UNITED KINGDOM:
Expect a period of policy stagnation

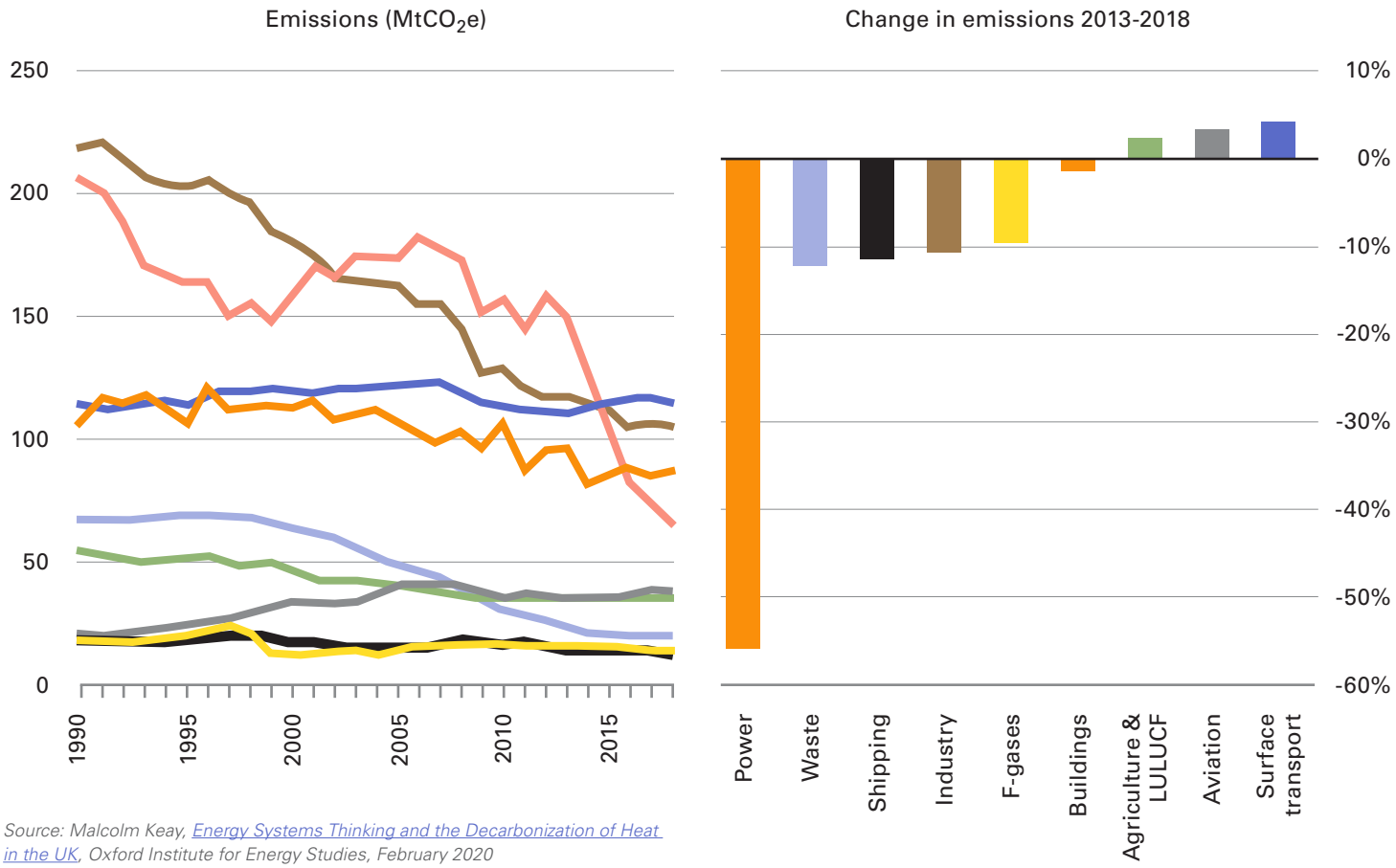
Now that the UK government has declared a zero-carbon emission target for 2050, "blue" hydrogen, based on natural gas with carbon capture, has become less attractive as an option for the decarbonisation of domestic heating, writes researcher Malcolm Keay of the Oxford Institute for Energy Studies. But it is unclear which alternatives the UK will pursue in the building sector.

Just as in other countries, such as Germany and the US, it's turning out to be much more difficult to reduce CO_2emissions in the built environment than in the power sector in the UK. In the period 2013-2018, the emissions from buildings barely changed, writes Malcolm Keay in a research paper, Energy Systems Thinking and the Decarbonization of Heat in the UK, published by Oxford Institute for Energy Studies (OIES) in February:

w could the UK government tackle this challenge? In an earlier paper, from 2018, Keay argued that "the main favoured solution" was "to introduce hydrogen for heating to replace natural gas". And "the cheapest way of generating hydrogen (and the main source worldwide today) is via the steam reforming of methane." So, if combined with CCS, "this could in principle reduce emissions of CO_2 to what were then seen as acceptable levels." In other words, "blue" hydrogen looked like a great solution back in 2018.

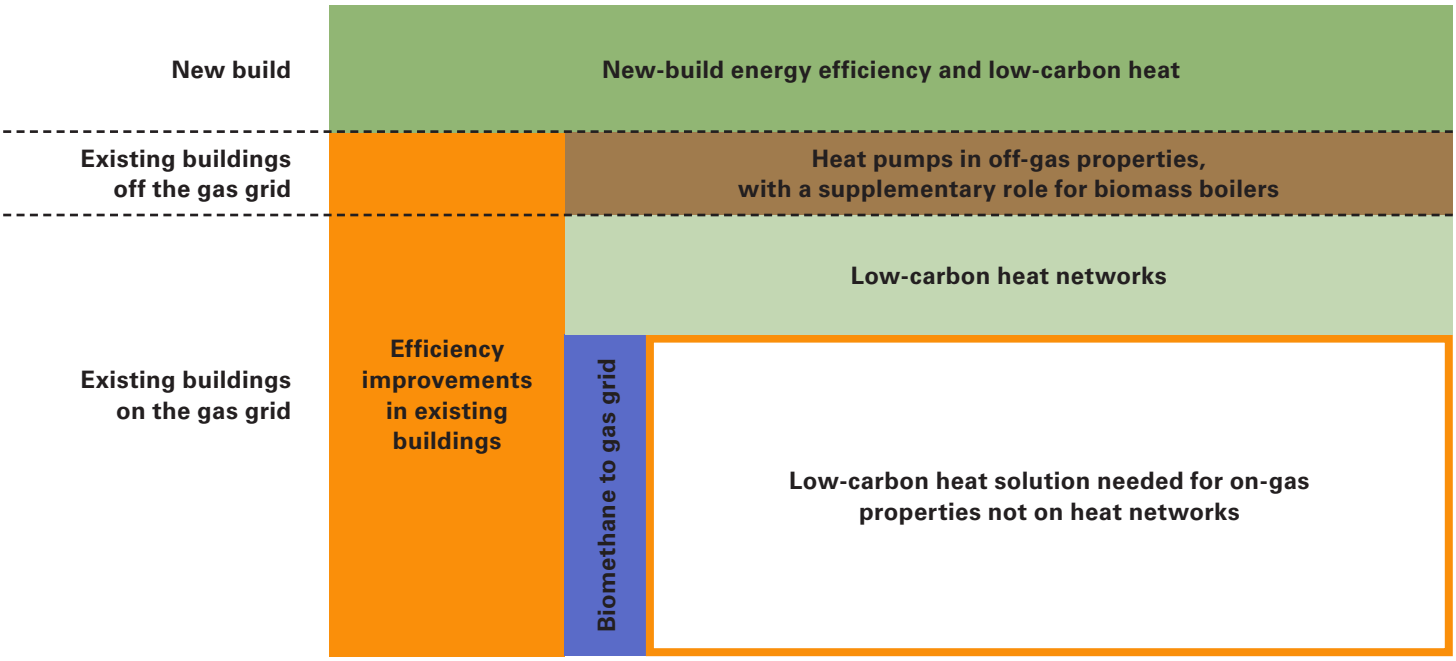
However, notes Keay, in 2018, the UK had a target to reduce emissions only by 80% in 2050. Since then, however, "a new goal has emerged, of reaching net zero carbon emissions by 2050". This new target was adopted by the government in June 2019. Since hydrogen made with natural gas and combined with CCS ("blue hydrogen") "only removes up to 90 per

FIGURE 1 – Trends in sector emissions in the UK



Source: Malcolm Keay, Energy Systems Thinking and the Decarbonization of Heat in the UK, Oxford Institute for Energy Studies, February 2020

FIGURE 2 – Mix of emission reduction solutions



Notes: The sizes of the blocks broadly reflect the scale of emissions reduction, but do not do so precisely. Some potential for heat networks will be in new-build and off the gas grid, rather than all on-grid as presented. Biomass for heat may also play a role in hard-to-insulate rural properties.

Source: Malcolm Keay, Energy Systems Thinking and the Decarbonization of Heat in the UK, Oxford Institute for Energy Studies, February 2020

cent of the CO_2", this is not an adequate solution anymore, according to Keay.

As a result, "thinking has moved on to the consideration of alternative approaches," although "the overall strategy [of the UK government] remains unclear". What does seem clear, he adds, is that "a mix of solutions will be needed, with different approaches for buildings on the gas grid and for off-grid buildings, and a range of different measures including greater energy efficiency, low-carbon heat networks, and the use of heat pumps."

However, "on most analyses, this still leaves a large residual gap to be filled – for properties on the gas grid but not on heat networks," as shown in *Figure 2*.

The key problem, writes Keay, is that "gas demand for heating is much more variable and much peakier than electricity demand. Various different estimates of the difference have been made, but the consensus is that peak heat demand is at least twice as high as current electricity demand. Meeting these peaks via electricity, even in the form of heat pumps, would be very expensive and require a huge increase in generating capacity (at a time when there are already significant problems in matching peak demand and generation because of the growth of intermittent generation capacity)."

Hence, the solution currently favoured is "the so-called 'hybrid' heat pump model. This would rely on heat pumps for the bulk of heat supply while peak heating demand would be met by an additional boost from a boiler (using hydrogen produced from the steam reforming of methane, or from electrolysis), along with a small amount of resistive heating."

According to Keay, in such a hybrid system, the boiler would have to be used only about 10% of the time. The hybrid approach "requires considerable investment, of course, but it could still be cheaper than an electricity-only solution, principally because the need for investment in electricity capacity would be lower."

What is more, notes Keay, "the hybrid approach to heating offers even greater benefits if the strategy evolves at an energy system level and is combined with a move to electric vehicles. In effect, it creates two major new areas of potentially flexible electricity demand – with appropriate pricing and other incentives, neither transport nor heating need add significantly to overall peak demand or increase electricity prices. Overall the systems approach should reduce overall costs, and could actually bring down the price of electricity."

Thus, there does seem to a way forward: a large degree of electrification, hydrogen to meet peak

demand, and battery EVs to help balance the system. Nevertheless, Keay is far from optimistic that the UK will manage to adopt coherent policy that will lead to this outcome. He notes that there are a number of obstacles:

- *Uncertainty* – "Many options are still potentially in play and for most or all of them the large-scale deployment needed would not only take considerable investment and disruption, but would need to be preceded by expensive pilot projects to assess the practicability of the favoured options. For a Government reluctant to 'pick winners' in a situation where there is no clear front runner, it is difficult to find a way through such a complex and expensive process." (…)
- *Price sensitivity* – "The heating sector is much more sensitive in political terms than transport and electricity … Furthermore, and to a large extent because those sectors already have a significant fiscal and environmental burden incorporated in their prices, the price impacts of decarbonization on the heating sector could be politically unmanageable without significant social measures of one sort or another (subsidies and/or cross-subsidies) to ease through the process." (…)
- *Lock-in and consumers* – "The existing 'socio-technical regime' in heating displays a high degree of 'lock-in' – people are used to their gas boilers and there would have to be radical advantages in any alternative heating source to make them change." (…)
- *Network effects* – "It would be extremely difficult to present individual consumers with a direct choice between natural gas and hydrogen. The gas network can accommodate only a certain proportion of hydrogen without change, and there is no prospect of competing networks for hydrogen and methane in particular areas. Hydrogen, if it were the government's chosen option, would probably have to be introduced as a matter of central decision-making rather than consumer choice, and the process of changeover would need to be planned and centrally managed, with appropriate subsidies or cross-subsidies to ensure equity between different consumers." (…)
- *Ideological obstacles* – "The result of the factors set out above is simply to increase uncertainty. Governments are not in a position to pick a technological winner, even if they wanted to do so; but promoting a consumer-driven outcome by the appropriate pricing of energy and the incorporation of environmental externalities is both politically unpalatable to the highest degree and unlikely in any event to produce the desired outcome, because of 'lock-in', network effects, and so on. As the apparent task, and the need for a more integrated systems approach, becomes more urgent and more complex, so the capacity of government for dealing with it declines." (…)
- *Coordination and the need to develop business models* – "One of the key problems … is the need to coordinate the activities of the various different parties involved and create business models for each element in the picture. The problems are further compounded when, as described above, a systems approach is required which would coordinate the activities of different energy sources." (…)

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>
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The "likely outcome", according to Keay, is "a period of policy stagnation, as the Government looks at a range of equally unattractive options for the heating sector and shrinks from deciding between them."

Keay ends by offering some suggestions that may help to solve the problem, namely:

- A carbon intensity target
- Local energy plans
- Cluster-based development – e.g. as in industrial clusters
- Attention to social needs
- Support for R&D
- A national policy framework
- A new institutional architecture

Not exactly simple solutions, as Keay well realizes. They "would lead to the need for a fundamental shift in the policy paradigm."