Decarbonisation of Heat in Great Britain

Public summary

October 2021

Foreword

In 2019, the UK set in legislation a bold ambition to fully decarbonise the economy by 2050. This will involve a transformation of the way we generate, store and use energy. Achieving this transformation will be a major societal challenge over the next few decades, but will be important if we are to play our part in averting catastrophic climate change.

Decarbonisation will affect all parts of our lives, but decarbonising the way we heat our homes raises especially difficult questions. In this report we examine how policy and economics could shape the future mix of technologies for residential heating, and what this could mean for the energy system and for consumers. Working closely with a group of stakeholders in industry and Government, Aurora has leveraged its expertise in energy market modelling to produce a sophisticated representation of the interactions between heating technology deployment and the power and hydrogen markets, and used this to derive insights for policymakers and industry.

Our report on decarbonisation of heat highlights the economics and potential roles of a range of different heating technologies, including air source and ground source heat pumps and hydrogen boilers. We consider how power demand, prices, and system costs will develop in different scenarios, analyse the value of thermal flexibility, and consider what would be needed to ensure security of supply during extremely cold weather events. Whatever the future technology mix, long term planning of infrastructure will be needed to provide the networks and storage to accommodate demand.

The consumer is central to the heat decarbonisation story: encouraging households to switch to low-carbon heating will require helping them to overcome both cost and non-cost barriers, and the need to protect lower-income households will influence the details of policy design. The report sets out a series of options for policy interventions that could be combined to help phase out the gas boilers that dominate the heating mix today.

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About the study

This study was conducted for a group of 15 clients in the public and private sectors interested in potential pathways for decarbonising residential heating, and the impact of these pathways on energy systems. Some of the clients involved are listed below.

Our findings and policy conclusions are based on our own independent analysis and do not necessarily reflect the views of the participating clients.

This document presents a summary of the key analysis and findings from the full report that was developed for participants.

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About Aurora Energy Research

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Aurora was founded in 2013 by University of Oxford professors and economists who saw the need for a deeper focus on quality analysis. With decades of experience at the highest levels of academia and energy policy, Aurora combines unmatched experience across energy, environmental and financial markets with cutting-edge technical skills like no other energy analytics provider.

Aurora's data-driven analytics on European and global energy markets provide valuable intelligence on the global energy transformation through forecasts, reports, forums and bespoke consultancy services.

By focusing on delivering the best quality analysis available, we have built a reputation for service that is:

- **Independent –** we are not afraid to challenge the 'norm' by looking at the energy markets objectively.
- **Transparent –** all our analyses undergo further refining through a detailed consultation process across our private and public sector clients.
- **Accurate –** we drill right down to the requisite level of detail and ensure results are internally consistent. In power market analysis, this means half hour granularity with complete internal consistency across energy, capacity, balancing and other markets.
- **Credible –** trusted by our clients, our results have proven bankability.

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Executive summary

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- **Phasing out gas boilers is crucial for the decarbonisation of heat:** banning gas boiler replacements by 2035 could put Britain on track towards zero carbon heating by 2050, but delaying a ban to 2040 would leave us in 2050 with 15Mt of CO_2 emissions from residential heating, about a quarter of today's total; to make a gas boiler ban in 2035 practical, action is needed now to ramp up deployment of low carbon alternatives
- **Without policy change, we expect gas boiler replacements to remain attractive to households:** heat pumps are a technology that can start being deployed today, but today's air source heat pumps (ASHPs) have typically twice the up-front cost of gas boilers; even after accounting for heat pumps' higher efficiency, and declining costs over time, they could still be 50% more expensive on an annualised lifetime cost basis in 2030
- **Achieving deployment of 600k heat pumps per year by 2028 will require policy intervention:** both cost and non-cost barriers need removing; costs could be addressed through a combination of grants, carbon taxes and reallocation of policy costs away from electricity (for example, onto gas or onto general taxation); an awareness of impacts on low-income households will be important for policy design
- **Decarbonisation of heat will drive higher electricity demand:** electricity demand from heating could quadruple by 2050 to over 100TWh per year, accounting for more than a quarter of the increase in total electricity demand
- **Not all electric heating is equal:** technologies like networked ground source heat pumps and thermal batteries can provide greater efficiency and flexibility, and in scenarios with greater deployment of these technologies we expect energy system costs to be lower by around £1bn a year on average to 2050, which is roughly 2% of total system costs
- **Household economics won't lead to an optimal system:** without targeted policy intervention, we do not expect the more efficient or flexible electrical heating systems to be economically attractive to householders, which could lead to over-dependence on ASHPs; although they are likely to be an important part of the mix, a system with only ASHPs would have unnecessarily high peak power demand and system costs
- **Scenarios using hydrogen for a share of heating have lower peak power demand:** using hydrogen in some homes means lower demand for electricity at peak times and in extremely cold weather events (assuming flexible electrolysis), and could lower power network costs by £0.5bn per year by 2050
- **Green hydrogen could drive higher electricity prices:** if around 30% of hydrogen is produced by electrolysis in the 2030s, baseload power prices could be up to £8/MWh higher in scenarios with hydrogen heating, as flexible electrolysers reduce the occurrence of low-price periods

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Decarbonising heat will be essential to reduce emissions from buildings, which accounted for 19% of UK territorial emissions in 2018

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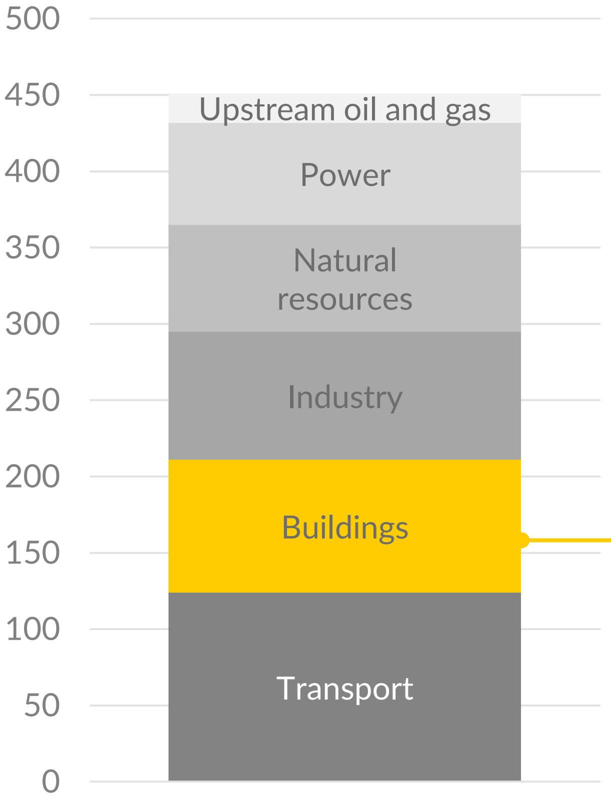
Heating is a major contributor to UK emissions

UK territorial emissions 2018
$MtCO_2e$



- Buildings accounted for 87Mt, 19% of the total of 451Mt
- Residential buildings accounted for 68Mt, more than the whole power sector
- Buildings demand includes heating, cooking and hot water
- Almost 90% of homes in England currently use fossil fuels
- About 85% of these are connected to the gas grid

Decarbonising heat represents a major challenge

- Although the UK has reduced its territorial emissions by over 1/3 since 1990, much of the progress came from the power sector
- Decarbonising buildings is more challenging for several reasons:
  - It involves reducing emissions at tens of millions of locations
  - It requires individual choices from households
  - The replacement rate for the building stock is low and heating systems have long lifetimes
  - Payback periods for economic switches to new technologies can exceed the time a household stays in one property
  - For rental accommodation, switching technology may require landlords to invest, but tenants often pay the heating bill
- However, the UK government’s updated Nationally Determined Contribution of 68% emissions reduction by 2030 (vs 1990 levels) and its target of net zero emissions by 2050 bring new urgency
- The government is under pressure to clarify decarbonisation policies before it hosts the COP26 summit in Glasgow in November 2021

Sources: Aurora Energy Research, BEIS Analysis of “Final UK GHG emissions national statistics” cited in Energy White Paper, December 2020

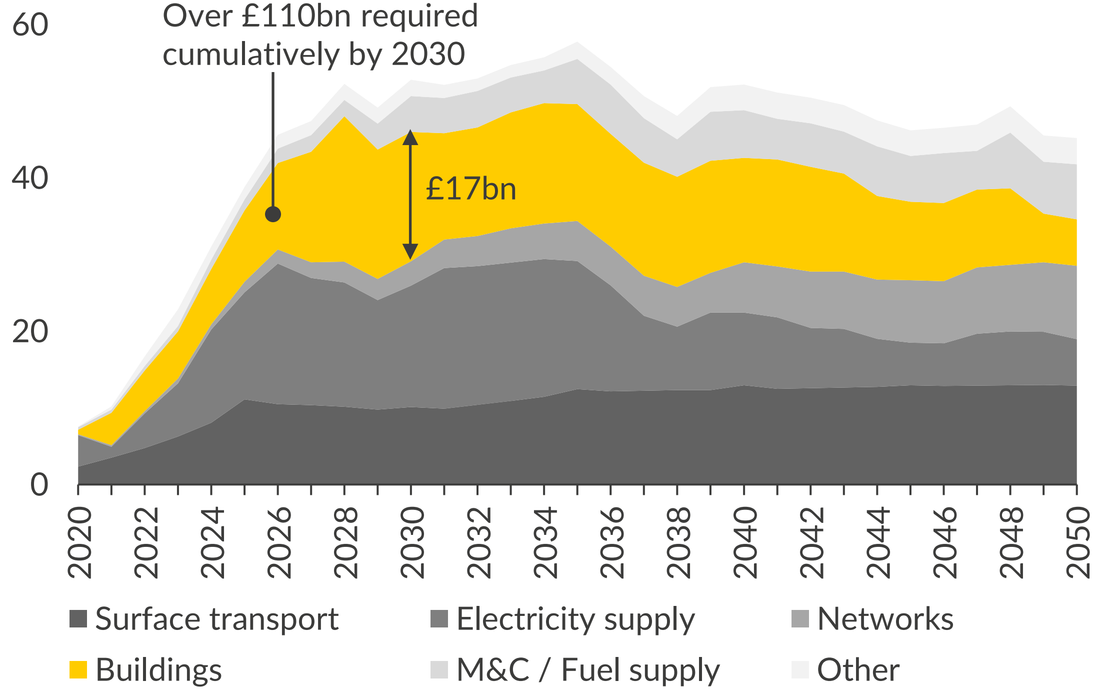
The UK government is developing its next policy steps on buildings and heat; £17bn of investment per year could be needed by 2030

The 2020 Energy White Paper promised a series of new policies, and progress has been made on several consultations

- **Buildings and heat strategy:** released in October 2021
- **Future homes standard:** consultation response published January 2021, with roadmap for full implementation by 2025
- **Fuel poverty strategy for England**: published February 2021
- **Response to consultation on green gas levy design**: published March 2021
- **Clean heat grant**: consultation on design ran to March 2021; government response expected in 2021; launch expected in 2022
- **Consultation on policy for UK heat pump market**: expected 2021
- **Consultation on local authority zoning for heat networks**: expected 2021
- **Call for evidence on role of "hydrogen ready" appliances**: planned for after the results of the Hy4Heat programme in late 2021

CAPEX to decarbonise buildings could reach £17bn in 2030

Capital and investment costs for "Balanced Pathway to Net Zero"
£bn/year, from CCC Sixth Carbon Budget, 2020



A variety of technologies could provide lower-emission heat, but there is uncertainty about how the future heating mix will develop

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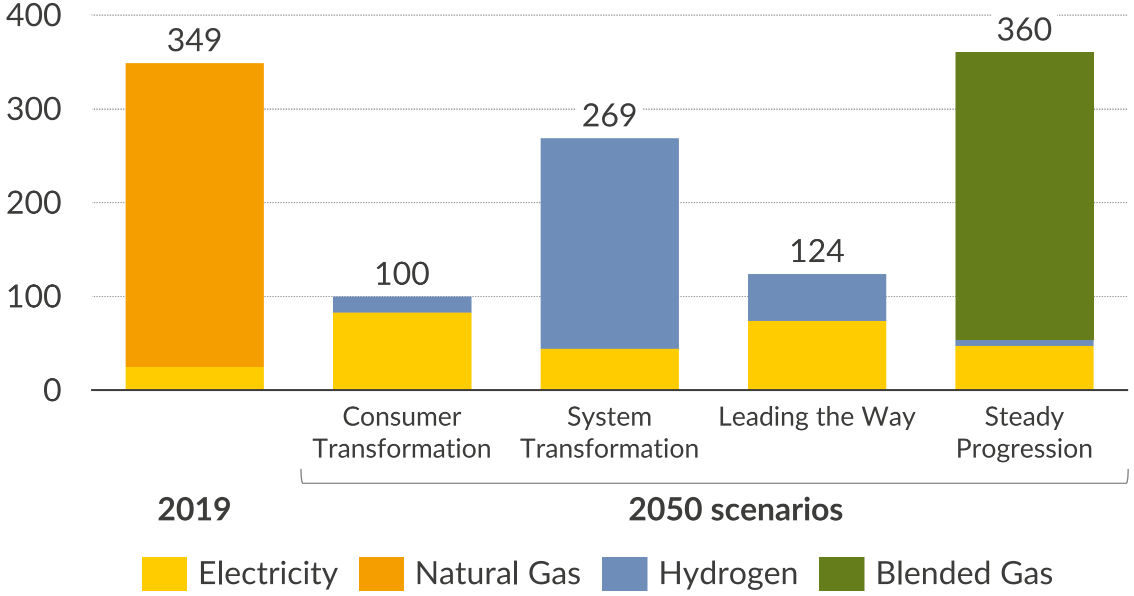
A variety of technologies could contribute

- **Electric heat pumps** are an efficient electric heating technology. The Energy White Paper set a target of 600,000 installations per year by 2028, compared with about 30,000 today.
- **Hydrogen** could be burned for heat in systems similar to today's gas boilers. 100% hydrogen systems are now being trialled.
- **Heat networks** serve about 0.5m homes today. The government plans to deploy them more widely, and to use more low-carbon sources like heat pumps, biomass or solar.
- **Hybrid systems** combining heat pumps with gas or hydrogen boilers could combine low emissions with low peak-time electricity demand.
- **Thermal storage** will become increasingly important as electrical heating becomes more widespread, given the variations in electricity prices within any given day.
- **Energy efficiency** measures will play a vital role in reducing energy demand for heat, and will be vital for homes switching to heat pumps, which tend to produce lower flow temperatures than typical gas boilers.

A broad range of outcomes is possible for future energy demand

Overall Networked Fuel Mix for Heating Homes
TWh, from National Grid Future Energy Scenarios 2020



- The future mix will depend on policy, economics, technological development, consumer choice and interactions between fuel market sectors

Sources: Aurora Energy Research, National Grid "Future Energy Scenarios", July 2020, Energy White Paper, December 2020

In this study, we investigated what could drive the future mix of heating technologies, and how this mix will affect the energy system

Our modelling process has two main parts.

1. We use an economic model of residential heat technology deployment to simulate the development of the future mix

- We consider the most economically attractive options for households to replace retiring heating systems
- We account for policy constraints and incentives, as well as practical limits on how fast installations can be scaled up
- We adjust deployment rates to reflect potential consumer acceptance of new technology

2. We use Aurora's power and hydrogen system models to assess the effects of the heating mix on the energy system

- We assess the scale and shape of demand for power and hydrogen from heating
- We model effects on market prices, and capture the feedback effect on relative costs of different heating types
- We assess the implications for network and system costs

By taking an integrated market modelling approach, we aimed in our study to provide a deeper understanding both of how today's policy decisions could influence the development of the heating mix, and of how the future heating mix will interact with power, gas and hydrogen markets. This document provides a high-level summary of the results of the study.

Our forecasts use a range of assumptions on uncertain future developments: for example, we assume power and gas systems on a trajectory towards net zero, a particular mix of blue and green hydrogen production, and flexibly operated electrolysers; under different assumptions, our results would change. Our market forecasts are based on long term fundamentals, and do not reflect short term variations such as recent historically high gas prices: we note that policy design over the next few years will also need to take these variations into account.

The scenarios we set out are not designed to be optimal solutions, and we do not seek to prescribe the best policies to follow, but we do aim to shed light on possible solutions by clarifying the economics and showing the consequences of different policy assumptions.

We explored scenarios with varying degrees of electrification and hydrogen penetration

Scenario	Description
Reference (R)	Base case for comparing alternative scenarios; assumes no additional subsidy support nor large conversion of gas networks to hydrogen
Increased Network Heat Pumps (IN)	Public & private support to increase penetration of network heat pumps
Mixed Approach (MA)	Mix of electrification and hydrogen network development
Max Hydrogen (MH)	Maximally ambitious deployment of hydrogen networks

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Common assumptions across scenarios

- Ban on all fossil fuel boiler sales for new homes by 2025
- Ban on all fossil fuel boiler sales by 2035
- GSHPs constitute 15% of total heat pump build limits in 2021, rising to and remaining at 50% by 2030
- 18% of heat demand met with low carbon heat networks by 2050
- Low efficiency homes looking to install a heat pump can either install an energy efficiency package or choose a larger heat pump

We differentiated the scenarios by varying levels of heat pump build limits and hydrogen infrastructure

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<table>
<tr><th>Scenario</th><th>Heat pump build limits</th><th>GSHP business models</th><th>Hydrogen infrastructure</th><th>Thermal storage policy & subsidy</th></tr>
<tr><td>Reference (R)</td><td>Build limit based on Energy White Paper target (0.6M p.a. by 2028, 1.2M p.a. by 2035)</td><td>Consumers pay all in-house & groundworks capital cost up-front; no network heat pumps</td><td rowspan="2">No hydrogen infrastructure for domestic heating</td><td rowspan="2">Technologies with heat batteries shift their demand to avoid the evening grid peak</td></tr>
<tr><td>Increased Network Heat Pumps (IN)</td><td>Build limit based on “Absolute” limit trajectory from the CCC 6th Carbon Budget (1.2M p.a. by 2028, 2.3M p.a. by 2035)</td><td rowspan="3">75% of the GSHP build limit is reserved for network heat pumps (run on ambient heat loops) where the groundworks capital cost is reallocated as operating expenditure</td></tr>
<tr><td>Mixed Approach (MA)</td><td>Build limit based on “Stretch” trajectory from the CCC 6th Carbon Budget (0.8M p.a. by 2028, 1.6M p.a. by 2035)</td><td>Development of hydrogen network in Northern England to serve 12% of heat demand by 2038</td><td rowspan="2">Technologies with heat batteries shift their demand to avoid the evening grid peak</td></tr>
<tr><td>Max Hydrogen (MH)</td><td>Build limit based on Energy White Paper target (0.6M p.a. by 2028, 1.2M p.a. by 2035)</td><td>Development of hydrogen networks to serve 50% of heat demand by 2050 (phased in from 2034)</td></tr>
</table>

Sources: BEIS – Energy White Paper, Element Energy report for CCC 6th Carbon budget

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Without policy changes, we expect gas boiler replacements to remain cheaper than heat pumps on an annualised lifetime cost basis

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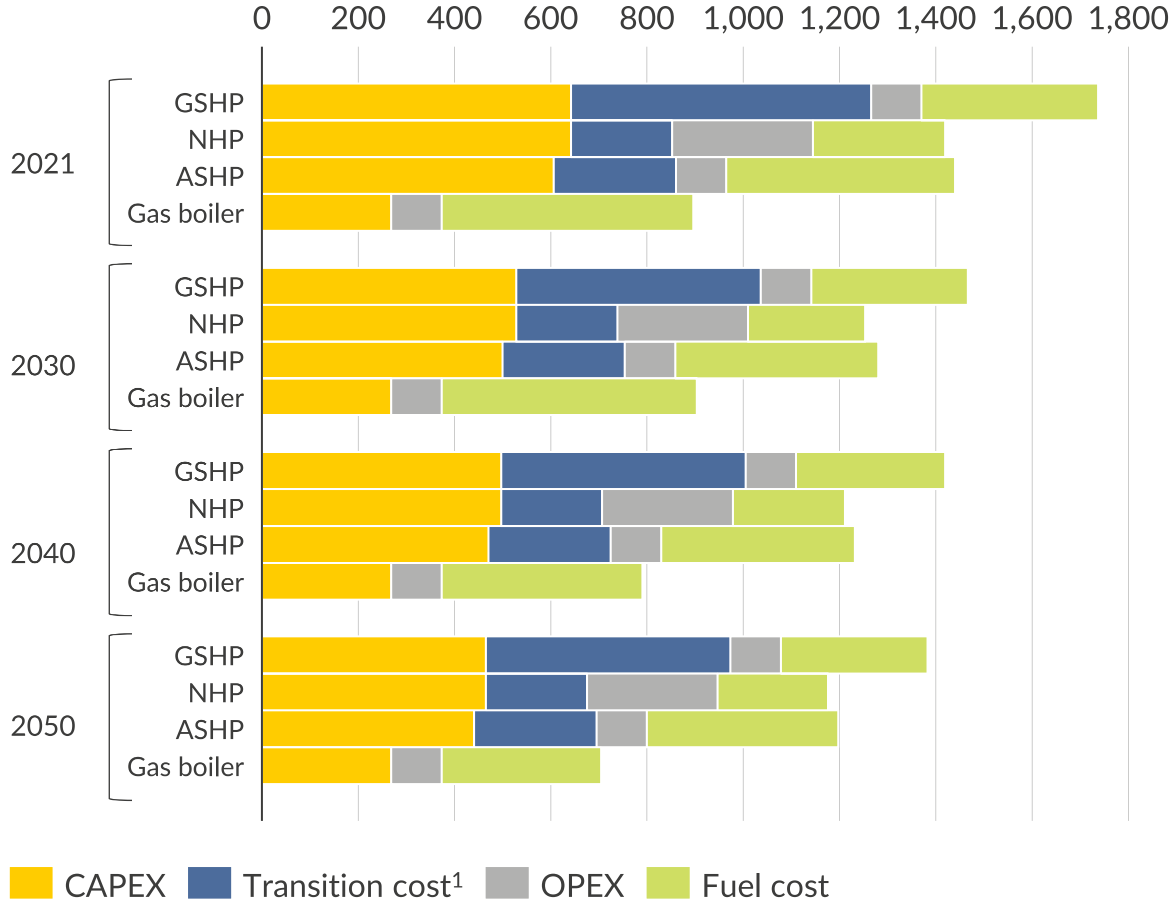
Annualised cost of new heating technologies, when switching from a gas boiler in an efficient, owner-occupied house
£/ year (2020 real)



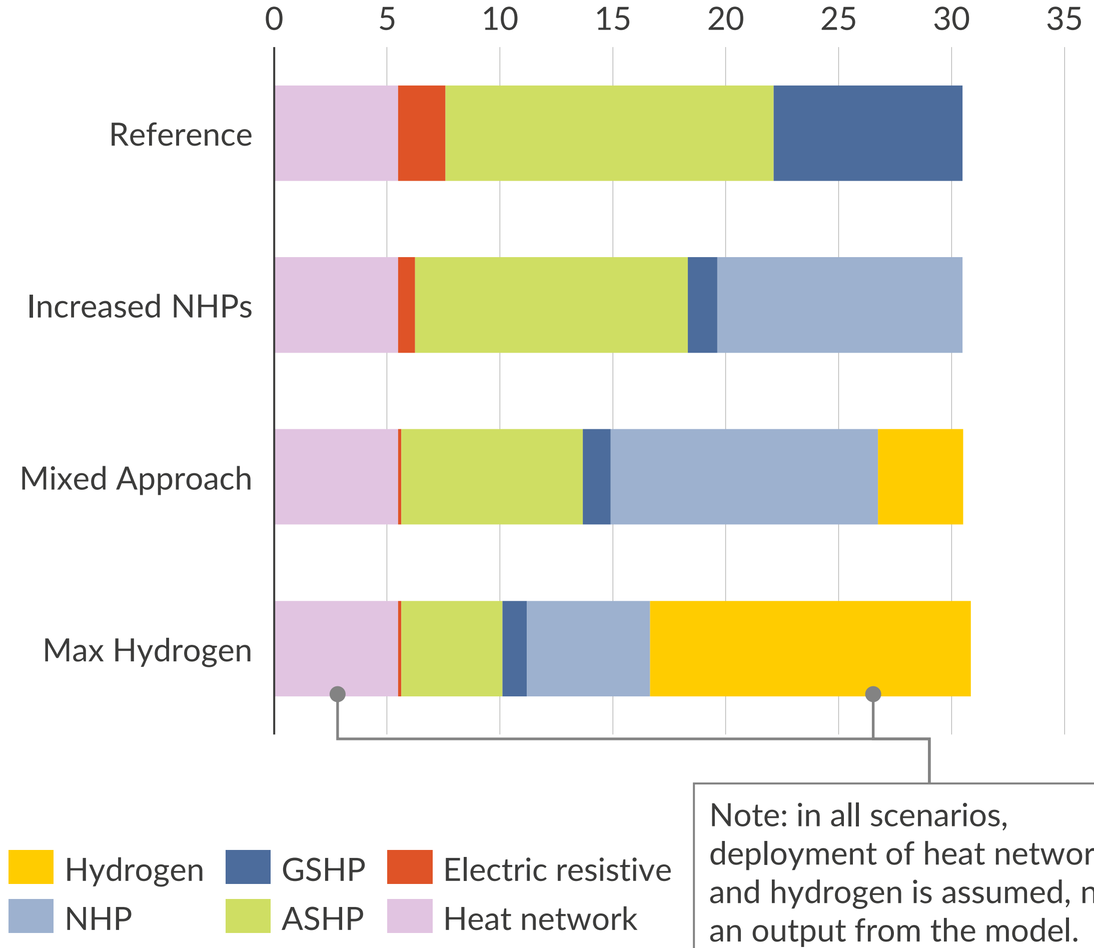
- For different types of homes and heating technologies, we assessed annualised lifetime costs including:
  - up-front cost for the heating unit
  - any needed home retrofits
  - annual maintenance, financing and fuel
- Across scenarios, in the absence of policy intervention, replacing a gas boiler remains lower-cost than installing a heat pump
- If gas boiler replacements are banned, we see air source heat pumps (ASHP) and networked ground source heat pumps (NHP) as competitive, with each being more appealing to some home types
- Beyond economics, there are practical constraints on deployment of each type of heat pump: for example,
  - Noise levels or space availability may make ASHPs unattractive for some high-density housing or flats
  - Refitting streets with shared ground loops to use NHPs will not be practical in all areas; it could require willingness of householders to shift from an individual to a partly shared system; and costs may be raised if some boilers have to be retired early in order to allow streets to be refitted all at once

1) Transition costs include: cost of decommissioning old heating technology; commissioning costs (costs associated with preparing the building for new technology); and owner costs (these are additional costs for the incoming technology, such as groundworks for GSHP)

Source: Aurora Energy Research

Under different technology and policy assumptions, we could reach very different mixes of heating technologies in 2050

Homes with each technology installed in 2050
Millions of homes



Note: in all scenarios, deployment of heat networks and hydrogen is assumed, not an output from the model.

- We assume that gas boiler replacements are banned in 2035, and that households then choose the most economical technology for them on an annualised cost basis
- In our "reference" case, we find air source heat pumps (ASHPs) are usually chosen over ground source heat pumps (GSHPs)
- In our "increased NHPs" case, we allow for networked ground source heat pumps (NHPs) to be built, with heat sources shared across several homes, and most of the initial cost met by a third party and charged back to households over time
- This leads to a greater economic uptake of NHPs rather than ASHPs, an effect which is more pronounced if we assume the in-home CAPEX cost for NHPs is as low as for ASHPs
- Note that in this analysis we have not factored in practical limits on which homes are suitable for ASHPs or NHPs, although we have accounted for less-well-insulated homes needing to spend more (on insulation or a larger pump) to use a heat pump
- We also study two cases in which hydrogen networks are deployed for home heating, either in just the North of England ("Mixed Approach") or across the country ("Max Hydrogen")

Source: Aurora Energy Research

Decarbonisation of heat will lead to higher electricity demand and could be a major driver of hydrogen demand

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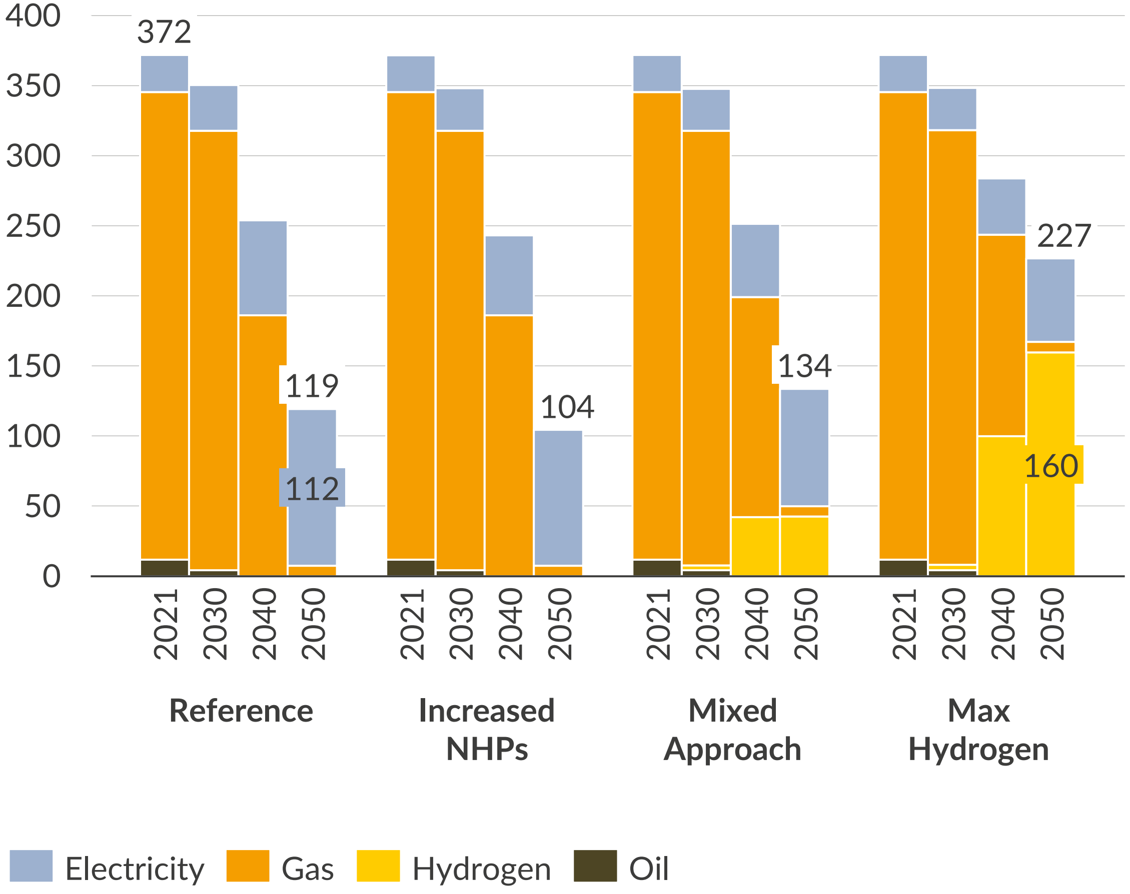
Fuel demand for heating
TWh

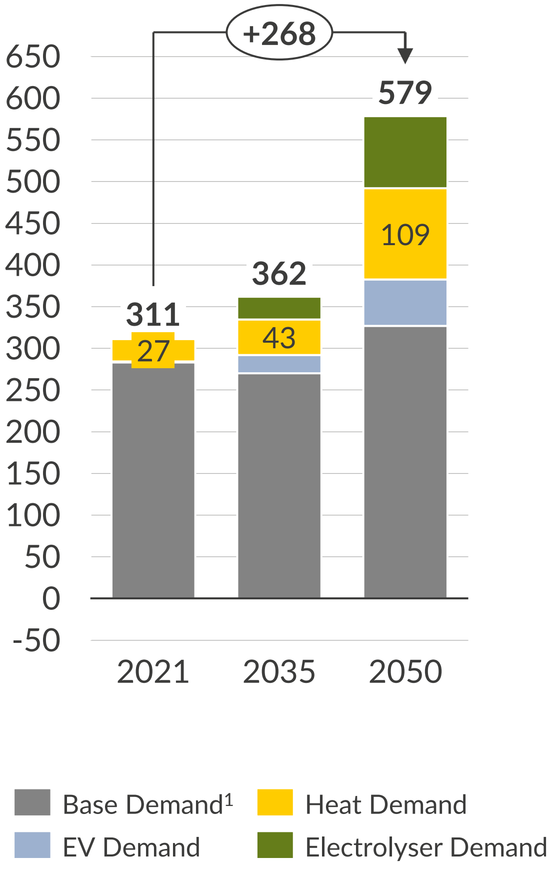


- We forecast a fall in total energy demand for heating by 2050, mostly due to the high efficiency of heat pumps replacing gas boilers
- This decline in total fuel demand is less steep in scenarios with hydrogen for heating
- We project the decarbonisation of the domestic heating sector by 2050 could lead to
  - Up to about 110 TWh annual **electricity** demand for heating
  - Up to about 160 TWh annual **hydrogen** demand for heating
- The hydrogen bars here represent the energy contained in the hydrogen, not all the energy needed for the production process; this can be 1.5 times bigger

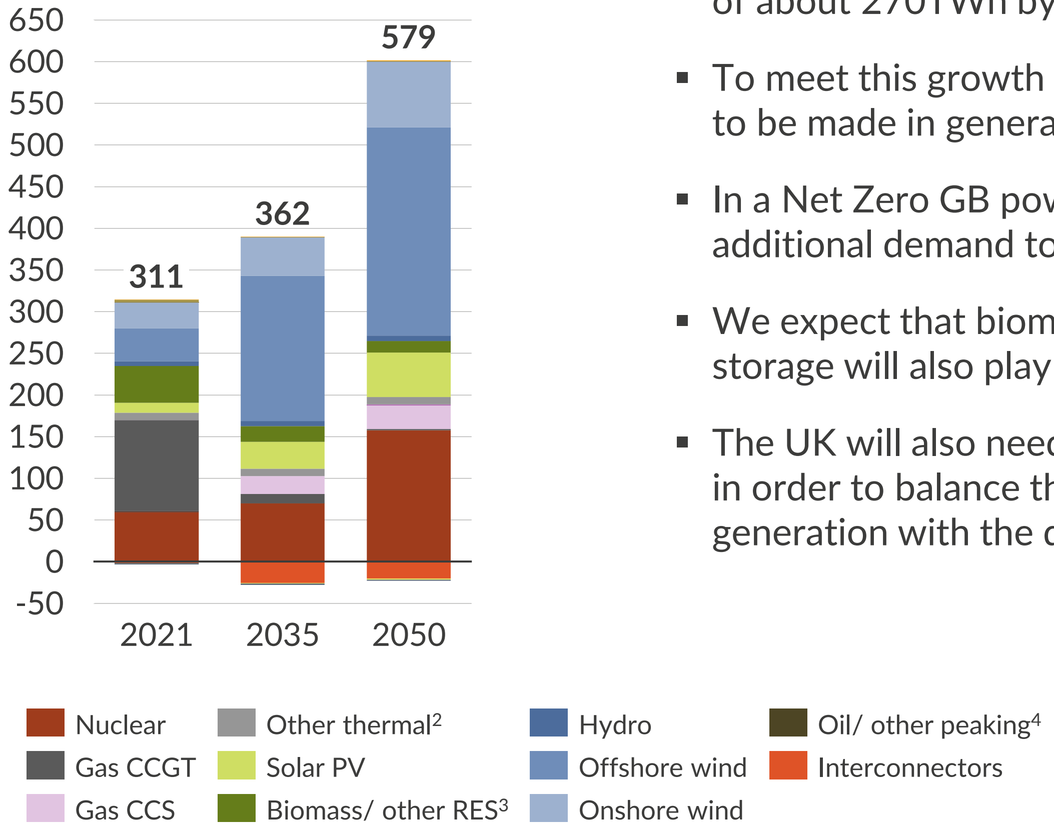
Source: Aurora Energy Research

Accommodating extra electricity demand will require deployment of additional power generation and investment in infrastructure

Electricity demand by sector for Reference scenario
TWh



Electricity generation for Reference scenario
TWh



- In our reference case, we expect a growth of electricity demand of about 270TWh by 2050, with over 80TWh of that from heat
- To meet this growth in additional demand, investments will need to be made in generation capacity, flexibility, and networks
- In a Net Zero GB power system, we expect most of this additional demand to be met by renewables and nuclear capacity
- We expect that biomass and gas plants with carbon capture and storage will also play a supporting role
- The UK will also need to invest heavily in long-duration storage in order to balance the interseasonal variation in renewables generation with the demand needs of the country

1) Base demand includes industrial and domestic non-heat demand; 2) Other thermal includes embedded CHP; 3) Other RES includes biomass, BECCS, EfW, hydro, and marine; 4) Peaking includes OCGT and reciprocating engines

Source: Aurora Energy Research

Scenarios in which hydrogen is used for a share of heating have lower peak power demand

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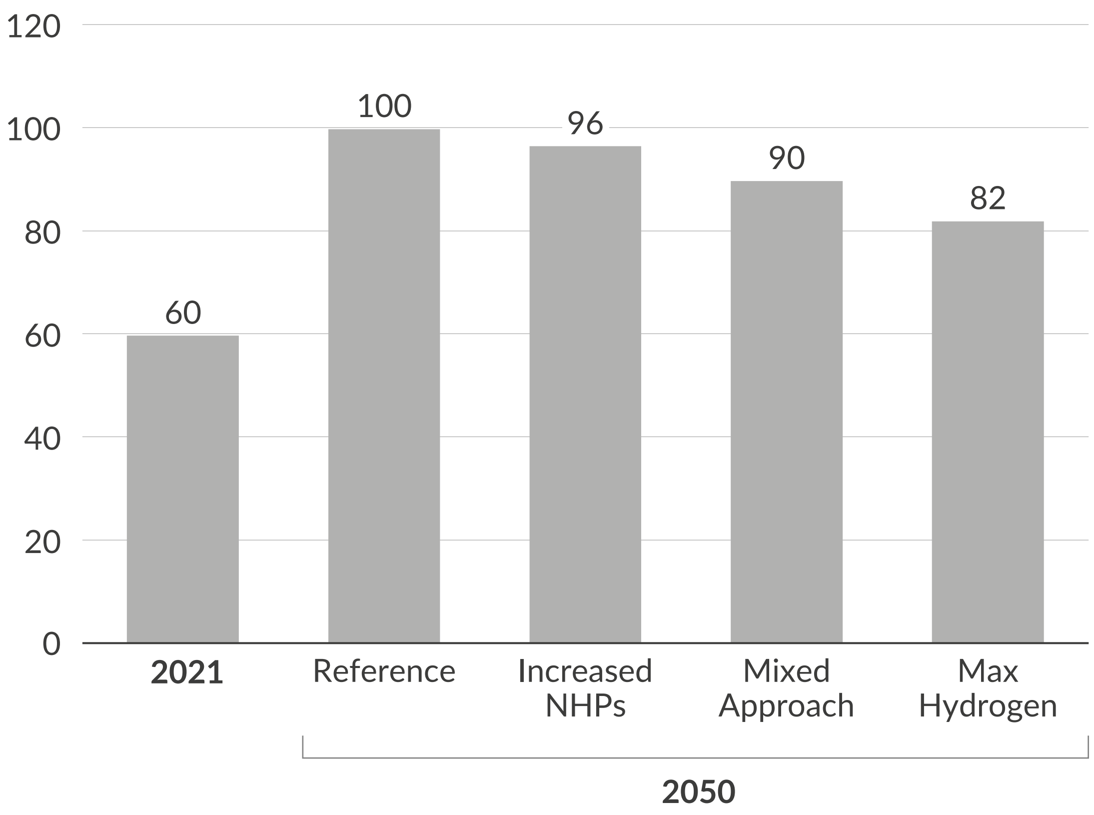
Peak power demand

Assuming flexible electrolysers that shift demand away from peak times, GW



- We project annual peak power demand to rise by around 40GW in scenarios without hydrogen used for home heating
- In scenarios with hydrogen for some home heating, we expect a smaller rise in peak power demand of 30GW or less
- This will mean less need for grid reinforcement and power network costs if some hydrogen is used, assuming all electrolysers are operated flexibly to avoid adding demand at peak times
- In our “Mixed Approach” scenario we estimate a power network spend by 2050 which is £0.5bn a year lower than in our “Reference” scenario

In scenarios with greater deployment of more efficient electric heating technologies, we see lower system costs

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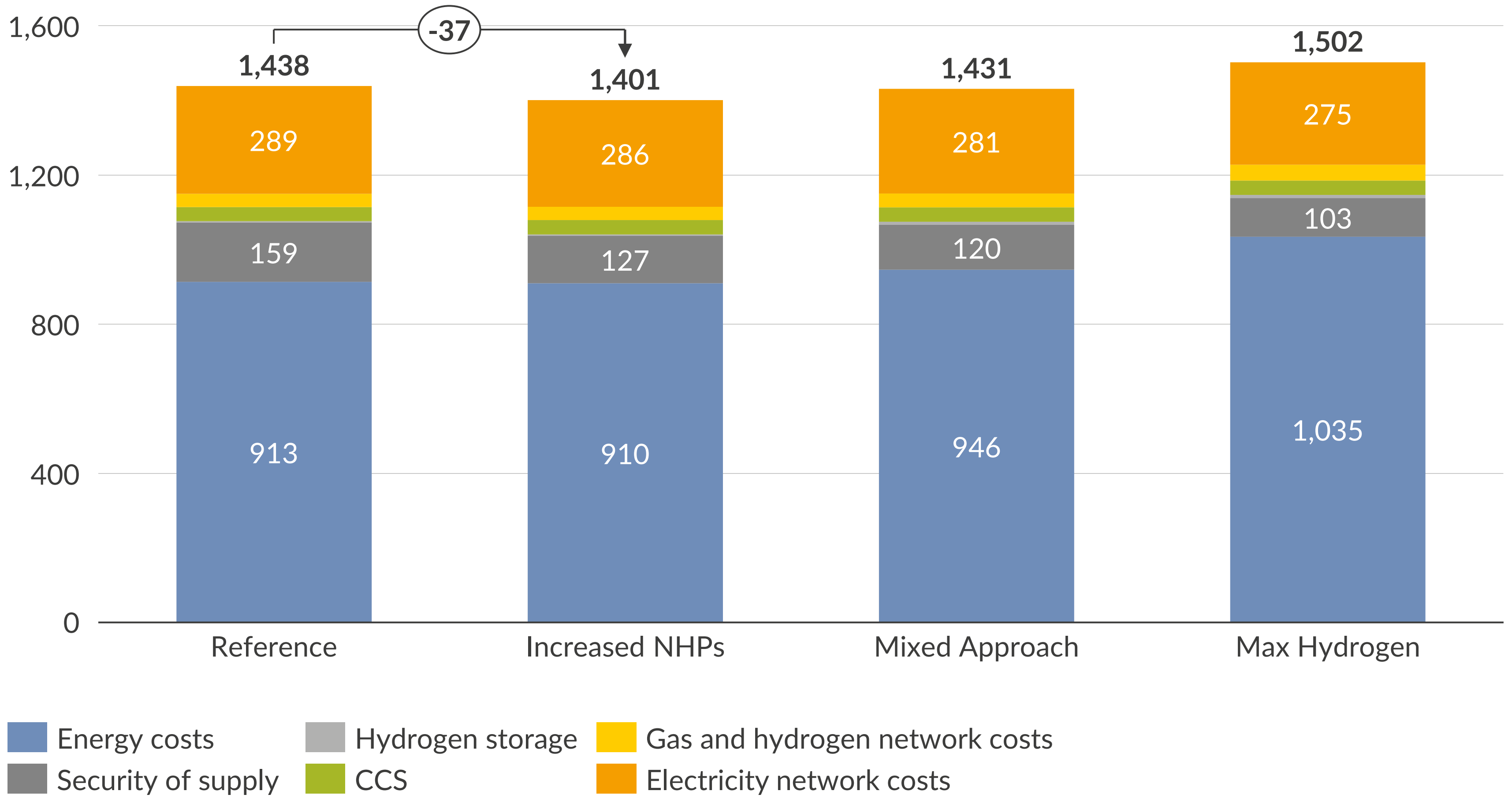
Sum of total system costs, 2021-50
£bn (real 2020)



- Energy costs and networks make up the most of the total energy system cost in GB
- An energy system with more high-efficiency heating technologies could save around £37bn over the next 30 years
- Scenarios that include green hydrogen production have higher power demand, which drives higher power prices and hence higher energy costs

Source: Aurora Energy Research

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Policy could play a vital role in overcoming barriers to the decarbonisation of heating in Great Britain

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- In the scope of this study, we have not sought to design a comprehensive policy framework for decarbonisation of heating
- However, our analysis of the economics of deployment of clean heating and the effects on the energy system has implications for policy design
- In this section, we highlight some of these implications and comment on some broader policy considerations

Illustration of potential components of policy to decarbonise heating

Consumer-focused policy

1. Structural incentives
2. Financial support
3. Regulatory limits
4. Consumer engagement

↔

5 Systems-focused policy

- Power networks
- Gas and hydrogen networks
- Power generation
- Hydrogen storage

- The best overall economics require a broad view of the energy system, beyond individual homes' heating technologies
- For example, investments in larger grants for more efficient or flexible technologies may save on the requirement for network investments and backup power generation by reducing demand at peak times or in instances of extreme weather

Changing the structure of policy charges on electricity and gas could help make heat pumps more economical compared with gas boiler replacements

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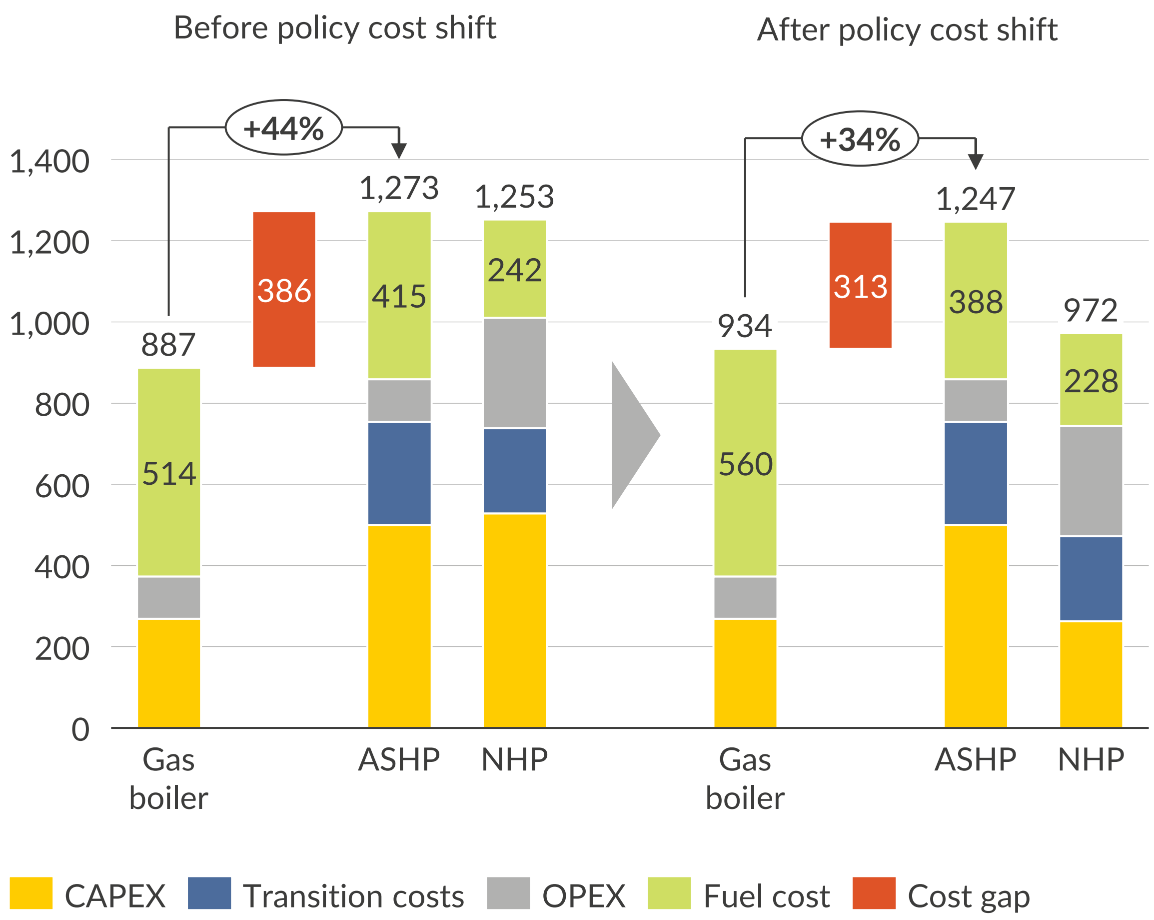
Annualised cost of new heating technologies installed in 2030
Example home type (efficient, owner-occupied house), £ (real 2020)

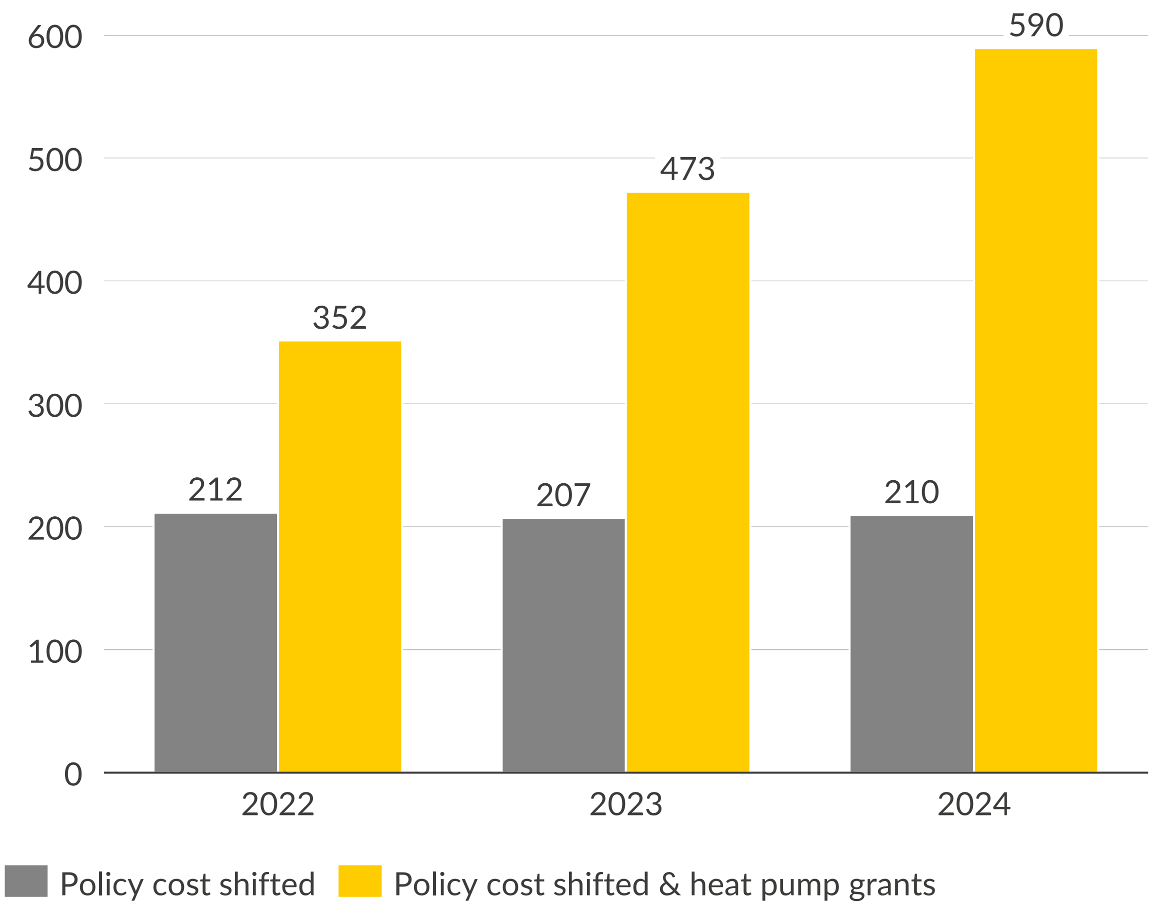


- Without policy changes, we expect gas boiler replacements to remain cheaper than heat pumps well into the 2030s, on an annualised lifetime cost basis
- The size of the cost gap varies between home types; on the left we show a gap of £386 in the annualised lifetime cost for an example efficient, owner-occupied house
- If the policy costs associated with subsidies for renewable power generation are shifted from electricity onto gas, then the cost gap to be bridged would be reduced to £313 in this example
- A carbon tax on gas could help bridge some of the gap, although covering the full lifetime cost gap only with a carbon tax (without any measures like grants for heat pumps) would require prices of £150/tCO_2 or more
- Introducing these kinds of structural price increases for gas must be done with care because of the risk of disproportionately affecting lower-income households
- This challenge could be addressed by raising the carbon price further, but using part of the proceeds to pay a credit to all lower-income households, regardless of their heating system
- Some study participants have also suggested shifting policy costs to general taxation, which would avoid gas bill increases

Source: Aurora Energy Research

Grants to support heat pump deployment may need to continue to 2028 if the 600k per year target is to be met

Annual economical deployment of heat pumps with grants
Thousands of homes



- Assuming that supply chain and installation capacity can be ramped up quickly enough, we calculate that grants of £7,000 per unit could make 600k heat pump installations a year economical by 2024
- However, discontinuing these grants would see the economic deployment rate drop back down after that
- A lower grant of around £5,000 - £6,000, sustained for a longer period, could be more effective
- We calculate that grants in this range would still make heat pumps economical for enough homes to push against the practical limits on deployment
- Note that this analysis is based on raw economics, without accounting for non-cost barriers and consumers' willingness to switch: these are essential to take into account, and we discuss these further on pages 26-27

Source: Aurora Energy Research

A gas boiler replacement ban by 2035 could play a major role in heat decarbonisation; 5 years' delay could leave 15Mt emissions in 2050

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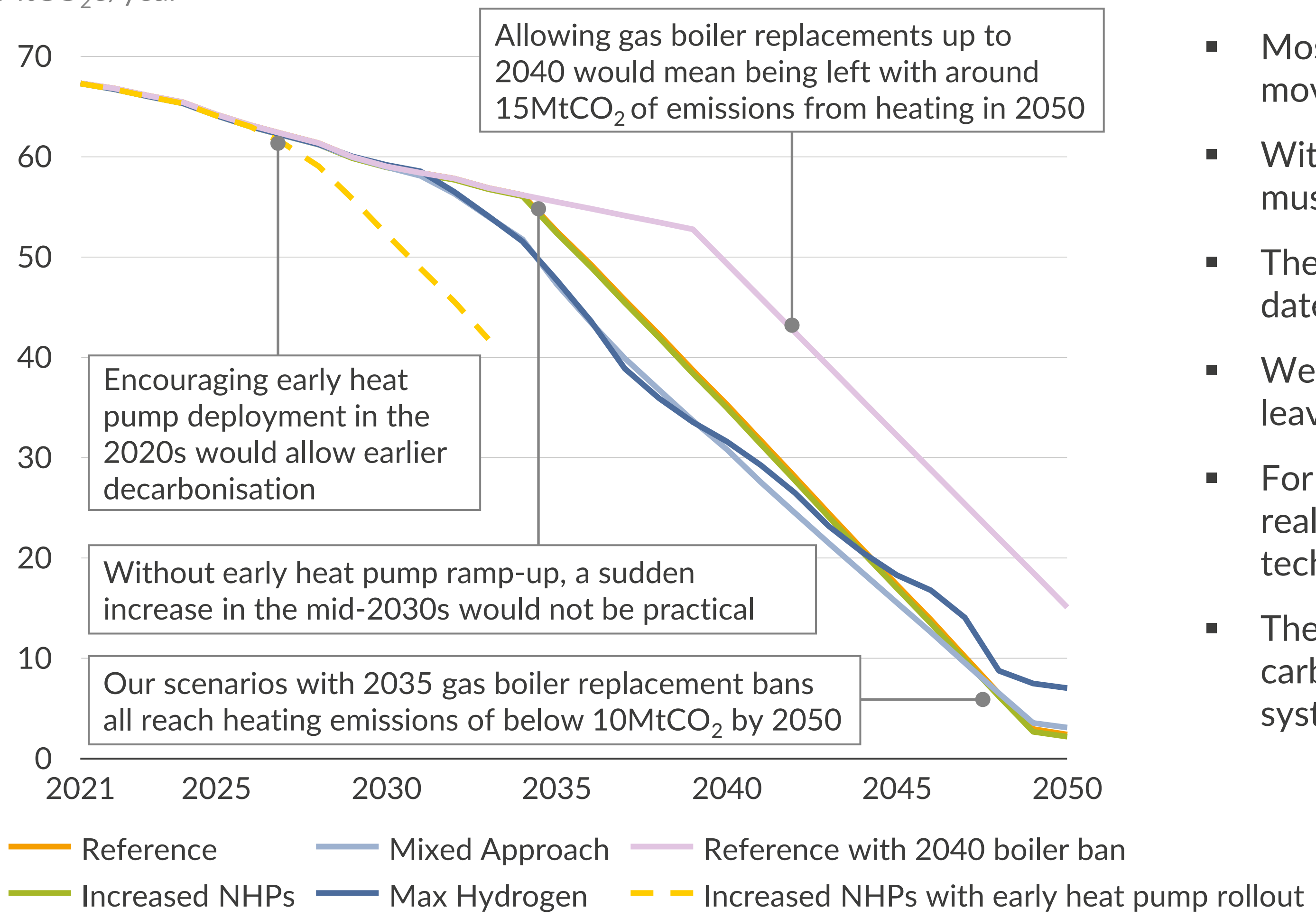
Carbon emissions from heat sector

$MtCO_2e$/year



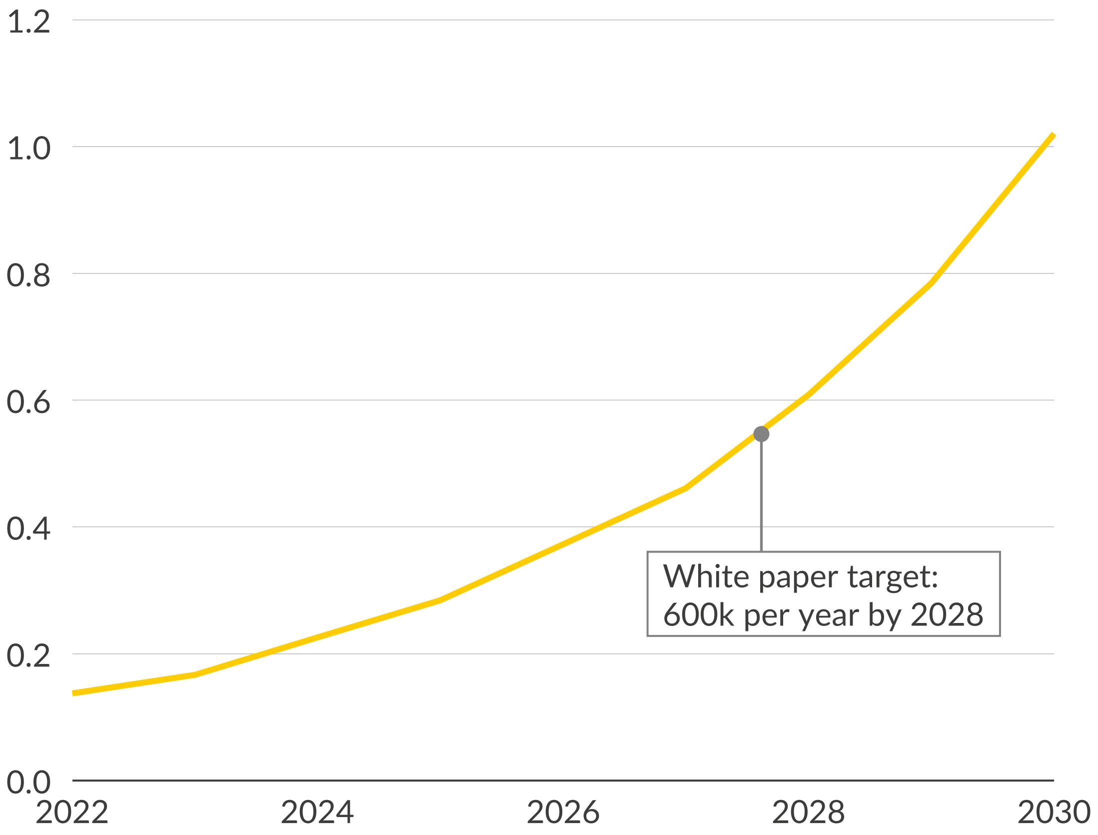
- Most heat sector emissions in GB today are from gas boilers, so moving away from these is central to heat decarbonisation
- With a typical life of 15 years for gas boilers, the last installations must be by 2035 if we are to approach zero emissions by 2050
- The Climate Change Committee has recommended an earlier date of 2033 for a ban on gas boiler replacement installations
- We estimate that delaying the date of such a ban to 2040 could leave 15Mt of emissions from the heat sector in 2050
- For a ban on gas boiler installations in 2035 or 2033 to be realistic, supply chains and deployment for low-carbon heating technologies must be ramped up well before this
- The country will need to be able to install about 1.6m new low-carbon systems a year by the date of the ban, to replace retiring systems

Sources: Aurora Energy Research, CCC Sixth Carbon Budget

Reaching deployment of 600k heat pumps a year by 2028 will require consumer engagement and removal of non-cost barriers

Annual deployment of heat pumps with rapid increase in consumer acceptance

Based on Increased Network Heat Pumps scenario, Millions of homes



- About 30,000 heat pumps were installed in 2020
- Raising this to meet the government target of 600,000 by 2028 will require both financial incentives and practical help
- We modelled a case in which the policy cost of renewables deployment is assigned to gas rather than electricity bills
- We also assumed grants of £6,000 per unit are provided for new heat pumps, enough to make them economically preferable to gas boiler replacements (based on annualised lifetime costs) for just over an additional 1 million homes per year
- We assumed that in 2022, only 10% of homes for which it is economical will deploy a heat pump, but that this "acceptance rate" will ramp up as they become more widespread
- To reach 600k installations by 2028, the acceptance rate must rise rapidly, exceeding 40% by the time we have just over 2m cumulative installations
- For this to happen, a range of non-cost barriers must be overcome, as discussed on the next page

Sources: Aurora Energy Research, HM Government Energy White Paper December 2020

A series of non-cost barriers stand in the way of homes that might consider switching to a low-carbon heating technology

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Examples of non-cost barriers

- Switching heating technology is not a priority for most households, most of the time
- When a heating system is replaced, it is often because the old system has broken down: in this kind of emergency, decisions are likely to be based more on speed and convenience than on economics or carbon-intensity, increasing the likelihood of a like-for-like replacement
- If a household is considering replacing their heating system in advance, they may not have easy access to the information they would need to make a choice between all the available options, making it more likely they will choose a like-for-like replacement
  - It may be difficult to understand long-term running costs for a particular home, especially for new technologies
  - It may not be obvious whether installing a new system means having to add a hot water tank or replace pipes or radiators
  - Households may be relying on local installers to explain the options and advise on suitable brands or configurations for their home
  - The customer journey to understand and compare new technologies can be lengthy
- Where government grants are available, low accessibility or process complexity could reduce uptake

- Policy measures to help overcome these barriers may be needed in order to achieve the levels of consumer acceptance needed to reach 600k heat pump installations per year by 2028

Source: Aurora Energy Research

Planning and investing in a more efficient heating system could save almost £40bn in system costs by 2050

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- In our reference scenario, we find ASHPs are widely chosen at the household level thanks to their relatively low CAPEX costs
- These tend to drive high peak power demand, especially in cold weather events, leading to high system costs
- Scenarios with hydrogen, network heat pumps or thermal storage all require more investment and joined-up policy beyond the household level
- However, they can reduce peak demand, power network costs, and the costs of system security during cold weather: for example our "increased networked heat pumps" scenario has £37bn lower total network cost over 2021-2050 than our reference scenario (see p20)

- Besides the investment required, preparatory work needs to begin early if any of these low-carbon heating scenarios is to be realised
- Long-term planning is needed for conversion of gas networks to carry hydrogen or for reinforcement and development of electricity networks
- Moreover, although hydrogen storage is a small part of the cost stack, the interseasonal flexibility it provides will be essential to the running of any system with significant electrification of heating (whether or not hydrogen is used directly for heating)
- Preparation of salt caverns for hydrogen storage can take many years, so early action is needed

Source: Aurora Energy Research

Details and disclaimer

Publication
Decarbonisation of Heat in Great Britain

Date
October 2021

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