

C|B|I



Net-zero

The Road to Low-Carbon Heat

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Infrastructure and Energy

In partnership with



UNIVERSITY OF
BIRMINGHAM



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The Commission

The CBI and University of Birmingham have created a joint commission on the challenges of decarbonising heat. Heat is the largest source of carbon emissions in the UK, accounting for over a third, and there is currently no clear plan from the government on how to tackle this. In order for the UK to meet its climate commitments, we need to accelerate action on decarbonising heat in buildings and industrial processes. Following the legislation of a net-zero emissions target, we need credible plans to deliver deep decarbonisation across the sector if we are to achieve this ultimate goal.

In the following report, the Heat Policy Commission makes thirteen recommendations on key interventions which will help move the sector more rapidly towards adoption of low-carbon technologies. The launch of the report is timed to help inform policy decisions that we expect to be made by the government on heat and buildings towards the end of the 2020s.

Commission members

Lord Bilimoria, CBI (Chair)

Tom Thackray, CBI

James Diggle, CBI

Abdul Kamara, CBI

Professor Martin Freer, University of Birmingham

Dr David Boardman, University of Birmingham

Dr Johnathan Radcliffe, University of Birmingham

Malcolm Arthur, National Grid

Simon Virley, KPMG

Stuart Easterbrook / Emily Wilson-Gavin, Cadent

Nick Winser, Energy Systems Catapult

Charlotte Owen, Association for Decentralised Energy

Jianzhong Wu, UK Energy Research Centre



Foreword

Decarbonising the UK's heating system is the greatest challenge the UK faces in meeting its net-zero 2050 target. This report outlines the sheer scale of this task, what the challenge means for consumers and communities and, importantly, the possible opportunities that could arise from successfully transitioning to low-carbon heat.

There is not a one size fits all solution. However, the UK public has a variety of approaches currently available to them that can be delivered by UK based businesses delivering new skills and jobs. Solutions include heat pumps, hydrogen fuelled boilers or even district heating. All exist and are ready to be deployed. However, in each and every case there is a significant scaling up of production required.

This transition will undoubtedly be disruptive to consumers and businesses, with many of those who are connected to the natural gas grid needing to install alternative low-carbon heating. The government, working with business will need to ensure that consumers are equipped with the right information to make informed decisions on the most appropriate low-carbon heating solution based on the region they are from and the type of building in which they reside. This local decision making linked with an overarching national plan to deliver the supporting infrastructure, will be vital if any decarbonisation of heat programme is to be successful.

Business will need clear signals from government, with guaranteed long-term commitments through supportive market interventions and infrastructure developments to help make the necessary investment in reskilling the workforce and manufacturing capacity in order to deliver the heating solutions that will be needed. The benefits of a successful programme are obvious, it will deliver decarbonisation, a new industrial sector, new services and new skills. Businesses themselves will operate in more energy efficient buildings through improvements in insulation, lighting and general energy management. Opportunities for further innovation in hydrogen production and the great exporting potential of existing low-carbon energy expertise, is a significant opportunity for UK businesses and UK Plc.

However, for these challenges to be overcome, the government has a pivotal role to play in setting the direction and the policy environment, working in collaboration with business and the investment community. This requires political courage and vision, but above all a level of national coordination which can only be achieved through a National Delivery Body for heat.

The CBI and University of Birmingham created a Heat Commission, with industry leaders, to assist the government in shaping the policy framework and to raise the awareness of businesses of the benefits of and need for decarbonising heat. As the government continues on the road to net-zero, a plan on successfully decarbonising heat should be at its heart.



A handwritten signature in black ink, reading "Karan".

Lord Karan Bilimoria of Chelsea
President, CBI



A handwritten signature in black ink, reading "M Freer".

Professor Martin Freer BSc, PhD, FInstP
Director, Birmingham Energy Institute

Executive summary

This report from the CBI and University of Birmingham joint commission, outlines the challenges and opportunities of decarbonising the heat in our homes and buildings around the UK. Decarbonising heat is one of the most significant challenges in reaching net-zero emissions by 2050, so it is vital business, government, regulators and communities work together to shape the policies and delivery mechanisms that will be needed.

Heat is the UK's largest source of carbon emissions, and predominantly delivered through the burning of natural gas. This is done at millions of locations around the country, from the boilers into people's homes to larger commercial buildings and industrial processes. Low-carbon alternatives will need to be delivered if we are to achieve net-zero emissions.

A national programme is required that must be able to be delivered locally, accounting for the diverse mix of technology choices that will be available to households and businesses. It will also need coordination with other sectoral net-zero challenges, including ongoing decarbonisation of our power supplies, and the future of low-carbon transport and heavy industry. Locality will be key, as some heating solutions will be best suited to certain areas where there is a system interaction with another sector, such as hydrogen production, carbon capture, transport hubs and industrial processes. The answer for one community might not always be the best for another.

The skills and supply chain requirements are also significant, and government will need to work with businesses and training providers to ensure that we have the industrial and installation capacities to undertake this major infrastructure project. At a time of significant uncertainty about the health of the economy and availability of jobs, there is an even greater need to plan for and deliver these skills and employment opportunities in a way that provides opportunities throughout the country.

The biggest challenge is likely to be the coordinated behavioural change and purchasing decisions of millions of householders as we implement new forms of heating. Building on the success of reducing the carbon intensity of our electricity supplies, heat pumps offer one of the most efficient solutions to low-carbon heat. But installing millions of these will require a major shift in consumer attitudes and can often require major heating technology and energy efficiency upgrades in the home. Hydrogen boilers may appear a simple solution, but the availability of low-carbon hydrogen in the volume and cost required to heat the nation's home remains a great unknown. It appears a mix of solutions, including these, hybrid technology and other heating options will be the answer. This must be delivered hand in hand with improvements in thermal insulation of the UK's housing stock.

An array of choices, different local approaches, the need for coordinated consumer action, and the creation of new industrial and service capabilities make this a major challenge. This report sets out some of the actions to policymakers that will make progress possible, and poses solutions that could be developed further. While it is too soon to say what the system will look like in 2050, it is imperative that we make progress, starting with low-regrets solutions and developing technology options and delivery mechanisms during this decade. Progress now will ensure that mass deployment of low-carbon heat can take place during the 2030s and 2040s, in time for our mid-century target.

Energy efficiency – a gateway for low-carbon heat

Improving energy efficiency is a vital part of the solution. High levels of thermal efficiency are essential for homes with heat pumps, and improved heat retention in buildings can act as mass energy storage, levelling out peak demand. The Commission recommends:

- Designating heat and energy efficiency as a national infrastructure priority to allow for more robust tracking of progress and accountability for meeting targets.
- Prioritising funding on energy efficiency, building on the welcome £3bn announcement confirmed during the Chancellor's summer economic update, with a long-term plan for using market-mechanisms and regulation to drive consumer and business action.
- Using savings from Winter Fuel Payments to directly fund energy efficiency measures for those receiving these payments, to help them save on their energy bills, and eventually remove the need for significant spending on this measure.

Clear signals about technology choices

While we need to keep technology choices open, there are decisions that can be made now to end the installation of the most carbon-intensive heat options. Government can also set long-term regulations in place to give consumers and business time to understand what will be required of them in the future. The Commission recommends:

- Government should mandate the phased switch over from existing natural gas boilers to other solutions like heat pumps and hydrogen technologies, including heat networks. As a result, by 2035 all new heating installations will need to be low-carbon, to help ensure that we are on track to meet net-zero emissions by 2050.
- Oil-fired boilers are particularly carbon-intensive, and there are now other options available. Therefore from 2023 no new domestic oil-fired boilers should be installed. Biomass or LPG boilers are just some of the alternatives, alongside heat pumps.

- Government should mandate that after 2025 all new domestic boiler installations must be part of a hybrid system or be 'hydrogen-ready'. By 2035 no new natural gas burning boilers or systems should be installed and only net-zero compatible technologies like air source or ground source heat pumps, hydrogen burning boilers or heat networks should be deployed.
- Increase the funding available for heat networks and align with approaches to using waste and industrial heat. All new energy from waste plants and waste heat producing industries should be required to use waste heat to feed into heat networks where the location permits.
- A consumer information portal should be introduced to help individuals and businesses to learn more about the low-carbon heating solutions available to them. The solutions will be based on the consumer/business building type and energy infrastructure in their area.

Creating demand for low-carbon heat

Consumer incentives and clear regulations will be needed to change entrenched behaviours and create demand for low-carbon heat technologies. These need to be carefully designed and given a long-term trajectory to inspire consumer and market confidence. The Commission recommends:

- Government should shape its new Low-Carbon Heating Scheme around a grant system to replace the domestic-RHI. This should last the length of this Parliament going into the next Parliamentary session 2027/8 and two years into the introduction of the Future Homes Standard. The scheme should over time become less generous, with grants being replaced by loans, followed by a clear end date to the scheme to encourage early adoption.
- Government should create a low-carbon heating obligation, to stimulate the demand for low-carbon sources of heating (including heat pumps, hybrid systems, and low-carbon gases such as biomethane and blue/green hydrogen) and reduce carbon content of gas supply over time.
- Regulatory changes, including updates to the Gas Safety Management Regulations would allow greater flexibility for the injection of hydrogen into the gas grid, which could help reduce emissions from the gas system and increase demand for hydrogen and other clean gas alternatives.

Delivering a national strategy in a local way

The Commission recommends that government creates a time-limited delivery body for heat decarbonisation that can coordinate a national plan with local delivery. The National Delivery Body (NDB) would be an independent, impartial body that will work with government on creating, coordinating and delivering an overarching national decarbonisation of heat programme. However, and crucially, the programme will be expected to be locally formulated and locally delivered by local authorities who will synergise their own local and energy plan with the national programme.

- The NDB will support the development of regional heat plans and ensure resource is appropriately deployed to deliver them. It will bring these together as part of a national delivery plan and ensure that manufacturing, infrastructure development and training plans align with the demand. It will support Ofgem with its responsibilities that relate to specific heat decarbonisation policies, including the Clean Heat Grant and Green Gas Support Scheme.
- One of the initial aims of the NDB will be to create a 'Low-Carbon Heat Accord' that will provide an overarching approach to decarbonising heat in England. This will include key principles around lowering heat demand in domestic and non-domestic buildings and increasing the use of low-carbon heating solutions. It will support Local Authorities with their own energy plans by coordinating approaches being taken in nearby areas, and providing advice on technology choices, and the local jobs and supply chains that will need developing.
- The NDB will be a source of expert advice to the government and Parliament on which regions of the UK the government should deploy demonstration projects of low-carbon technologies that are more place-based, such as hydrogen-based heat in areas close to CCUS clusters.
- It will produce an annual report detailing the progress of the NDB and its plans for the following year. Local authorities will be expected to follow these principles and will be expected to provide annual updates to the NDB which will feature in its annual report to Parliament.



Summary of recommendations

Delivering Green Skills

Recommendation 1: Government should include 'low-carbon skills' in the national retraining scheme.

Further info

- The delivery of a nationwide heat infrastructure upgrade will require a massive mobilisation of installation, service and systems engineering skills. There needs to be a national plan to train and reskill a workforce. National apprenticeships and a CPD programme needs to be developed in collaboration with industry.
- A national low-carbon skills programme, which includes skills needed to decarbonise heat, is required to ensure that the breadth and balance of skills is developed. There is a need for a coherent plan which will create the skills for the installation and retrofit work that then transitions to maintenance and customer service. There needs to be a well-developed skills roadmap which sets out the skills required at each stage of the programme and an agreed skills checklist for each role.
- As the scheme currently includes functional skills training with the focus on English and Maths, skills around low-carbon solutions installations, collecting and managing consumers energy data should be included.

Energy efficiency and heat

Recommendation 2: Operational performance ratings

- Government should consider introducing operational performance ratings alongside EPCs for all non-domestic buildings. We understand that the government will be consulting on this later this year.

Further info

- As EPCs are used for benchmarking the energy efficiency of the fabric of a building, an additional tool that informs owners and tenants of the actual energy use of the building would be beneficial in identifying building performance gaps.

Recommendation 3: Designate energy efficiency and heat as a national infrastructure priority

Decarbonisation of heat and energy efficiency should be made a national infrastructure priority. Energy efficiency funding has been cut over the last 10 years and this urgently needs to be redressed.

Further info

- Designating heat and energy efficiency as a national infrastructure priority would also allow for more robust tracking of progress and transparent reporting, and will assist in accountability towards meeting targets and embed role of the delivery body (see below).

Recommendation 4: Fund energy efficiency upgrades

- Government must provide a detailed strategy on how it intends to spend the £9.2 billion allocated in the Conservative Party manifesto for energy efficiency upgrades in homes and public sector buildings. The Chancellor's announcement in July of £3bn of spending on energy efficiency is a welcome allocation of some of the funding in the manifesto commitment. It will act as an immediate stimulus to the sector, providing much needed jobs and some progress on improving levels of energy efficiency in buildings. It is important this package is followed-up by a clear strategy for maintaining action after that funding has been used.

Further info

- Government spending on energy efficiency should be aligned with plans for installing low-carbon heating solutions (see below). Priority should be given to those that are fuel poor, those in social housing and off-grid homes.
- In July 2020 the Chancellor committed to spend £1bn on retrofitting public sector buildings, £50m to pilot new energy efficiency projects in social housing, and £2bn backing for 'Green Home Grants' that will help home-owners install much needed but expensive energy efficiency measures. Households will be eligible for vouchers valued at up to £5,000 for energy efficiency upgrades, such as wall and loft insulation, covering at least two-thirds of installation costs. Those in low-income households, who could benefit the most from lower energy bills, will be eligible for vouchers up to £10,000.

- The government's commitment to a Future Homes Standard that will ensure "new build homes are future-proofed with low-carbon heating and world-leading levels of energy efficiency" is a positive step in building more energy efficient homes with less heat demand. However, we need emissions from residential and non-residential buildings to fall at a faster rate than they currently are.
- The government's strategy on energy efficiency should be in line with its Smart Systems and Flexibility Plan. Within this strategy, the government should increase the focus on the role of energy and heat storage and how this can help drive the efficient decarbonisation of heat.

Recommendation 5: Reform Winter Fuel Payments so that it is more targeted to only support those most in need and use savings to improve energy efficiency in these homes

Money from the Winter Fuel Payments (WFP) should be directly targeted at improving energy efficiency in homes – with the aim of every home being EPC C by 2035 – in line with the government's ambitions outlined in the Clean Growth Strategy.

Further info

- As those who are receiving WFP would get more efficient homes, some would stop needing WFP, enabling reform of the system, with better targeting of WFP to those in the most need. Should this be done, there could be substantial WFP savings. Some of the £2bn spent on WFP could be saved annually in the longer term by an upfront initiative to improve thermal insulation. The money saved longer term could then be reinvested into a national heat programme, enabling increased support for those in fuel poverty.
- This needs to be properly targeted and led through data sharing between government and local authorities.

Helping Consumers

Recommendation 6: Introduce a consumer information portal

- Government should create a 'energy efficiency and heat' online/phone portal for individuals and companies to learn more about the low-carbon heating solutions available to them. The solutions will be based on the consumer/business building type and energy infrastructure in their area. The portal should be able to deploy, when necessary, trusted specialists to do energy audits on consumer homes and SME businesses.

Recommendation 7: Create a new Low-Carbon Heating Scheme to replace the Domestic Renewable Heat Incentive with a grant system

The government announced in the Budget this year that RHI will be extended for another year to 2022, with a new Low-Carbon Heat Support Scheme replacing the RHI from April 2022. The government has followed this up with a consultation on a Clean Heat Grant that would provide £4,000 to consumers to cover a proportion of the costs of heat pump or biomass boiler installation.

To help shape this scheme, the Commission is recommending that the government should shape its new Low-Carbon Heating Scheme around a grant system to replace the domestic-RHI. This should last the length of this Parliament going into the next Parliamentary session 2027/8 and two years into the introduction of the Future Homes Standard. The scheme should over time become less generous, with grants being replaced by loans, followed by a clear end date to the scheme to encourage early adoption. The priority for this funding should be existing social housing and off-grid homes in order to stimulate the market for low-carbon heating.

Further info

- The government's Low-Carbon Heating Scheme, backed by £100m of funding announced in the Budget is a positive, step, including proposals for a Clean Heat Grant.
- From 2027/8 the government should review the take-up of low-carbon heating solutions. If there is significant take-up the grant system should transition to loans-based system. If there has not been significant take-up the review should highlight where the gaps are and the government should use the remaining money from the grant system to try and address this.
- While the proposed Clean Heat Grant under consideration offers proposed support for heat pump and biomass boiler installations, we recommend that a flexible choice to technologies is maintained. The scheme should also allow installers to change radiators and improve insulations as well as providing the low-carbon heat technology.
- Ultimately, grants and loans should become less generous over time and such phasing should be signalled years in advance to create certainty for business and consumers.

Delivering this national infrastructure challenge

Recommendation 8: Create a National Delivery Body to coordinate heat decarbonisation

The scale and urgency of heat decarbonisation is of a magnitude and level of importance that it requires the creation of a time-limited delivery body for heat decarbonisation that delivers a national level plan. This would be in coordination with other decarbonisation priorities such as transport, industrial emissions reduction and decentralised electricity supplies. The delivery body would draw on expertise of large-scale infrastructure projects, and coordinate activity across different government departments and regulatory bodies. Crucially, the delivery body would work with the government in creating an overarching national decarbonisation of heat programme. The main element of this programme would be a 'Low-Carbon Heat Accord'. The Accord would provide key principles focused on reducing heat demand and increasing the use of low-carbon heating solutions.

Further info

- An Olympic Delivery Authority-style body that works across government and coordinates stakeholders is required. This should also link with local authorities who are best placed to develop the local plans needed to deploy low-carbon heat solutions.
- The National Delivery Body would be an independent, impartial body. The body would work with the government in agreeing on a 'Charter' outlining its objectives and responsibilities upon its creation.
- The body would operate in a board-like structure made up of representatives from the energy, infrastructure, financial and consumer behaviour sectors.
- The delivery body should have the capabilities to work with specific regions and cities, coordinating these efforts with the national approach that can coordinate national deployment alongside system changes in power, transport and industry. This would ensure that there is a deliverable national heat plan.
- The NDB would support local energy plans being developed by local authorities. The body would also work to map skills requirements and coordinate with government and industry on how to address these.
- The body would be time-limited and would be in place until at least 2040, with its objectives being reviewed every 3-5 years.
- Heat decarbonisation would provide economic stimulus via a national infrastructure programme as it touches every region and every citizen, requires major upgrade in national infrastructure, energy efficiency measures would save energy in the future and will create greater national resilience. It is also a bottom up activity which engages the citizen in their future at a time when coordinated national action is valued.



Accelerating low-carbon heat installations

Recommendation 9: Mandate that after 2025 all new boiler installations must be part of a hybrid system or be 'hydrogen-ready'. By 2035, no boilers capable of burning natural gas should be installed, with all new heating systems being zero-carbon.

Government should mandate that after 2025 all new boiler installations must be part of a hybrid system or be 'hydrogen-ready'. By 2035 no new natural gas boilers should be installed and only air source or ground source heat pump or hydrogen powered boilers should be installed, including heat network connections. Advice on this can come from the consumer centre and determined by the National Delivery Body. The government should support, through a competitive process, a large-scale hydrogen for heat demonstration project.

However, a comprehensive plan from government is first required to build supply chains, tackle the upfront and installation costs of low-carbon heat, the ongoing running costs, development of new standards and the perceived inconvenience of new systems.

Further info

- Government should rapidly produce a clear cross-sector strategy on the value of hydrogen to industry, to transport and for heating in order to determine which parts of the country should be a priority of hydrogen hubs, which in the UK will likely be regional and tied to CCUS infrastructure.
- Prototypes of hydrogen-ready boilers have already been developed by boiler manufacturers and installing boilers that can be easily adapted to burn hydrogen will create optionality as local decisions are made around low-carbon heat solutions.
- Hybrid heat pumps allow a mix of condensing boiler and heat pump technologies which allow the installation to a wider range of energy efficiency standard housing. These are not zero carbon solutions when using natural gas and hence are only seen as a transitional technology, unless they use hydrogen in the future.
- The Commission is of the view that the government should consult with business on the delivery of these timelines to ensure they are achievable.

Recommendation 10: Develop proposals for a low-carbon heating obligation

- Create a low-carbon heating obligation, to stimulate the demand for low-carbon sources of heating (including heat pumps, hybrid systems, and low-carbon gases such as biomethane and blue/green hydrogen) and reduce carbon content of gas supply over time. Further work and engagement with industry must be taken forward by Ofgem, BEIS and the National Delivery Body, to understand how such an obligation would function and at what point in the system it would be levied.
- The trajectory of the obligation should be based on BEIS, Ofgem and the National Delivery Body's work on regional solutions to decarbonising heat.

Further info

- This obligation should be aligned with next phase of Ofgem's RIIO-GD2 and RIIO-ED2 to allow networks to prepare and deliver networks that can provide low-carbon heat.
- This will need to be a technology-neutral regime that allows local decisions to be made on the appropriate technology, for example different decisions will be made depending on housing types and heat pumps suitability, access to heat networks and waste heat, or proximity to potential hydrogen clusters.

Recommendation 11: Update Gas Safety Management Regulations to allow greater flexibility for the injection of hydrogen into the gas grid

The government should make changes to the Gas Safety Management Regulations including the Wobbe index, which defines the energy content of the gas for a given gas pressure. Changes to the governance arrangements for the Calculation of Thermal Energy Regulations should also be made to enable necessary amendments without the constraint of legislation. These changes would allow a greater flexibility for the injection of hydrogen into the gas grid.

Recommendation 12: Increase the funding available for heat networks and align with approaches to using waste and industrial heat. All new energy from waste plants and waste heat producing industries should be required to use waste heat to feed into heat networks where the location permits.

The current funding for the Heat Networks Investment Project, HNIP, is £320 million with a further £270m announced for a new Green Heat Networks Fund in the budget of March 2020. The government should commit to raise funding to the level needed to achieve the Committee on Climate Change target; this would be £3 billion if the market demands.



All new energy from waste plants and waste heat producing industries should be required to use waste heat to feed into heat networks where the location permits.

A mechanism to address demand risk and policies to place the heat networks industry on a level playing field with other networks may also be necessary to achieve the levels of growth needed to meet net-zero.

Further info

- Heat networks are a major component of future heat solutions, particular in high building density/population density areas where there is an economy of scale. The installation of heat networks into existing built up areas is disruptive and hence has greatest potential in new developments. However, to reach CCC targets for close to a fifth of heat being delivered through heat networks, retrofitted heat network connections will be required.
- Thought should be given in regional and local infrastructure planning for simultaneous electricity grid reinforcement and heat grid installation and development.
- The continuation of government support and funding is required to meet the scale of infrastructure required to ensure an adequate deployment of heat schemes. Heat networks also allow the use of waste heat from both industrial and waste incineration, which can displace heat produced by burning natural gas.

Recommendation 13: End the sale of new oil-fired boilers

No new domestic oil-fired boilers for heating should be installed from 2023. The government's Low-Carbon Heating Scheme, which we propose should be a grant system replacing the current domestic RHI, could cover consumers that use oil-fired boilers.

Further info

- These are particularly carbon-intensive, and lower carbon alternatives, such as biomass boilers or a heat pump and appropriate energy efficiency measures are transitional technologies that can support reductions in emissions from heat.

Context of the challenge

Scale of the challenge and timescale for achieving low-carbon heat

If the UK is to meet its commitment to decarbonise energy by 2050 then the decarbonisation of heat is the biggest challenge. Heating accounts for around 40% of energy consumption and in large part is delivered through the combustion of natural gas. Heat is generated locally in homes and businesses, meaning that any transition requires over 20 million individual interventions that will need to be coordinated nationally, regionally and locally. This stands in contrast to recent success in decarbonising the power sector, which has relied on comparatively little consumer and business action.

The scale of intervention required is colossal. A major overhaul of national infrastructure with mass engagement of the population will be required. The manufacture of heat pumps and hydrogen-ready boilers needs to be scaled up from essentially zero to millions of units per year. Many more skilled engineers will be needed to install and then service these new technologies. There are over 100,000 gas engineers in the UK with an average age of 46. For the transition to be successful a major training and recruitment programme is required.

This all needs to be underpinned by a programme which will ensure that the electricity grid, nationally and locally, can support the roll-out, that district heating systems are deployed and that the gas-infrastructure is hydrogen-ready. To set the scale, if all of the UK's heat were to be delivered through grid-scale electricity generation, then this would require the UK to deliver new electricity generation infrastructure which is far greater than that presently installed.

Moreover, heat solutions will not be a one size fits all. Population density, existing regional infrastructure, mix of new and old housing stock and consumer preferences, all will influence what needs to be deployed. This will necessitate local and regional planning which needs to be aggregated into a national plan, which respects the available energy supply. At present, regional planning is either limited or non-existent and presents a fundamental barrier to delivering solutions.

Similarly, at a household level, few have an appreciation of the challenge that decarbonisation of heat presents, there are many other issues which demand immediate attention and the incentives to transition are either not there or not great enough. Public awareness campaigns, hand in hand with the delivery of incentives schemes, are needed in order to generate the increase in public engagement and action required.

The majority of consumers are connected to the gas grid, with approximately 85% of UK households and 65% of non-domestic buildings using natural gas for heating. Although, household gas and electricity consumption has fallen by 17% over the past decade, with emissions 18% lower in 2015 compared with 1990 levels, fossil fuels are still the dominant heating source in our domestic and non-domestic buildings.¹ These homes will all need to be switched to low-carbon heating over the next 30 years. According to the Energy Technologies Institute, this could mean that between 2025 – 2050, around 20,000 households would have to be transitioned to low-carbon solutions every week.² Heat is simply the biggest challenge the UK faces domestically.

Included in these households, there are approximately 4.5 million people living in fuel poverty.³ Fuel poverty in England is measured using the Low Income High Costs indication, which classifies a household as fuel poor if they have required fuel costs that are above the national median level and if they were to spend that amount, they would be left with a residual income below the official poverty line.⁴ Any transition pathway must ensure that those in fuel poverty are given access to the correct government schemes and beneficial low-carbon solutions. These considerations should form part of a wider government strategy to ensure that a 'Just Transition' is delivered, with the development of a low-carbon economy giving benefits to communities across the country.

Direct emissions in the UK from buildings fell by 4% in 2017. Despite this improvement, further strides on making buildings more efficient must be made in order to reduce heat demand and prepare the ground for low-carbon heat solutions needed for net-zero. Reducing the emissions that come from these buildings by reducing the heat demand and increasing the energy efficiency of the buildings will lead to fuel savings and associated costs.⁵

With regards to industrial processes which account for 21% of all UK emissions, there has been progress. For example, through efficiency gains each tonne of steel produced in the UK requires 40% less energy to produce compared to 40 years ago. Government will have to continue working with business in helping energy-intensive industries continue to improve energy efficiency and adopt new low-carbon technologies that will help reduce heat demand and the carbon impact of processes that rely on intense heat. There are likely to be competitive advantages in the future from producing materials with lower carbon content, and it is vital that government and industry continue to work together on the reduction of emissions from manufacturing and industrial processes. The recent launch of the Industrial Energy Transformation Fund is a welcome step in this long-term transition.

There is no single solution

There have been extensive analyses on the specific routes to heat decarbonisation. Notable research includes work by Imperial College, that analysed the technical feasibility and overall system costs of heat decarbonisation pathways, high electrification, hybrid heat pump solution, and a hydrogen-dominated solution involving conversion of the gas grid. It pointed towards a hybrid pathway being the most cost-effective route, but the scenarios and assumptions about costs and systems interaction highlight the challenge of forecasting the optimal solution that remains decades away.

An evidence review conducted by the Department for Business, Energy and Industrial Strategy in 2018 remains highly relevant, although its analysis pre-dates the UK's setting of a net-zero target for 2050. It noted that it was unlikely that a single low-carbon heating technology found be suitable for all consumers, and that a future policy framework would need to take this into account.

The Heat Commission believes this remains the case, and that a multifaceted approach needs to be planned for, with a set of location-specific strategies likely to deliver optimal cost and feasibility.

Different areas will face different challenges. There will need to be considerations around suitability of buildings, the disruption that would be needed such as changing the radiator size of buildings, a buildings fabric performance, capacity for installation supply services and potentially a hot water tank within the building should decisions be made to prioritise heat pump installation.

Meanwhile, there are significant uncertainties about the future of hydrogen production through steam methane reformation or through electrolysis and whether this can be zero-carbon and cost-effective. There is currently not a wide-ranging electrolysis hydrogen production nor significant demonstration projects to understand the amount of hydrogen that is available in the UK.⁶ The absence of a UK hydrogen strategy makes it difficult and subjective to make assumptions about the availability, cost and priority use of hydrogen across the economy.

However, despite these uncertainties, there are opportunities to use much of the existing natural gas infrastructure, supply chains and standards. This could potentially limit the amount of disruption involved for consumers and businesses, particularly in buildings where electric or hybrid solutions are impractical or cost-prohibitive.

Alongside these pathways, there will likely need to be an increase of heat networks in the UK. According to Energies, there are currently around 14,000 heat networks across the UK supplying about 2% of heat to domestic and non-domestic buildings.⁷ This increase will likely be in urban high population density areas where it will be most suitable. However, heat networks could be used more in domestic buildings, particularly terraced homes.

Cost of doing nothing

If the transition to low-carbon heat solutions does not happen, deeper emissions reductions will need to be made in other sectors and at a higher cost, and we will be unlikely to achieve our legal target to reach net-zero greenhouse gas emissions by 2050. In its net-zero report the Committee on Climate Change stated that according to its estimates, the current costs of reducing emissions by 80% by 2050 relative to 1990 are between 1-2% of GDP.⁸ The Government has recognised the challenge but needs to make progress and is aiming to publish its 'Heat and Buildings Strategy' later this year, which will set out the latest plans from government to accelerate progress towards heat decarbonisation. This present report aims to inform that policy development by outlining a series of policy and delivery recommendations that activate the low-carbon heat market and inform the development of a future policy framework.

The global market for low-carbon solutions is a significant opportunity for UK business. The heat sector is a market worth tens of billions of pounds per year in the UK and hundreds of billions to trillions of pounds globally. International leadership in this sector is a golden opportunity for UK business, manufacturing and jobs.

Green Skills

The transition to low-carbon heating solutions will also mean the development of the UK's current skills capabilities and supply chains. Analysis presented by National Grid estimates that during the decade 2031-2040, the UK will need 152,000 new jobs in the net-zero workforce, which is a period when installation of low-carbon heat solutions will need to ramp-up. These new skills will be needed in a range of sectors, such as construction, and skilled tradespeople who will install low-carbon heating solutions such as heat pumps, hybrid hydrogen boilers and wall insulations, as currently, most heating system installers would need upskilling in order to advise and install new low-carbon heating solutions.⁹

Recommendation 1: The government should include 'low-carbon skills' in the national retraining scheme.

- The delivery of a nationwide heat infrastructure upgrade will require a massive mobilisation of installation, service and systems engineering skills. There needs to be a national plan to train and reskill a workforce. National apprenticeships and a CPD programme needs to be developed in collaboration with industry.
- A national low-carbon skills programme, which includes skills needed to decarbonise heat, is required to ensure that the breadth and balance of skills is developed. There is a need for a coherent plan which will create the skills for the installation and retrofit work that then transitions to maintenance and customer service. There needs to be a well-developed skills roadmap which sets out the skills required at each stage of the programme and an agreed skills checklist for each role.
- As the scheme currently includes functional skills training with the focus on English and Maths, skills around low-carbon solutions installations, collecting and managing consumers energy data should be included.

In the first instance as the UK recovers from the COVID-19 pandemic, the government should prioritise reducing short-term unemployment while laying the foundations for more radical retraining and reskilling within high demand areas, including the low-carbon economy as described above.

Panasonic

For many years, the search for a reliable, efficient and long-standing renewable energy solution has been at the top of the agenda for social housing providers, councils and communities alike.

Renewable technologies not only provide a cleaner, safer and more efficient heating and hot water solution, but these technologies are above all cost-effective.

This project saw 110 Panasonic Aquarea air source heat pumps and tanks successfully installed to Wealden District Council.

The aim was to update the heating systems of 110 village properties to fall in-line with the government's energy efficiency targets.

There was a significant variety in the properties. The houses were mainly rural buildings, built from the 1900's to 1990's, with differing build materials, insulation and existing heating systems. To overcome this problem, surveyors undertook detailed surveys of each property to calculate the heating requirements and ensure that the most appropriate heat pump features (including capacity and size) were specified for each property.

Additionally the properties had a variety of tenants, from families with small children to persons of an elderly age. With little knowledge of renewable technologies, a number of tenants were unsure about replacing their existing, traditional heating system with a new renewable technology. Therefore, over a series of days, Panasonic took its fully working Aquarea air to water demonstration trailer to the Wealden district, allowing visitors to see the system first hand, hear how quiet it is, and appreciate the size of it.

Panasonic Aquarea air source heat pumps have a COP of 5.08, meaning for every one unit of heat the heat pump consumes, 5.08 units of heat is produced. This will reduce the Wealden District's carbon footprint by an impressive 5000 tonnes over the next seven years and, on average, will save tenants £500 a year on heating bills. By replacing oil boilers and inefficient storage heaters, Wealden District Council has also seen a significant reduction in maintenance costs and breakdown call outs.



For a successful transition, the Department for Business, Energy and Industrial Strategy, would need to work in synergy with the Department for Education and Department for Media, Culture and Sport and the business community, in ensuring that low-carbon skills and knowledge of low-carbon jobs are interwoven into technical and vocational training. In addition, these government departments should work with the further and higher education sectors in developing courses on green skills that will be required in the net-zero society.

Export opportunities

In the CBI's report, 'The Low-Carbon 2020s – a decade of delivery', we detail how the UK has world leading low-carbon energy expertise, an energy efficiency sector that already exports £1 billion and a globally renowned financial sector.¹⁰

These elements place the UK in a unique position to be a world leader in exporting clean growth and green finance expertise. As the UK moves into a new trading relationship with the EU and the rest of the world, climate action and the growth of low-carbon exports should be viewed as priorities for new export and trade strategies.

Existing academic expertise, indeed, two leading UK universities rank in the top 5 of universities in the world for engineering degrees.¹¹ The UK also has existing industrial expertise in project design and software tools for buildings such as lighting solutions, supply of HVAC equipment, logistic for construction process and products and services for post occupancy. Combined with a strategic focus on developing solutions that can deliver cross-sector decarbonisation, such as CCUS, where the UK has a strong R&D and ancillary services and the potential cross-sector uses for hydrogen will support the UK's ability to compete in the international race to reduce emissions. Developing low-carbon technology and service exports will help maintain the UK's record of growth while delivering emissions reduction both at home and abroad.¹²

The critical role of energy efficiency

One of the main barriers to decarbonising heat in the UK, is the need to significantly improve energy efficiency of our homes and buildings. Reducing and eliminating emissions during the generation and use phases through implementing more efficient technologies and processes will provide significant savings for consumers and businesses. The government must address these barriers and scale up the energy efficiency market in the UK if it is to successfully decarbonise heat at an affordable rate.

The impact of the coronavirus pandemic on the economy has highlighted the potential role of energy efficiency improvements in helping to drive an economic recovery. The labour-intensive nature of building renovation, and opportunities to deliver this work in all regions of the UK with an estimated 85,000 supported to 2030¹³ means that there is a unique opportunity at hand to deliver vital infrastructure updates at a time when large-scale unemployment appears likely. The CBI has called for energy efficiency to be prioritised as part of any post-COVID-19 economic stimulus programme.

The energy efficiency policy landscape has gone through a variety of changes aimed at improving energy efficiency amongst businesses and consumers. And is largely a result of the European Union's Energy Efficiency Directive and the Energy Performance of Buildings Directive, which urged member countries to design policies on improving energy efficiency that *achieve a highly energy efficient and decarbonised building stock by 2050, create a stable environment for investment decisions and enable consumers and businesses to make more informed choices to save energy and money*. At a UK level, the coalition government's Green Deal, provided a financial framework aimed at improving residential energy efficiency. The then Department of Energy and Climate Change, created the Energy Efficiency Deployment Office to "drive a step change in energy efficiency."¹⁴

There have been other policy interventions such as the Energy Company Obligation scheme, aimed delivering energy efficiency and low-carbon heating improvements to low income and vulnerable households. The scheme is similar to its predecessors CERT and CESP which target improvements in cavity wall and loft insulations.¹⁵ Previous governments have also used the tax system to incentivise action, such as the Enhanced Capital Allowance scheme which allowed businesses to offset costs of certain energy efficiency products against tax.

Additionally, there have been attempts at behavioural changes through the introduction of Energy Performance Certificates (EPC) and the smart meter rollout. However, despite these interventions, the energy efficiency of UK buildings lags our European competitors significantly.

Recommendation 2: Government should consider introducing operational performance ratings alongside Energy Performance Certificates, EPCs, for all non-domestic buildings. We understand that the government will be consulting on this later this year.

- As EPCs are used for benchmarking the energy efficiency of the fabric of a building, an additional tool that informs owners and tenants of the actual energy use of the building would be beneficial in identifying building performance gaps.

Recommendation 3: Designate energy efficiency and heat as a national infrastructure priority

- Designating energy efficiency and heat as a national infrastructure priority would change the way in the issue is treated by government and government departments. Energy efficiency would be given similar attention as other major infrastructure investments on road, rail and broadband. This would send a clear message to the investment community and consumers of the government's long-term policy commitment therefore providing confidence for further investment in energy efficiency and low-carbon heat.

Although the Department for Business, Energy and Climate Change (BEIS), leads on energy efficiency and heat policy, it cuts across various government departments. The Treasury is responsible for the Exchequer revenue and the Ministry of Housing, Communities and Local government is responsible for building regulations and social housing. Designating it as an infrastructure priority would encourage better coordination between these departments. Additionally, the change would also affect the classification of energy efficiency in the government's accounting from 'resource' to 'capital', which increases the value of infrastructure.¹⁶

There are examples from elsewhere in the UK where energy efficiency is considered to be a national infrastructure priority with successful policy resulting from it. In Scotland, energy efficiency was designated a national infrastructure priority in 2015 and delivered through Scotland's Energy Efficiency Programme (SEEP).

The aim of the programme was to integrate domestic fuel poverty and energy efficiency programmes with heat generation and non-domestic energy efficiency activity. The Scottish government allocated a potential spend of over £6 billion over the life span of the programme, 15-20 years, through a mixture of public and private investment. In addition, the Scottish government worked with local authorities in developing pilot projects as it aimed to improve energy efficiency, therefore adopting a more integrated approach.¹⁷ Moreover, £119.6 million as allocated in the 2019/20 Scottish Budget for energy efficiency and fuel poverty, with plans to invest £500 million in energy efficiency by 2020/21.¹⁸

Designating energy efficiency as a national infrastructure priority ensured the long-term stability of energy efficiency and heat funding through this long-term policy commitment. It also gave the private sector in Scotland the policy certainty to invest in Scottish buildings.

Domestic Buildings

Currently, there are 19 million out of 27 million homes in the UK with an EPC rating below C.¹⁹ For the government to reach its target for as many homes as possible to be EPC C by 2035, where practical, cost-effective and affordable,²⁰ there will need to be a significant uplift in renovations which has seen a steep decline in recent years. In its report, *UK Housing: Fit for the future?*, the Committee on Climate Change (CCC) outlined that current energy efficiency policy is failing to drive uptake of energy efficiency in existing homes and that only around 1 million homes have low-carbon heat.²¹

In its report, the Energy Technologies Institute stated that 20% of CO₂ emissions that come from the way in which domestic buildings are heated, need to be eliminated. Currently, the UK housing stock is made up of approximately 27 million homes. With around 90% of these homes being family detached, semi-detached or terraced houses.²² Additionally, the vast majority of these homes (90%) have gas powered central heating and domestic energy use dominated by space heating.²³

Goldsmith Street scheme

The Goldsmith Street scheme provides an example of the advantages of better energy efficiency in homes. The scheme, which is a development of 105 brick properties near Norwich City Centre was designed by Mikhail Riches for Norwich Council and is built to the German Passivhaus standard, which ensures high levels of comfort for occupants with limited energy use for heating and cooling. The homes include a mechanical heat and ventilation system that circulates air throughout the properties and it is estimated that the heating bills for these properties should be around £150 a year, with the average price for a similar sized home to be £795 a year.²⁴ The scheme is also the first social housing project to be awarded the Royal Institute of British Architects Stirling architecture prize.

Reducing heat demand in domestic buildings would reduce consumer energy bills, tackle health costs associated with inefficient homes and help the UK on its journey towards net-zero by 2050. However, due to a buildings size, location and housing type means that there is not a 'one size fits all' approach to improving efficiency of homes and in turn reducing heat demand. Passivhaus certification includes a slightly relaxed standard for retrofit projects, called EnerPHit, where existing architecture or conservation requirements means that the Passivhaus standard is not feasible.

Recommendation 4: Fund energy efficiency upgrades

- Building on the welcome announcement of £3bn of spending on energy efficiency at the Chancellor's summer economic statement, government should outline its plans to deliver the full £9.2 billion promised spending on energy efficiency in the Conservative 2019 election manifesto. A clear strategy to deliver the funding will be needed to ensure this initial stimulus package can be part of a longer-term plan to drive retrofits, as anticipated in the government's Heat and Buildings Strategy.

In July 2020 the Chancellor committed to spend £1bn on retrofitting public sector buildings, £50m to pilot new energy efficiency projects in social housing, and £2bn backing for 'Green Home Grants' that will help home-owners install much needed but expensive energy efficiency measures. Households will be eligible for vouchers valued at up to £5,000 for energy efficiency upgrades, such as wall and loft insulation, covering at least two-thirds of installation costs. Those in low-income households, who could benefit the most from lower energy bills, will be eligible for vouchers up to £10,000. This is a welcomed stimulus, but the need for a long-term plan remains vital.

Of the £9.2 billion, the £3.8bn allocated for a Social Housing Decarbonisation Fund should be prioritised to deliver immediate employment opportunities from projects delivered by local councils and housing associations that are able to progress quickly. For example, an initial spend of £300m over the next two years could leverage an additional £300m from Registered Social Landlords.²⁵

This spending would support the goal for all social housing to achieve EPC rating C by 2030 and help build the capabilities of the energy efficiency sector, which will be vital for reaching the government's target of improving the EPC rating of all homes to C or higher by 2035. Taking forward plans for the £2.5bn funding of a new Home Upgrade Grants scheme focussed on those in fuel poverty would also help in delivering energy efficiency improvements and low-carbon heating to those most in need, whilst supporting jobs and growing the low-carbon heat sector.



Business and non-domestic buildings

The commitments made in the Clean Growth Strategy in 2017 outlined government priorities for decarbonising all sectors of the UK economy, with improving energy efficiency in business, industry and UK homes playing a significant role in this process. The government has committed to improving energy efficiency of businesses by 20% by 2030, achieving this could deliver up to £6bn in cost savings by 2030.²⁶

Changing the way in which we use energy in commercial buildings will play an essential role in the UK's transition to a low-carbon economy. There are approximately 1.8 million non-domestic buildings in the UK, accounting for around 12% of greenhouse gas emissions.²⁷

Due to the diversity of the UK's non-domestic building stock, which ranges from solid wall Victorian public buildings through to modern and old offices and a dominant natural gas grid, decarbonising heat in this sector would inevitably mean changes in infrastructure to meet the heating needs of each type.

However, in transitioning the way in which these buildings are heated through better efficiency, there is potential to reduce energy consumption by 39% through better energy management and installing energy efficiency measures. These measures could include relatively easy improvements such as changing the lighting of a building to, for example, LED lighting. Additionally, insulation improvements is an area for potential opportunities.²⁸

Improving energy efficiency would help businesses reduce wasted energy, while enjoying the same level of output. Businesses can use the money saved from implementing energy efficiency measures on other parts of their business which could potentially lead to greater productivity.

Currently, many businesses are put off by both the upfront cost of investing, the time it takes to implement energy efficiency measures and the complexity of existing support mechanisms. These barriers are the most commonly known, however these barriers impact businesses differently according to their size and function.²⁹

Public Sector leadership

The government could lead by example by implementing ambitious standards in its public buildings. In its report, *Powering Britain's Public Sector*, Centrica notes that the annual energy bill for the public sector is approximately £3.4 billion. Centrica focuses on three areas of the public sector, the NHS, defence and universities, representing approximately 55% of energy use that could be improved through distributed energy. The buildings in these sectors all have a variety of energy demands, particularly around the ways in which these buildings are powered – including the lighting and the heating of these buildings.

Should the government implement distributed energy solutions in 50% of these sites, there could be a potential annual savings of £375 million, a linked carbon saving of 658,000 tCO₂e, supporting 25,000 jobs and £1.7 billion in additional gross value added (GVA).³⁰ This is also an opportunity to save some of the £3.4bn spent annually by the public sector on energy.³¹

Additionally, as part of the aforementioned £9.2 billion energy efficiency manifesto commitment, the government should also focus on programmes of energy efficiency improvements within the schools that remain closed until the autumn, using the opportunity created by empty buildings to carry out this disruptive work. The Commission concluded that some of the £2.9bn allocated for the Public Sector Decarbonisation Scheme to improve energy efficiency in public buildings could achieve immediate impact by funding existing energy efficiency plans through tried and tested delivery architecture. With a phased return to schooling likely, there is a clear opportunity to target buildings that will be empty until the autumn, delivering immediate employment over the summer months. The £1bn spending commitment on public sector buildings is a welcome first step towards realising this goal.

The Modern Energy Partners (MEP) programme signifies how the public sector, in collaboration with the private sector to improve energy efficiency in public buildings. The MEP is a project between the Energy Systems Catapult, BEIS, Cabinet Office and Crown Commercial Services, that aims to grow private sector expertise in optimised energy efficiency solutions and energy demand management amongst other things to benefit public sector estates.³² This proactive approach is one that could be rolled out further in public sector estates, in order to do this the government would have to increase the £2 million funding the project receives from BEIS's Energy Innovation Programme.

Industrial processes and energy from waste

Progressing with the steps that energy intensive sectors, such as cement, steel and chemicals, can take to reduce their carbon emissions will be key to achieving the government's net-zero target and delivering a successful transition to a low-carbon economy.

Industrial processes account for approximately 90% of industrial emissions and the majority of industrial heat demand. The heat requirements for industrial processes vary in terms of temperatures required, how the heating occurs (directly or indirectly) and the technologies used to generate heat. Additionally, the use of heat in industry is typically to heat and cool buildings and for the processes of manufacturing products.

There are further opportunities to reduce the heat demand by improving the efficiency of industrial processes through significant innovation. This would improve businesses performance and reduce their energy costs.³³ But there are limits to efficiency gains, particularly as any easy action has already been taken, so the opportunity for progress here is a challenge. The government's new Industrial Energy Transformation Fund is a welcome support to encourage the innovation required to make efficiency improvements.

A consumer and community challenge

Due to the variety of ways in which we use heat, it affects our comfort, mental health, our energy bills and our daily routines. Heat is a personal experience, and one where consumer action and behaviour will be critical as we change to low-carbon heating systems.

Different consumers value different aspects of heat, particularly in their homes. This ranges from the temperature levels of their home, the ease in which you can control the temperature, the reliability of their heat source and the amount they pay to get the comfort they want.³⁴ As highlighted in BEIS's report, *Clean Growth – Transforming Heating*, domestic consumers are responsible for almost 60% of final energy consumption and this demand is mainly from keeping homes warm, generation of water and cooking.³⁵

Additionally, consumer heating demand is likely to change over time with population growth and economic changes. The number of households in the UK is set to rise to 31 million between now and 2037. This provides an opportunity to use house building regulation, such as the Future Homes Standard to ensure that that new homes will include low-carbon heating solutions such as heat pumps, hybrid boilers and hydrogen boilers the appropriate levels of energy efficiency to ensure that new homes will not need retrofitting to make them compatible with our net-zero target.

Locality is key

For the majority of people, heat is generated at home. But it is also a community, city and regional challenge due to the role of district heating, heat networks, and the structure of the gas grid. The development of city and local authority-level net-zero ambitions, and potential for Local Area Energy Plans as called for by the Energy Systems Catapult (ESC), emphasise how local approaches to decarbonisation must embed action to deploy low-carbon heat. The ESC report on Local Area Energy Planning noted that pilots conducted in Newcastle, Bridgend and Bury have demonstrated that the mix of low-carbon heating options are "highly specific to local conditions and that no single mix of options could be applied nationwide."³⁶

As heat is a local issue, the decarbonisation strategies that we must make will vary from region to region. Local authorities, which have responsibilities for important administrative functions such as, local planning, council tax and enforcing of building standards, will have an important role to play in any success of a decarbonisation of heat programme. There will need to be a significant increase in energy efficiency investment, particularly in buildings. Local authorities will therefore need to have better access to data on local buildings (domestic and non-domestic) and would need to be equipped with the correct resources to support and monitor the low-carbon investments.³⁷

Regional showcase: The North of England

The North of England currently accounts for approximately a quarter of the UK's carbon emissions. Its regions, comprising of the North East, North West and Yorkshire and Humber areas, is also more carbon intensive than much of the regions in the UK. The area also has high value and energy intensive industries, ranging from advanced manufacturing, petrochemicals, energy – particularly around power generation, storage, offshore wind and nuclear, through to digital technology. However, there are opportunities for industries in this region to reduce its carbon emissions, lower costs for consumers while remaining competitive.³⁸

Decarbonising heat in the North of England also presents opportunities for advancement of new technologies, particularly hydrogen. The region currently has an existing advantage with the Tees Valley's existing hydrogen infrastructure and its current production of around 50% of hydrogen in the UK³⁹ and sites such as the Cheshire Salt Caverns for hydrogen storage.

For example, in Leeds an ongoing project, H21 – led by Northern Gas Networks, focusing on demonstrating how converting the UK gas network to carry 100% hydrogen can tackle the UK's decarbonisation challenges, is a good example of the work going on in the region. Leeds was specifically chosen due to its complex and large gas grid and geographical location, in the north close to the east coast which has an infrastructure for the construction of salt cavern storage and hydrogen supply from the North Sea.

Another example is the HyNet North West project, which is based on the production of hydrogen from natural gas. The £0.9 billion project includes the creation of the UK's first CCUS infrastructure and development of a hydrogen pipeline with the aim of the project being fully delivered by 2023. The project backers Cadent and Progressive Energy Ltd note that due to the industry in the North West region, existing technical skills base and unique geology were central to the decision to launch the project in the North West. Additionally, this project meets the decarbonisation challenges in reducing emissions in industry, domestic heat and transport and is in tune with the government's levelling up agenda through the creation of jobs and innovation. The project could also be used as a replicable model for other similar programmes in the UK.⁴⁰

However, any production of hydrogen at scale will most likely require the deployment of carbon capture, usage and storage (CCUS) technology. Currently the most economical way to make low-carbon hydrogen at scale is through Steam Methane Reforming (SMR), which if combined with CCUS could produce hydrogen with reduced carbon emissions. Such an application could share CCUS infrastructure that would also support decarbonisation of industrial processes in the region, which demonstrates the value cross-system planning at a local and regional level.

There are currently innovation and trials of CCUS ongoing in the region. One example is the Net-Zero Teesside project, which is a cluster of energy intensive industries with the aim of establishing Teesside as a hub for future clean industrial development by creating a CCUS equipped industrial zone. This region and others would also benefit from the development of at-scale electrolysis, a process where hydrogen is produced from water and electricity, as an alternative to hydrogen production via steam methane.

Cadent

HyNet is a combined hydrogen and CCUS project in the North West that has gained significant support to date from industry and the public sector. It utilises existing oil and gas infrastructure for CO₂ transport and storage and is a low-cost route to initial deployment of CCUS in the UK.


Cadent was responsible for initiating the HyNet concept back in 2017 with development partner Progressive Energy and since 2017 the project has gained significant momentum and is now viewed as the leading hydrogen and CCUS project in the UK today. This is due to its ability to capture and store 400,000 tCO₂ / yr, the equivalent of 200,000 cars being taken off the road, or 200,000 domestic heating systems being transitioned to low carbon.

HyNet is the only industrial cluster to include hydrogen distribution at this stage and consists of incremental projects that present a clear pathway to up to 10 MtCO₂ / yr. Cadent has developed and

consolidated a core consortium which is comprised of Cadent, Progressive Energy, Essar, CF Fertilisers and the ENI. These are the partners that will deliver the project.



Fossil fuels continue to dominate the way in which consumers heat their homes with approx. 24.5 million homes and two million businesses' heating being supplied by the mains gas grid. In comparison, around 3.7 million homes in the UK use non-mains gas fuels for their primary heating and less than 5% of home heating is currently low-carbon. This outlines the major task for government and businesses to provide and encourage consumers to switch to low-carbon solutions before the UK must reach net-zero emissions in 2050.⁴¹



Consumers will need to understand the low-carbon heat solutions available to them, the cost of these and how their choices could affect how they go about their daily lives. These individual actions will also need to be coordinated with local and regional approaches to decarbonisation, such as grid reinforcement required for increased heat pump use or electric vehicle charging, or upgrades to the gas grid and development of hydrogen distribution networks. This will require government and business working together to outline the options available and guide consumers through the process of making certain choices.

The delivery of new solutions will need to be judged based on the type of housing stock, the cost and ease of development of new infrastructure such as the local electricity and gas network and the ease with which new district heating systems can be deployed. This requires a detailed knowledge of the existing and future town planning and integration into the planning system. Solutions will need to be deployed on a community by community basis which mandates strong local engagement which can only be delivered by local or regional government. To be successful there needs to be local capacity and capability, integrated across the region to ensure sharing of best practice and learning and also to provide flexibility in resource.

Recommendation 6: Introduce a consumer information portal

- Government should create an 'energy efficiency and heat' online and phone portal for individuals and companies to learn more about the low-carbon heating solutions available to them. The solutions will be based on the consumer/business building type and energy infrastructure in their area. The portal should be able to deploy, when necessary, trusted specialists to do energy audits on consumer homes and SME businesses.

These actions will also need to be coordinated with local and regional approaches to decarbonisation, such as grid reinforcement required for increased heat pump use or electric vehicle charging, or upgrades to the gas grid and development of hydrogen distribution networks. This will require government and business working together to outline the options available and guide consumers through the process of making certain choices.



Regional showcase: London

London has the lowest CO₂ per capita emissions of any region, in part due to its transport system, high population density (approx. 8.9 million people) and to its lower level of large industrial facilities in comparison to other regions.⁴² However, the capital faces a major retrofit challenge as nearly three quarters of energy used in London's homes is for heating and hot water, with the majority of these homes heated by gas-fired boilers. The Mayor's Environment Strategy highlights that one in ten electricity substations are approaching full capacity and that the redevelopment of large parts of the city will only increase this demand.⁴³ Non-domestic buildings account for 42% of its emissions, with companies paying £4 billion each year in gas and electricity bills.⁴⁴

City Hall has been consistent in its ambitions to address the climate change challenges London faces. The Mayor, Sadiq Khan, recently announced a £50 million fund for green energy projects as part of his 'green new deal for London'. This would assist in achieving the Mayor's commitment of making London a net-zero city by 2030.

However, all of the pathways to net-zero by 2050 presented by City Hall, highlight a heavy reliance on vast improvements of energy efficiency in buildings by 2030. Many of London homes will still be in use by 2050 and only 35% currently achieve EPC C or above. At least 70 per cent of London's buildings need to reach EPC C by 2030. To achieve this, retrofit rate per year would need to reach more than four times their historical peak and energy efficiency programmes would need to reach 160,000 homes by mid 2020s. The capital costs of installing the energy efficiency measures required total to £10 billion by 2050. Should these improvements be delayed, this could lead to an additional 33 MtCO₂e or a 7% increase in total emissions over the period modelled by City Hall. City Hall suggest that due to the government cutting support for energy efficiency programmes in 2012, action on building retrofits has fallen.

Additionally, any energy demand should be offset by energy efficiency deployment and an increase of smart technology usage to address peaks in demand. City Hall's modelling highlighted that the additional demands on the electricity grid through the use of heat pumps and electric vehicle charging doesn't mean there needs to be the building large scale electricity generation capacity. The cumulative costs associated with upgrades to the grid, in all of the scenarios presented by City Hall, is 4 billion to 2050.⁴⁵

Coupled with improvements in energy efficiency and upgrades to the grid, City Hall views an increase in heat pump deployment, district heating and rollout of heat networks as low-regrets actions that the government could take now. The Bunhill Heat and Power Network and Islington Council scheme, a first to take waste heat from an underground station (Northern Line) into homes, businesses, schools and leisure centres is an example of the potential of using waste heat in London.⁴⁶ This analysis by City Hall highlights the challenges and potential solutions that could be taken now on the way towards London reaching net-zero.

As EPCs are used for benchmarking the energy efficiency of the fabric of a building, an additional tool that informs owners and tenants of the actual energy use of the building would be beneficial in identifying building performance gaps. We have seen positive results due to the implementation of operational performance ratings, the Australian performance-based energy rating scheme, National Australian Built Environment Rating System (NABERS) exemplifies this. NABERS can be used to measure a building's energy efficiency, carbon emissions, water consumption and waste production and compared to similar buildings. The focus placed on the operational performance aspect of buildings is something the UK could learn from.

Actions by the government

The government has developed schemes to try and incentivise consumers to switch to low-carbon heating solutions in their home. Some of these schemes have been focused on able-to-pay market, while there have also been moves to target those on low-incomes and in fuel poverty.

Energy Company Obligation

The Energy Company Obligation (ECO) scheme aims to help deliver energy efficiency and heating measures to consumers' homes. The scheme began in 2013 and has changed over time to its current format (ECO3), which focuses the entire scheme on supporting low income, vulnerable and fuel poor homes. The distinction between this version of ECO and the others is the inclusion of the Home Heating Cost Reduction Obligation (HHCRO). This requires energy suppliers to promote the installation of insulation and heating measures.

Renewable Heat Incentive

The Renewable Heat Incentive (RHI), non-domestic and domestic RHI schemes were launched in 2011 and 2014 respectively, is a government financial incentive to support the deployment of low-carbon heat technologies in homes and businesses. Ofgem is the body responsible for approving application, enforcing compliance and releasing payments to successful applicants.

However, there has been an issue of expectation vs reality with the scheme. BEIS expected the scheme to fund 513,000 installations by 2020. The reality is, according to the outcome of an inquiry by the Public Accounts Committee, RHI has funded 78,048 installations by the end of December 2017. It is estimated that the RHI will fund 111,000 new installations by 2020–21, this is 78% less than BEIS predicted. The planned spend on the scheme's over its lifecycle from 2011–2041 was £47 billion, but this is now expected to fall by 51% to £23 billion due to low take-up of the scheme.

Feed-in-Tariffs

The Feed-in-Tariffs (FiT), introduced in 2010. FiT allows consumers who generate their own electricity, via solar panels for example, to get payments from their energy supplier.

The scheme has been successful in encouraging the installation of small scale, low-carbon electricity generation technologies. This success came from a combination of different incentives, such as, the ability to sell any unused energy units via the export tariff in addition to the generation tariff.

Winter Fuel Payment

In addition to this, the government's Winter Fuel Payment (WFP) introduced in 1997 aims to help consumers born before October 1955 pay their heating bill. A payment between £100 - £300 goes to around 12 million people and costs the Treasury approx. £2 billion a year.⁴⁷ However, as those receiving housing benefit, council tax reduction, child benefit or universal credit are not eligible to receive the allowance which has raised questions around whether the money is being put to good use.

Recommendation 5: Reform Winter Fuel Payments so that it is more targeted to only support those most in need and use savings to improve energy efficiency in these homes

- In order for better targeting of WFP, the Commission is recommending that money from this should be used to improve energy efficiency in homes – with the aim of every home being EPC C by 2030, which the CBI has recently called for to support progress towards net-zero emissions.



As those who are receiving WFP get would more efficient homes, some would stop needing WFP, enabling reform of the system, with better targeting of WFP to those in the most need. Should this be done, there could be substantial WFP savings. Some of the £2bn spent on WFP could be saved annually in the longer term by an upfront initiative to improve thermal insulation. The money saved longer term could then be reinvested into a national heat programme, enabling increased support for those in fuel poverty.

This needs to be properly targeted and led through data sharing between government and local authorities. The data should be focused on who receives WFP and the EPC of their property. In order to get this data, local authorities may have to provide energy audits on households receiving WFP. The government would have to ensure that local authorities are well resourced to do this.

Supporting consumer action

Some fuel poverty charities are of the view that the current schemes (particularly FiT and RHI) benefit those with higher incomes and are not inclusive as they incentivise action in property types that are most suited for low-carbon heat solutions.

One of the main challenges of FiT and RHI, is that there is a clear barrier of the upfront costs of purchasing and installation of the low-carbon heat solutions which successful applicants of RHI are required to do. Affording these costs are easier for high income earners. Moreover, there is the issue of overcoming the practical barriers of major home upgrades and the disruption that comes from essential work, including radiator upgrades, and additional insulation.⁴⁸ It is crucial that the government works on removing the barriers of the scheme while preserving the benefits.

Recommendation 7: Introduce a Low-Carbon Heating Support Scheme

- Government should shape its new Low-Carbon Heating Scheme around a grant system to replace the domestic-RHI. The scheme should over time become less generous, with grants being replaced by loans, followed by a clear end date to the scheme to encourage early adoption. The priority for this funding should be existing social housing and off-grid homes in order to stimulate the market for low-carbon heating.

The government announced in the Budget this year that RHI will be extended for another year to 2022, with a new Low-Carbon Heat Support Scheme replacing the RHI from April 2022. The government has followed this up with a consultation on a Clean Heat Grant that would provide £4,000 to consumers to cover a proportion of the costs of heat pump or biomass boiler installation.

To help shape this scheme, the Commission is recommending that the government should shape its new Low-Carbon Heating Scheme around a grant system to replace the domestic-RHI. This should last the length of this Parliament going into the next Parliamentary session 2027/8 and two years into the introduction of the Future Homes Standard. The scheme should over time become less generous, with grants being replaced by loans, followed by a clear end date to the scheme to encourage early adoption. The priority for this funding should be existing social housing and off-grid homes in order to stimulate the market for low-carbon heating.

There is a strong argument for using public funding to deliver projects related to some of the more challenging parts of the UK housing stock and fuel poor communities, which can help prove solutions and de-risk the investment required from industry and the general public to allow the market to deliver the more widespread change that is required. Such pioneering demonstration projects are essential in overcoming many of the hurdles required for the transition.

New business models and finance solutions are going to be crucial. From 2027/8 the government should review the take-up of low-carbon heating solutions backed by the grant. If there is significant take-up, the grant system should transition to loans-based system. If there has not been much take-up, the review should highlight remaining barriers to uptake government should use the remaining funding from the grant system to try and address this. Ultimately, grants and loans should become less generous over time and such phasing should be signalled years in advance to create certainty for business and consumers. While the proposed Clean Heat Grant under consideration offers proposed support for heat pump and biomass boiler installations, we recommend that a flexible choice to technologies is maintained to help support consumers if cost is prohibitive.

This recommendation addresses one of the key barriers to uptake of low-carbon heating solutions, which is affordability, as this helps tackle the upfront costs of purchasing and installation of low-carbon heating solutions. Such a scheme would build on the progress resulting from the BEIS Electrification of Heat Demonstration Project where consumers are being offered low-carbon heating solutions at no cost by a number of providers in select areas of the country. The monitoring of this scheme would provide further data to BEIS on the effectiveness of various low-carbon heating technologies and barriers to uptake.

“The government has a pivotal role to play in setting the direction and the policy environment, working in collaboration with business and the investment community. This requires political courage and vision, but above all a level of national coordination which can only be achieved through a National Delivery Body for heat.”

National Delivery Body

The challenge is clear, with heat contributing to a third of total UK CO₂ emissions and accounting for more than half of the UK's energy consumption.⁴⁹ The changes required to decarbonise heat, including energy efficiency upgrades, installation of low-carbon heating technologies and changes to heat generation and distribution systems, will inevitably be disruptive to consumers and businesses. There are clear lessons to be learned from recent policy efforts to install low-carbon technologies in peoples' homes. Schemes to deliver energy efficiency measures have varied in success, meanwhile there have been significant delays and operational issues relating to the installation of new smart meters. These challenges and learnings demonstrate the need for a delivery mechanism that links together national policy, consumer interaction, and local delivery.

The positive impact of this national decarbonisation of heat is that it would provide economic stimulus creating jobs via a national programme that touches every region and every community through a major upgrade in infrastructure. The required energy efficiency measures necessary for a successful heat decarbonisation programme have been widely identified as a fundamental priority for the country's recovery from the coronavirus epidemic due to the job creation opportunities. This improvement in energy efficiency would then create the conditions needed for the heat decarbonisation programme, maintaining the jobs create and national investment opportunities that will support a clean and resilient recovery from the pandemic.

Recommendation 8: Create a National Delivery Body to coordinate heat decarbonisation

- The scale and urgency of the decarbonisation of heat is of such magnitude importance that the Commission has recommended that a time-limited delivery body for heat decarbonisation is created that can deliver a national level plan. This would be in coordination with other decarbonisation priorities such as transport, industrial emissions reduction and decentralised electricity supplies.⁵⁰

What is a National Delivery Body?

The National Delivery Body (NDB) would be an independent, impartial body that will work with government on creating, coordinating and delivering an overarching national decarbonisation of heat programme. However, and crucially, the programme will be expected to be locally formulated and locally delivered by local authorities who will synergise their own local and energy plan with the national programme. The main objectives of the NDB are to:

- Create and implement a 'Low-Carbon Heat Accord'.
- Support the development of regional heat plans and ensure resource is appropriately deployed to deliver them.
- Aggregate regional plans into a national delivery plan and ensure that manufacturing, infrastructure development and training plans align with the demand.
- Provide expert advice to the government and Parliament on which regions of the UK the government should deploy demonstration projects of low-carbon technologies that are more place-based, such as hydrogen-based heat in areas close to CCUS clusters.
- An annual report detailing the progress of the NDB and its plans for the following year

The NDB should have the capabilities to work with devolved governments, specific regions and cities, coordinating these efforts with the national approach that can coordinate national deployment alongside system changes in power, transport and industry. This would ensure that there is a deliverable national heat plan.

Low-Carbon Heat Accord

The 'Low-Carbon Heat Accord' provides an overarching approach to decarbonising heat in England. The approach includes key principles around lowering heat demand in domestic and non-domestic buildings and increasing the use of low-carbon heating solutions. One key principle for example, is a significant increase in energy efficiency measures. A full list of principles of the Accord can be found at the end of this chapter.

Many local authorities have created their own energy plans which include steps that they plan on taking in decarbonising heat in local businesses and homes. The Accord aims to provide a guide on steps that aims to increase local jobs, i.e. focus on energy efficiency via local supply chains and innovation through the focus on developing local heat solutions across the country, recognising that there is a diversity of heating solutions. Local authorities will be expected to follow these principles and will be expected to provide annual updates to the NDB which will feature in its annual report to Parliament.

Structure of the National Delivery Body

Upon its creation, the NDB and government will agree a 'Charter' which will outline the responsibilities and objectives of the NDB. The Prime Minister working with the Leader of the Opposition will agree a terms of reference for the NDB to sit alongside the 'Charter'. The Prime Minister and Leader of the Opposition will also sign the Charter enshrining the NDB's independence. Signing the 'Charter' also signals that the key principles from the 'Low-Carbon Heat Accord' is government and opposition party policy and a commitment to long-term policy framework.

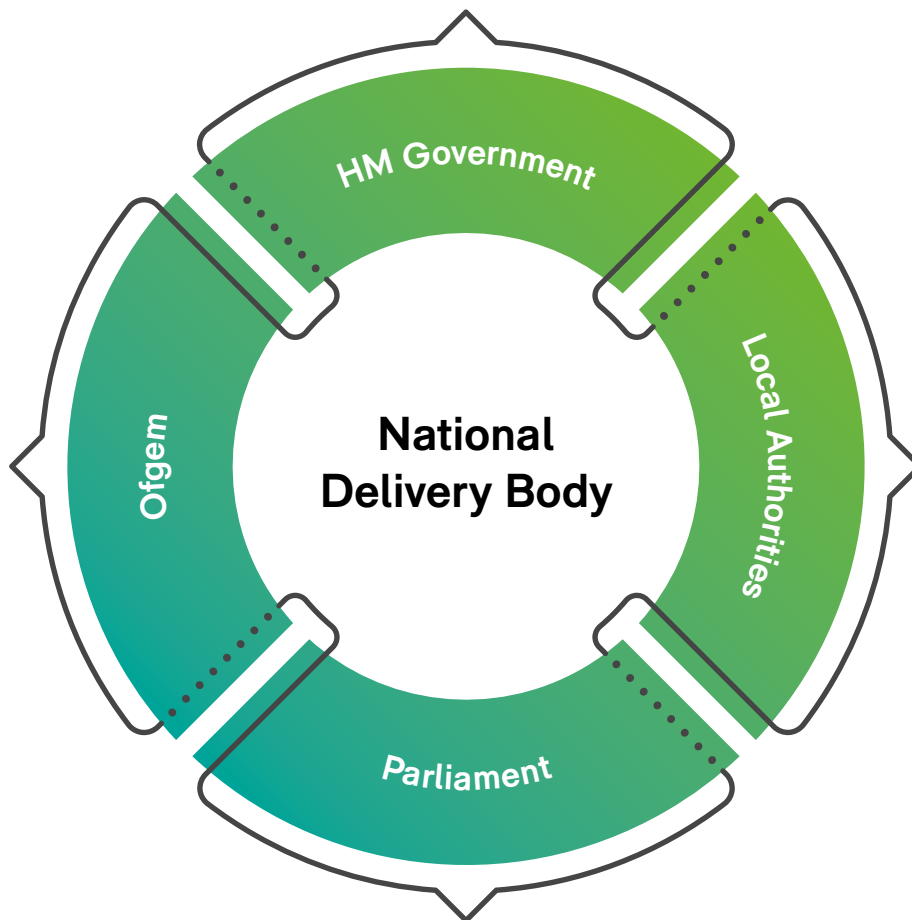
The NDB will operate a board-like structure made up of individuals from the energy, infrastructure and financial sectors as well as consumer protection and behavioural insights to provide expert advice on consumer acceptability of potential recommendations made by the NDB. The NDB will be expected to continue to work with consumers through continuous communication with local authorities to try and minimise disruption of implementing key principles of the 'Low-Carbon Heat Accord'.

As the NDB will be a time-limited body, it is expected to be dissolved once the objectives have been met. However, to provide clarity we are recommending that the creation of the body should be in place until at least 2040, with its objectives reviewed every 3-5 years. The length of the NDB's term should firstly provide consumers with confidence that they know the body delivering the overarching programme of changes in their region. Additionally, investors will have confidence in the low-carbon heat sector with the knowledge of a stable policy environment on heat through towards the government's net-zero target.

Accountability and relationship with stakeholders

The NDB will operate in a transparent manner and will be accountable to Parliament. To ensure transparency, the Chair of the body will be required to appear in front of MPs in the form of a Select Committee following the publication of its monitoring report. The NDB will be in regular contact with the government, Ofgem and leaders of local authorities on policy recommendations and progress of the 'Low-Carbon Heat Accord'.

It is important to note that Ofgem has been provided with responsibilities for some of the government's heat policy, namely the Green Gas Support Scheme, which will begin in financial year 2021 and will run until 2026. Ofgem also has responsibility for the Clean Heat Grant, which is expected to begin in April 2022 following on from the Domestic Renewable Heat Incentive and will run for two years. It is evident that Ofgem are a key component of the national delivery of heat but do not have oversight of all of the elements, e.g. scale-up of skills and capacity, to deliver a successful national heat programme. The NDB, working with the government and Ofgem would decide how these new policies will interact with the NDB's 'Low-Carbon Heat Accord' and the wider relationship between the NDB and Ofgem.

Diagram of approach:**Low-Carbon Heat Accord Principles**

- Net-zero is the driving principle
- A key focus on reducing heat demand and managing peak heat demands
- Increase in low-carbon heat solutions investment
- Waste heat is a vital resource and should be exploited
- Best value to consumers whilst maintaining (or improving) comfort, reliability and convenience
- Must provide credible solutions for all not just a few
- Local priorities are as important as national priorities
- The delivery of a national heat programme should deliver a *just* transition
- No one is left behind, and fuel poverty is minimised or eliminated
- Avoid unintended consequences of distorting other sectors
- Public engagement and education is vital
- Public and private partnership is essential

Technology options

The challenge of transitioning 85% of homes connected to the gas grid, reducing the 12% of greenhouse gas emissions from non-domestic buildings and reducing industrial heat demand by making industrial processes more efficient and low-carbon will not be easy. There are a range of technologies that will be required, with some ready for immediate rollout and others needing added innovation before being delivered at scale. We explore three technological options that we think will be needed, including, heat pumps (also hybrid heat pumps), hydrogen and heat networks. We recognise that other solutions are possible and will be needed and may feature strongly in particular sectors, including off grid solutions. But a number of solutions for mass-uptake of low-carbon installations will be needed, and to reach net-zero by 2050 we recommend that by 2035 all new heating installations are low-carbon.

For these technologies to be deployed at scale, the government will need to create the right policy environment taking into account the different challenges and advantages each technology presents. Long-lead time regulation will help signal the changes that need to take place, and give consumers and businesses the confidence to invest in new technologies. Also recognising the profiles of different regions and the capabilities each have in reaching the level of development required to implement some of the changes that will be needed, in particular this applies to the hydrogen pathway. Over time the rebalancing of costs between electricity and gas would be a powerful force for change toward meeting heat decarbonisation commitments. Similarly, there will need to be consideration on the role of carbon pricing for fossil fuels used for heating.

Further considerations around the level of disruption to communities and consumers will have to be made in creating the correct policy framework for the deployment of these technologies.



Recommendation 10: Develop proposals for a low-carbon heating obligation

- Government should create a low-carbon heating obligation, to stimulate the demand for low-carbon sources of heating (including heat pumps, hybrid systems, and low-carbon gases such as biomethane and blue/green hydrogen) and reduce carbon content of gas supply over time. Further work and engagement with industry must be taken forward by Ofgem, BEIS and the National Delivery Body to understand how such an obligation would function and at what point in the system it would be levied.
- The trajectory of the obligation should be based on BEIS, Ofgem and the National Delivery Body's work on regional solutions to decarbonising heat. This obligation should be aligned with next phase of Ofgem's RIIO-GD2 and RIIO-ED2 to allow networks to prepare and deliver networks that can provide low-carbon heat.
- This will need to be a technology-neutral regime that allows local decisions to be made on the appropriate technology, for example different decisions will be made depending on housing types and heat pumps suitability, access to heat networks and waste heat, or proximity to potential hydrogen clusters.
- This is a long-term recommendation and would build on the proposals for a Low-Carbon Heating Scheme, as proposed in Chapter 3.

Heat pumps

Heat pumps take heat from the environment and deliver this into the building. The heat can be drawn from the air or ground (air-source or ground-source) and usually electrical energy is required to power the heat pump. Ground-source heat pumps are hard to deploy in existing urban environments which are built-up and access to the geological subsurface is challenging and expensive, but may be deployed in rural and new build situations. The most significant deployment of heat pumps will be air-source. Heat pumps are not particularly compact and are installed outside the house. They draw several kW of electrical power and hence widespread deployment within a community will place new demands on network capacity. Within the next 5 years the UK should aim to significantly increase the installation of heat pumps (e.g. increasing up to 1 million installations a year) if we are to get the market moving.

The simultaneous roll-out of heat pumps and electric vehicle charging infrastructure requires careful local planning. Heat pumps do not deliver heat quickly as gas boilers and are more challenging in winter months when the available external heat is lower and hence significant changes to the thermal efficiency of houses is required in parallel with installation.

Storage of heat is an issue which has historically been provided by hot water tanks but are absent from many current combi-boiler installations. Heat pumps installation may require additional hot water tanks, changes to radiator size and may take up significant outside space for installation (with regards to ground source heat pumps). In addition, network reinforcement may be needed with a high penetration of heat pumps, according to MDPI (Energies) report, £5.7m full heat pumps by 2035 would require reinforcement of 42% of the distribution network at a cost of £40.7bn.⁵¹ However, the Commission notes that installation of heat pumps in combination with smart technologies, such as within home storage, would reduce this cost. Therefore, the installation of heat pumps needs to be done in conjunction with smart technologies to balance the home costs and network/supply costs. There are currently very few heating engineers trained to install heat pumps and careful system design is required in order to make the installation successful.

Hybrid heat pumps

Hybrid heat pumps are increasingly being seen as a useful transitional technology, and long-term solution where there is access to green gas or hydrogen. Hybrid heat pumps work through a combination of a smaller electric heat pump and a small back-up gas boiler.⁵² As the technology uses a mix of condensing boiler and heat pump technologies it could be installed in a wider range of housing where energy efficiency standards are not appropriate for heat pumps alone. However, these are not zero carbon solutions if used with natural gas. The provision of hydrogen and biomethane networks could produce hybrid designs which do not produce carbon emissions and could therefore be a viable long-term solution.

Hydrogen

There is potential for less disruption to consumers and communities through the injection of hydrogen into the existing natural gas networks. However, the amount of emissions reductions from hydrogen injection is partially dependent on the method in which hydrogen is produced and the extent hydrogen can be used in retrofitting buildings.

Blending hydrogen in the existing gas grid could help reduce carbon emissions from heat in the nearer-term before large-scale adoption of low-carbon heating technologies is rolled-out. Government and regulators should support further trials into hydrogen and biomethane blending.

Recommendation 11: Update Gas Safety Management Regulations to allow greater flexibility for the injection of hydrogen into the gas grid

- Government should update to the Gas Safety Management Regulations and make changes to the Wobbe index, which defines the energy content of the gas for a given gas pressure. This would allow a greater flexibility for the injection of hydrogen into the gas grid.

There are a number of manufacturers who have developed hydrogen-ready boilers that are now being tested for safety and energy efficiency. It has been argued that this approach is attractive as the distribution infrastructure is available and the conversion in people's houses is relatively straight forward compared with installation of heat pumps. The existing gas network acts as an energy storage facility which can support rapid changes to heat demand during the day, but also seasonal variation. In addition to this, the transition to hydrogen has lower training requirements than other low-carbon solutions as Gas Safe Engineers could easily be trained in using different types of gas.

The energy density of hydrogen as a gas is less than methane and the materials damage that long term exposure to hydrogen creates are both issues which would need to be accounted for. However, significant uncertainty remains about the availability of sufficient supplies of low-cost low-carbon hydrogen to make this a viable national solution on its own.

Heat networks

Heat networks can be deployed in communal buildings such as new-build apartments and could also be used for a cluster of homes. Heat networks are attractive in high-density built up areas such as city centres. Heating for buildings in these areas could be supplied through industrial waste heat and combined heat and power plants.⁵³ The IPPR calculates that if government invested £3 billion, it would leverage private investment of £22 billion, enough to supply 10% of UK heat by 2030, the target set by the Committee on Climate Change (CCC).

Recommendation 12: Increase the funding available for heat networks and align with approaches to use waste and industrial heat. All new energy from waste plants and waste heat producing industries should be required to use waste heat to feed into heat networks where the location permits.

An optimal heat solution from the UK would involve full exploitation generated from industrial sources and waste incinerators. Even now, incinerators continue to gain planning permission without such obligations, potentially locking us into high-CO₂ electricity only plants for decades to come. In Scandinavia the heat capture from Energy from Waste (EfW) plants makes them four times more efficient than the way such plants are deployed in the UK.

Progressing deployment of these technologies

Heat pumps are likely to be one of the primary solutions for low-carbon heat in the UK. Although heat pumps efficiency decreases during cold temperatures, they represent an efficient use of energy through transferring heat from low temperature sources raising it to higher temperatures and are one of the low-regret opportunities that currently exist. There are opportunities to install heat pumps in homes that are not on the gas grid and in low-carbon heat networks in density areas such as cities.⁵⁴ Heat pumps have been deployed in multiple European cities however in the UK sales of all types were less than 20,000 in 2017,⁵⁵ which is significantly smaller than what it needs to be to continue to reduce emissions in buildings. The CCC indicated that in the next decade, there should be a significant roll-out of heat pumps. This roll-out should include a focus on off-gas grid homes, with the aim of transitioning 1 million homes that are using high-carbon fossil fuels to heat their homes, such as oil-fired boilers.⁵⁶

Recommendation 13: No new domestic oil-fired boilers for heating should be installed from 2023.

- Government should target off-gas grid homes to enable the development of the market for low-carbon heat and help eliminate some of the most high-carbon heating options currently used. Oil-fired boilers are of particular concern and should not be installed after 2023.
- These are particularly carbon-intensive, and lower carbon alternatives, such as biomass boilers or a heat pump and appropriate energy efficiency measures are transitional technologies that can support reductions in emissions from heat.
- As there are fewer interdependencies on future use of the gas grids and heat networks, off-grid homes offer more flexibility for installations ahead of a more developed national and regional plans. As such, they can help prime the heat pump market, as this technology should be one of the main options for these homes, alongside biomass or LPG.

Like the CCC, the Commission is of the view that there needs to be a significant deployment of heat pumps in the UK. However, within the next 5 years the UK should aim to significantly increase the installation of heat pumps (e.g. increasing up to 1 to 1.5 million installations a year) if we are to get the market moving.

Energy efficiency is key to reaching this level of deployment and in making this transition for many consumers affordable. In a typically sized home that is efficient, installation of a heat pump could be £1,000 cheaper than for a home that is not and running costs would be significantly lower.⁵⁷

However, consumer awareness and acceptability of heat pumps presents a particular challenge in the wider deployment of heat pumps and increasing of the heat pump market. Additionally, there is a skills gap in the market, which the government working collaboratively with business will have to fill.

Hydrogen

Producing hydrogen in the UK

The major challenge of hydrogen is not on the delivery side but generation. The “cleanest” way of generating hydrogen is through electrolysis. This takes water and uses electricity to split the water into oxygen and hydrogen components. If the electricity is produced from low-carbon sources, such as offshore wind or nuclear, then the hydrogen (known as ‘green hydrogen’) produced could support a hydrogen economy that is compatible with net-zero. This process is not very efficient and would require a significant upgrade in the grid scale generation of low-carbon electricity. The UK has ambitious plans to increase low-carbon electricity generation, including the target for 40GW of offshore wind by 2030. If the UK is able to achieve this, and other ambitions, including the construction of new nuclear power stations, there is opportunity to use hydrogen production to offset variable power demand and renewable power generation, and even contribute to energy storage.

The alternative are processes such as steam methane reforming, which create hydrogen from natural gas, but generate CO₂ in parallel. This CO₂ must be captured in order to make this a carbon zero process. The options are pumping the CO₂ into underground, or undersea, reservoirs (carbon capture and storage) or converting the CO₂ into useful products, such as materials for the construction industry.

The majority of hydrogen produced today is from fossil fuels, referred to as ‘grey’ hydrogen. However, the UK has significant potential to produce both ‘blue’ hydrogen where fossil fuels are also used but carbon emissions are captured and stored, and ‘green’ hydrogen, which is generated by zero-emission energy sources, such as renewables and nuclear. Natural gas is currently the dominant source of producing hydrogen with Steam Methane Reformation being the most primary technology for producing hydrogen.⁵⁸ All forms of clean hydrogen will be needed to deliver the UK’s 2050 net-zero target, with ‘blue’ hydrogen likely initially providing the greater scale.

Currently, the UK does not produce significant amounts of low-carbon hydrogen nor are the correct mechanisms in place for significant development of CCS to provide a market for hydrogen. Should these challenges be addressed, hydrogen could play a role in industry by reducing emissions from industrial heat, in transport via hydrogen fuel cell vehicles, the built environment as a heating solution in combination with heat pumps providing a ‘hybrid’ solution. Hydrogen could also play a role in the power sector in replacing natural gas plants.⁵⁹

What steps need to be taken on hydrogen now and in the future

There needs to be significant market building for hydrogen in the UK in order to create the demand for hydrogen and drive down the production costs. In the longer term a Contracts for Difference mechanism or another market-based model could be deployed in the sector, learning from the successes of using long-term policy to drive innovation and cost reductions in the power sector. The European Commission has proposed a “carbon contracts for difference” (CCfD) in its newly released Hydrogen Strategy as a tool to support scale-up.⁶⁰ The long-term commitments and policy certainty that come with such mechanism builds market confidence. However, in advance of this there need to be several large-scale, publicly co-financed, regional hydrogen test beds which demonstrate that a hydrogen-based heat economy can be successfully delivered.

Government has taken some steps to addressing these barriers and increasing hydrogen production in the UK. In February this year, the government announced a £90 million investment to try and reduce emissions from homes and heavy industry and to create Europe’s first large scale, low-carbon hydrogen plants with the possibility of generating enough clean energy to heat over 200,000 homes.

Recommendation 9: Mandate that after 2025 all new gas boiler installations must be part of a hybrid system or be ‘hydrogen-ready’. By 2035, no boilers capable of burning natural gas should be installed, with all new heating systems being zero-carbon.

- The Commission recommends government could go further by mandating that after 2025 all new gas boilers installed should either be ‘hydrogen-ready’ or installed as part of a hybrid-system, such as a hybrid heat pump. By 2035 no new natural gas boilers should be installed and only air source or ground source heat pump or hydrogen-fuelled boilers should be installed, or other low-carbon heat solutions like heat network connections.
- The government should support, through a competitive process, a large-scale hydrogen for heat demonstration project. Prototypes of hydrogen ready boilers have already been developed by boiler manufacturers and installing boilers that can be easily adapted to burn hydrogen will create optionality as local decisions are made around low-carbon heat solutions.

The above requires a comprehensive plan from government to build supply chains, tackle the upfront and installation costs of low-carbon heat, the ongoing running costs, development of new standards and the perceived inconvenience of new systems.

Heat Networks

Heat networks are seen as a major component of future heat solutions, particular in high building density/population density areas where there is an economy of scale. The installation of heat networks into existing built up areas is disruptive and hence has greatest potential in new developments. However, to reach CCC targets for close to a fifth of heat being delivered through heat networks, new heat networks and new heat network connections will be required. At present most heat networks focus on easy to reach solutions such as city council buildings. There needs to be serious thought given as to how to deploy such solutions into existing housing, particularly where waste heat sources are in close proximity. There is much to learn from the approach in Scandinavia. Many district heating systems operate using combined heat and power generation, CHP. This is not low or zero carbon as such engines combust methane. Priority needs to be given to exploitation of waste heat for such networks and alternative low-carbon fuels for CHP engines.

Heat networks can provide a range of environmental, economic and employment benefits. According to the Association of Decentralised Energy, heat networks could lead up to 64,000 jobs created annually over the five-year lead-time of a heat network scheme delivery.⁶¹

Heat networks funding

The current funding for the Heat Networks Investment Project, HNIP, is £320 million with a further £270m announced for a new Green Heat Networks Fund in the budget of March 2020. The government should commit to raise funding to the level needed to achieve the Committee on Climate Change, CCC, target; this would be £3 billion if the market demands. Thought should also be given in regional and local infrastructure planning for simultaneous electricity grid reinforcement and heat grid installation and development.

The continuation of government support and funding is required to meet the scale of infrastructure required to ensure an adequate deployment of heat schemes. Heat networks also allow the use of waste heat from both industrial and waste incineration, which can displace heat produced by burning natural gas. A mechanism to address demand risk and policies to place the heat networks industry on a level playing field with other networks may also be necessary to achieve the levels of growth needed to meet net-zero.

Creating the correct policy framework to allow significant deployment of these and other low-carbon solutions is one of the key immediate steps the government needs to take if it is to reduce emissions coming from heat. As we have outlined, steps are being taken, however, not at the speed that is required. The heat pump market needs significant scaling up with more information provided to consumers on the different technologies and grants to assist them with the costs of heat pumps and installations. Further government funding for heat networks, as outlined above, is needed should the technology be able to reach its full potential in providing local job growth.

Who pays

The CCC has estimated that the UK's 2050 net-zero target is likely to cost between 1-2% of GDP as technology costs continue to fall, and innovation continues to increase. The estimates from the manifestos of both political parties at the time of the last election suggested levels of investment of the order of hundreds of billions of pounds. This will need to be drawn from both the public and private sector. The costs of some technologies will depend on improvements in existing energy efficiency measures. For example, should energy efficiency measures be scaled up, then costs of installing heat pumps could be lower.⁶² There will also be cost benefits following from the scaling up of the mass production of, for example, heat pumps which will make them more price competitive with present boiler technologies. There are lessons to be learned from the offshore wind sector relating to the cost reduction programme of that sector and interventions that might be accommodated into the heat sector. Certainly, ensuring that there are a common set of standards and specifications is a key element of such a plan. For developing technologies such as hydrogen the cost to the consumer is yet unclear. The cost is dependent on the method of production. At present most industrial hydrogen is produced through steam methane reforming, but this needs to include carbon capture and storage or usage in order to make the production low-carbon. This additional step has a price penalty. There are also opportunities to produce more low-carbon hydrogen via electrolysis from renewables and nuclear. Electrolysis is inefficient and the hydrogen produced is more expensive than from steam methane reforming, therefore there needs to be an innovation programme that will drive down the cost of hydrogen production from electrolysis. This route will also require a scaling up of low-carbon electricity generation. These uncertainties mean that it is not possible to be confident of the cost of heat from hydrogen.

The cost of the transition will need to be borne by a combination of the public and private sector. For the social housing sector, public funding will be required to drive the transition which could have the benefits of aggregated scale and a common heating solution for those communities. Throughout most of the transition this will be driven through consumer choice of technology solutions, vendors and installers. To initiate the transition public funding through the form of grants will be required, transitioning to loans with a final cut-off mandating a switch from gas boilers to low-carbon solutions. For the consumer choice and market to function, that choice needs to be genuine, with viable options for households and businesses. For this to be the case then the infrastructure to support the technology alternatives needs to be in place, including electricity, hydrogen or heat networks. Of course, not all of these options will be available everywhere but for the market to function and drive prices through competition some optionality is required. This infrastructure investment needs to be supported by government through clear regulation and market-support where required.



Just transition

The transition to low-carbon heating is not low-cost. There will be those who can afford the changes to the insulation of their home and the installation of new heating appliances. They will then be able to benefit from the lower heating costs due to higher building efficiency and lower heat usage. This will unbalance the market and could drive prices up for others. Most concerning is those in fuel poverty faced with the heat or eat decision, who will not be able to afford the transition.

The government needs to work with business and consumers to ensure in deploying these technologies and in turn improving the living standards of consumers, that it is done in a just way. It is a matter of principle that sections of society do not lose out on the UK transitioning to a low-carbon economy. It is vital that both government and industry look to prioritise projects that will benefit fuel poverty communities, working hand in hand with local government. There needs to be public funding for such heat transition projects to establish approaches to community engagement, infrastructure roll-out, coordinated insulation and heat generation installation and a customer service programme. These large-scale projects then form the basis for building consumer and market confidence which will draw in finance to allow scale up of manufacturing and delivery.

The policies that will be implemented in the next decade and beyond will be key in meeting these opportunities. The policies linking education, training, tax and spend and approach to regional decision making will be key enablers to ensuring that the transition also supports revitalisation of towns, rural communities and is in line with the government's 'levelling up' agenda.⁶³

The Treasury's review of the costs of the net-zero transition is a crucial opportunity for the government to outline how it intends to incentivise much needed investment. The review, which aims to look at how various households and business could contribute to the transition needs to take into account the economic positions of these consumers and business when asking them to make the necessary changes on the transition particularly as the UK recovers from the COVID-19 pandemic.⁶⁴ There is a need to develop plans which will provide long-term confidence for consumers, investors and manufacturers. Without such signals the heat transition will continue to bump along the bottom.

Mobilising private finance

The business community will have a critical role to play in driving the low-carbon heat transition but also ensuring that the transition is just to consumers. The finance sector in particular has a role to play in this via green finance. Green finance will play a significant role in addressing the decarbonisation challenges outlined.

The UK is the world's second-largest financial centre and the largest centre in Europe; nearly three times the size of centres in France and Germany.⁶⁵ Whilst London is already a leading hub for green finance, backed by direct access to investment, liquid capital markets and a global reputation for expertise and innovation, it is arguably falling behind other financial leaders.

Some businesses and financial institutions have seized the opportunities green finance can bring, however, there are others who are yet to embrace it fully. This inertia seen in many large organisations may be linked to the reliance on established business models which presently continue to provide a return and an inadequate policy environment that is not supplying the right guidance for this sector. There is clearly a role for policymakers to play to ensure that all businesses can access green finance and can fund their activities, where sustainability, fairness and green principles are seen as key criteria for investment.

The creation of the Green Finance Institute and the government's Green Finance Strategy published last year, are key steps in providing the correct policy framework to accelerate green finance in the UK. The Institute convened a Coalition for Energy Efficiency of Buildings (CEEB) for the purpose of developing the market for financing net-zero carbon and climate-resilient buildings. The CEEB recently published a report putting forward 21 scalable demonstrator projects, designed to overcome the barriers to mobilising capital towards the social rented, private-rented, and owner-occupied residential sectors.⁶⁶ Should some of these demonstrator projects be viable and therefore developed, they would be the much-needed flagship projects pioneering and driving the low-carbon heat transition.

“Heat solutions will not be a one size fits all. Population density, existing regional infrastructure, mix of new and old housing stock and consumer preferences, all will influence what needs to be deployed.”

Conclusion

What is clear from this Commission's report is that due to the scale of the challenge of decarbonising heat, coordination between government, business and consumers will be critical.

As there is no single technological solution to this challenge, business and government must work together in creating a clear public awareness campaign setting out what decarbonising heat entails for the country, what this means for the public and how the government plans on working with the public in tackling this challenge. Due to the intervention required and the disruption that will be caused, this awareness campaign will be critical in preparing the public for the changes that will occur in the next decade, through to net-zero and beyond.

Parallel to this, the government will need to work with the business community to scale up the technologies the UK already has, and additionally the technologies that will be needed through the medium, and long-term. A major skills programme will be needed and there will be opportunities for the UK to build its industrial and manufacturing capacity to respond to the challenge. Therefore, the government will have to engage with business leaders to further explore opportunities needed to scale up manufacturing, installation and service capabilities that will help the UK transition to low-carbon heat.

Moreover, as coordination will be the key element to successfully decarbonising heat, the government must work with local and regional decision makers, in delivering an overarching plan. A plan that takes into account the challenges that different regions face, from lack of resources through to a shortage of expertise on decarbonising heat. This is where the Commission believes a National Delivery Body will be central.

The Commission's recommendations aim to provide a platform that the government and businesses can build upon. The government's recent announcements on energy efficiency has been welcomed by business, however, increasing investment in the energy efficiency market must continue at a faster rate as this will be integral to the success of decarbonising heat.

As the government looks towards the next phase of its reaction to the COVID-19 pandemic, the rebuild, it must ensure that it is a green recovery. The forthcoming Heat and Buildings Strategy is a prime opportunity for the government to show this and to show that it has listened to businesses on what they require in the transition to low-carbon heat. Additionally, as the UK prepares to host the postponed COP26 climate summit, this will allow government and business to showcase to the world the low-carbon expertise the UK has, and the plan it is to reach net-zero.

The transition to low-carbon heat and achieving to net-zero will not be easy. However, the Commission hopes that this report will contribute to thinking around how the UK ensures that the transition is Just for consumers and businesses.



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About the CBI

Founded by Royal Charter in 1965, the CBI is a non-profit business organisation that speaks on behalf of 190,000 UK businesses of all sizes and from across all sectors, employing nearly 7 million people between them. That's about one third of the private workforce. This number is made up of both direct members and our trade association members. We do this because we are a confederation and both classes of membership are equally important to us.

The CBI's mission is to promote the conditions in which businesses of all sizes and sectors in the UK can compete and prosper for the benefit of all. With offices around the UK (including in Scotland, Wales and Northern Ireland) and representation in Brussels, Washington, Beijing and Delhi, the CBI communicates the British business voice around the world.

Our mandate comes from our members who have a direct say in what we do and how we do it

The CBI receives its formal mandate from 9 Regional Councils, 3 National Councils from Scotland, Wales and Northern Ireland plus 16 sector based Standing Committees. These bodies are made up of members in that region, nation or sector who serve a term of office. The chair of each Standing Committee and Regional and National Council sit on the CBI's Chairs' Committee which is ultimately responsible for setting and steering CBI policy positions.

Each quarter this formal engagement process across the CBI Council reaches over 1,000 senior business leaders across 700 of our members who have a direct say in what the CBI do and how they do it, from refreshing their workplan to discussing the key business issues of the day and re-calibrating its influence. Over 80% of the businesses represented on the CBI Council are outside of the FTSE350 as the CBI represents a wide range of sizes and sectors from the UK business community. This formal governance process is supported by a wide range of working groups, roundtables, member meeting and events that makes the CBI unparalleled at listening to and representing British business.

CBI Council in numbers



1000+

Committee and Council representatives



28+

Regional and National Council and sector based
Standing Committees



50%

Representatives of the CBI Council at C-Suite level



80%

Of the CBI Council from non-FTSE 350 businesses

Produced by Abdul Kamara, the **Infrastructure and Energy** team and the University of Birmingham
To share your views on this topic or ask us a question, contact:



Abdul Kamara
Policy Adviser
abdul.kamara@cbi.org.uk