Putting a price on carbon that reflects its true cost would help raise money to support all these measures and make green options more appealing to consumers. In Sweden, adoption of heat pumps soared after a carbon tax was introduced in the 1990s.

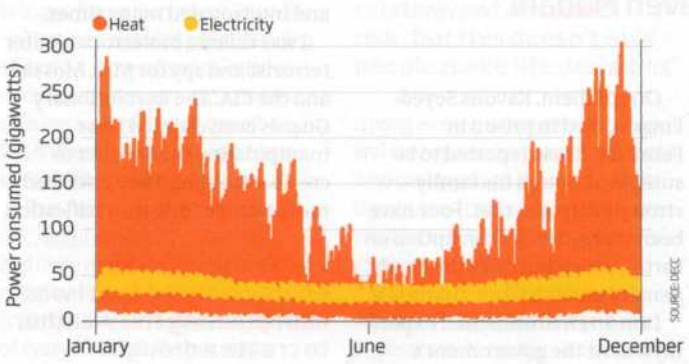
Other countries are now getting serious. In the Netherlands, new homes can't be connected to the gas network, and there is discussion about requiring all householders to replace old gas boilers with heat pumps.

But the policies of most governments around the world are woefully inadequate given the scale and urgency of the task. Take California, which recently declared that it intends to go carbon neutral by 2045. "To achieve California's... goals, high-efficiency electric heat pumps need to become mainstream by 2030," states an October report by the environmental group NRDC. That gives the state little more than a decade to make the technology affordable and accessible to all.

The UK, meanwhile, is going backwards, cutting measures such as a requirement for all new buildings to be zero carbon. Meanwhile, it is still connecting more houses to the gas grid, and greenhouse emissions from heating have actually risen over the past two years, says Lowes.

Now the heat is on to make a change. "Every day [we delay] it gets more difficult, but it's still not impossible," says Lowes. ■

In the UK, peak winter demand for heat far exceeds that for electricity



EUROPE'S DIRTY SECRET

What is the biggest source of "clean" energy for renewable heating in Europe? The surprising answer is wood.

To reduce greenhouse emissions from heating, Europe has been going all out for wood. But burning it produces lots of harmful air pollution. And although burning genuine waste wood instead of leaving it to rot does reduce greenhouse emissions, cutting down forests that would otherwise grow and absorb carbon can be worse than burning coal. What's more, high demand for wood is driving deforestation around the world.

Forest campaigners say that burning wood on a massive scale is catastrophic for the environment, and are urging a rethink.