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Getting on track to net zero

A policy package for a heat pump mass market in the UK

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Figures

Acronyms, abbreviations and units of measure

BEIS . . . . . Department for Business, Energy and Industrial Strategy

CCC . . . . . Climate Change Committee

GHG . . . . . Green Homes Grant

HAAS . . . . . Heat as a service

RHI . . . . . Renewable Heat Incentive

RHPP . . . . . Renewable Heat Premium Payment

UKERC . . . . . UK Energy Research Centre

Executive summary

Heat pumps are widely seen as a central element of the UK's transformation to net-zero compatible heating. This paper considers the practical choices that policymakers face supporting the deployment of heat pumps to achieve a net-zero UK.

The government's current target of 600,000 heat pumps installed annually by 2028 is ambitious, but it falls short of the deployment levels recently suggested (900,000 per annum) by the Climate Change Committee (CCC). It is clear that existing and proposed policy is currently insufficient to drive the market at anything near the required deployment levels. The still active Renewable Heat Incentive (RHI) is set to deploy less than one-sixth of the domestic heat pumps it intended by its original end date of April 2021. Other existing and planned programmes will not significantly increase the amount of heat pumps deployed, pointing to a policy gap. This paper examines how this gap can be closed and the targets met.

To achieve sensible and sustainable scale-up of the market for heat pump retrofit, its growth in homes on the gas grid needs to be driven now, in parallel with off-gas and newly built homes. This will require a much fuller, longer-term and more coordinated set of policy interventions than the limited measures presently planned by the government.

The scale and required speed of the transition should not be underestimated. Accordingly, individual interventions cannot result in deployment of heat pumps at the scale needed. It's necessary, therefore, to have a strategically governed combination of measures, which includes regulation, restructuring of taxes and levies, financial support, area-based planning and citizen engagement.

At the very least, this **requires major decisions now** regarding:

- **Governance** of the heat transition, including a common understanding of the responsibilities and powers of different institutions and actors, ensuring they are able to deliver outcomes required.
- The levels of **financial support** for different groups over time to build the market and protect vulnerable consumers.
- The role of **structural incentives**, including **fiscal and pricing signals**, over time to sustain the market long term.
- A regulatory **end date for fossil heating systems** installation.

We consider previous policy to deploy low-carbon heating as evidence of an optimal approach and propose a heat pump policy package on a clear timeline. Key elements of our proposed package to 2030 include:

- **Raising the ambition for heat pump deployment**, to be consistent with the Climate Change Committee's Balanced Pathway to net zero.
- **Establishing a heat pump council this year**; formed of national and local government, regulators, industry and civil society; to coordinate simple and effective consumer engagement and protection. The council will also ensure the supply chain is developed, including training of installers as part of a coherent approach to governing and financing the transition to a net-zero energy system.
- **Scaling up financial support using capital grants starting in 2021** — prioritising low-income households — to peak at £3 billion per year, with the potential to be funded by carbon revenues, while transitioning to a more market-led approach for the long term.
- **Permanently restructuring fiscal and pricing signals by the end of this parliament** by pricing carbon within the heat market to remove implicit subsidy for fossil fuels and support low carbon heating, and pricing energy and carbon performance into property values through Stamp Duty reform.
- **Signalling the intention to regulate for all segments of the home heating market this year**, providing early long-term certainty to the market that regulation will drive fossil fuel heating appliance phase-out in all homes — requiring non-fossil heating when appliances are replaced no later than 2033 for all homes and earlier for homes off the gas grid — and by raising carbon and energy performance standards for all homes.

In combination, these measures can transform the heat pump market in the UK from a niche application to the scale needed to reach the UK's carbon targets.

We have deliberately used conservative heat pump costs in our analysis, reflecting limited UK heat pump cost data, which itself reflects a heavily subsidised market.

We are confident that the potential for innovation, competition and cost reduction in financing, technology, deployment and running costs is significant and that decisive early action can harness and drive these forces.

Decisions taken now can provide a major boost to the UK's COP26 presidency and outcomes of this year's crucial climate negotiations.

The prizes are significant. Beyond the emissions reductions, switching from fossil gas to heat pumps could drive major, inclusive post-Brexit and post-Covid green growth and reduce reliance on fossil fuel imports. In fact, the government has acknowledged the growth of heat pumps can build on the UK's existing appliance manufacturing base and potentially lead to a heat pump export market.

Introduction

Heat pumps are expected to form a central element of a net-zero compliant UK energy system. They work by using electricity to extract heat from the environment and effectively circulate it to warm buildings and heat hot water. They have clear value because they reduce primary energy demand, use low-carbon electricity, support the growth of renewable energy and reduce reliance on fossil fuel imports.

Numerous publications, scenarios and models released by the UK government and its advisors have highlighted the importance of heat pumps and the need for rapid growth of this technology. This paper has been written as a supportive guide to policymakers, who are looking to drive the UK's transformation towards low-carbon heating.

The paper investigates the scale of the heat pump challenge, previous heat pump policy delivery and the issues associated with them. We also investigate policies that have worked elsewhere around the world to support heat pumps.

Following our review, we explain the potential options available to policymakers and propose a package of measures for use by policymakers to support UK goals for heat decarbonisation.

Chapter 1: The scale of the challenge

As identified in the Climate Change Committee's recent advice on the sixth carbon budget,[1] HM Government's 'Powering Our Net Zero Future' white paper,[2] the prime minister's 10-point plan[3] and synthesis by the UK Energy Research Centre (UKERC),[4] heat pumps are a strategically important sustainable energy technology.

The CCC suggests that the 'critical' technology of heat pumps[5] reach deployment levels of 600,000 per annum in existing homes and 300,000 in new homes by 2028, reaching a total 1 million installations per annum across all homes by 2030 in their Balanced Pathway scenario.[6] The CCC target, closely aligned with the analysis by UKERC into net zero heating,[7] is therefore significantly ahead of the prime minister's target of 600,000 per year in all homes, including new builds, by 2028.[8]

Heat pumps may be used in individual homes and commercial buildings or connected to heat networks. The CCC's modelled uptake in residential buildings is shown below in Figure 1[9] and suggests that initially, the largest growth in heat pumps takes place in new build homes, with off-gas grid homes following, before existing homes connected to the gas grid rapidly take up heat pumps from the late 2020s.

Insufficient historic support for heat pumps

For the past decade, domestic heat pumps in the UK have received financial support from the Renewable Heat Incentive policy, the primary policy instrument to accelerate low-carbon heating in the UK. Originally, the Renewable Heat Premium Payment (RHPP) scheme offered capital to households following the installation of low carbon heating, including heat pumps.

Households who had claimed RHPP support could then join the full domestic RHI scheme, which launched in April 2014, when the RHPP was closed. The RHI income would be reduced however by the RHPP grant amount, if it had been claimed.

Under the RHI, households that have installed a heat pump (subject to installation requirements) can claim the incentive, which offers a quarterly income for seven years based on the installed technology and the heat demand of the dwelling. The tariff level has been consistently higher for ground source heat pumps than air source heat pumps. The tariffs were increased for air source in December 2016 following a consultation with the Department for Business,

Government target in relation to CCC scenarios

The government's 2028 goal is most closely aligned to the CCC's 'Headwinds' scenario for net zero, which has the lowest level of heat pumps deployment (600,000 total), compared with the Balanced Pathway's deployment of 910,000 heat pumps in 2028. The Headwinds scenario achieves the same overall emissions reduction by 2050, but at a cost of 0.83% of GDP by 2050, compared to 0.48% with the Balanced Pathway.

1 Department for Business, Energy and Industrial Strategy (BEIS). (2020 a). *Heat pump manufacturing supply chain research project.* https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project

2 HM Government. (2020 a). *Energy white paper: Powering our net zero future.* https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future

3 HM Government (2020 b): *The Ten Point Plan for a Green Industrial Revolution.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf

4 Rosenow, J., Lowes, R., Broad, O., Hawker, G., Wu, J., Qadrdan, M. & Gross, R. (2020 a). *The pathway to net zero heating in the UK.* https://ukerc.ac.uk/publications/net-zero-heating

5 Climate Change Committee. (2020 a). *The Sixth Carbon Budget: The UK's Path to Net Zero.* https://www.theccc.org.uk/publication/sixth-carbon-budget

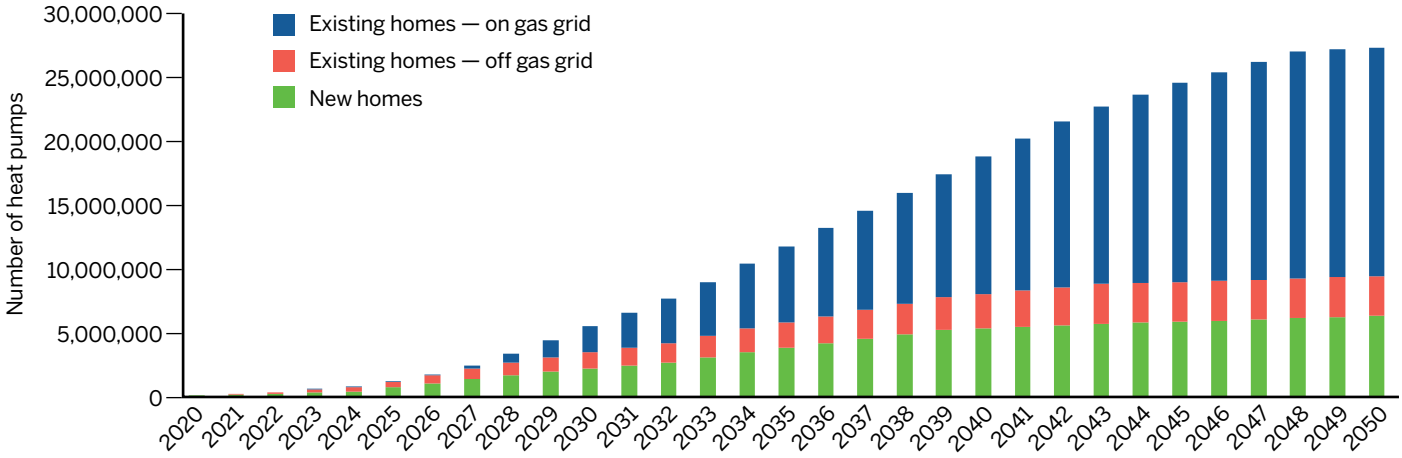
6 HM Government, 2020 b.

7 Rosenow et al., 2020.

8 HM Government, 2020 b.

9 Climate Change Committee, (2020 a).

Figure 1. Cumulative uptake of heat pumps in homes under the Climate Change Committee's Balanced Pathway scenario



Source: Climate Change Committee. (2020). *The Sixth Carbon Budget The UK's path to Net Zero.*

Energy and Industrial Strategy (BEIS) to ensure the RHI was funding strategically important technologies at appropriate levels.[10]

Deployment of heat pumps under the RHI has fallen consistently below expectations, with the National Audit Office predicting in 2018 that the scheme would deliver just 22% of planned renewable heat installations (across domestic and non-domestic buildings).[11] The 2013 impact assessment for the domestic scheme suggested that the domestic RHI would support 491,000 heat pumps by the original[12] end of the scheme in April 2021.[13] At the end of November 2020, however, only 62,492 heat pumps had been accredited, suggesting a major policy failure (Figure 2).[14]

Although deployment has increased since 2016 levels, the RHI supported only around 11,000 heat pumps (air and ground source) in existing homes in 2019. A further 3,000 were installed without RHI support, whereas nearly 10,000 were deployed in new build homes.[15] The number of domestic heat pumps installed in the UK therefore needs to increase dramatically.

Other policies such as the different incarnations of the Energy Company Obligation and the Green Deal also included heat pumps as an eligible measure, but uptake was extremely limited with only 270 heat pumps installed under both schemes since 2013.[16]

A widely recognised issue with the domestic RHI is that it does not provide upfront capital support, meaning that households are required to dig deep to finance the installation. In 2018, the so-called 'assignment of rights' was introduced to allow a third party to finance systems and then receive RHI payments, although data on the use of this business model are not publicly available.

Although significant financial support has been available for some time, it is apparent that pure financial incentives with long paybacks will not encourage anywhere near the take-up needed to meet the UK's energy goals. Some combination of financial support, shifting to upfront capital support with a regulatory mandate, will therefore likely be needed.

10 BEIS. (2016 a). *The Renewable Heat Incentive: A reformed scheme.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/577024/RHI_Reform_Government_response_FINAL.pdf

11 National Audit Office. (2018). *Low-carbon heating of homes and businesses and the Renewable Heat Incentive.* https://www.nao.org.uk/wp-content/uploads/2018/02/Low-carbon-heating-of-homes-and-businesses-and-the-Renewable-Heat-Incentive.pdf

12 The RHI has been extended by one year, matching the current timeline of the Green Homes Grant.

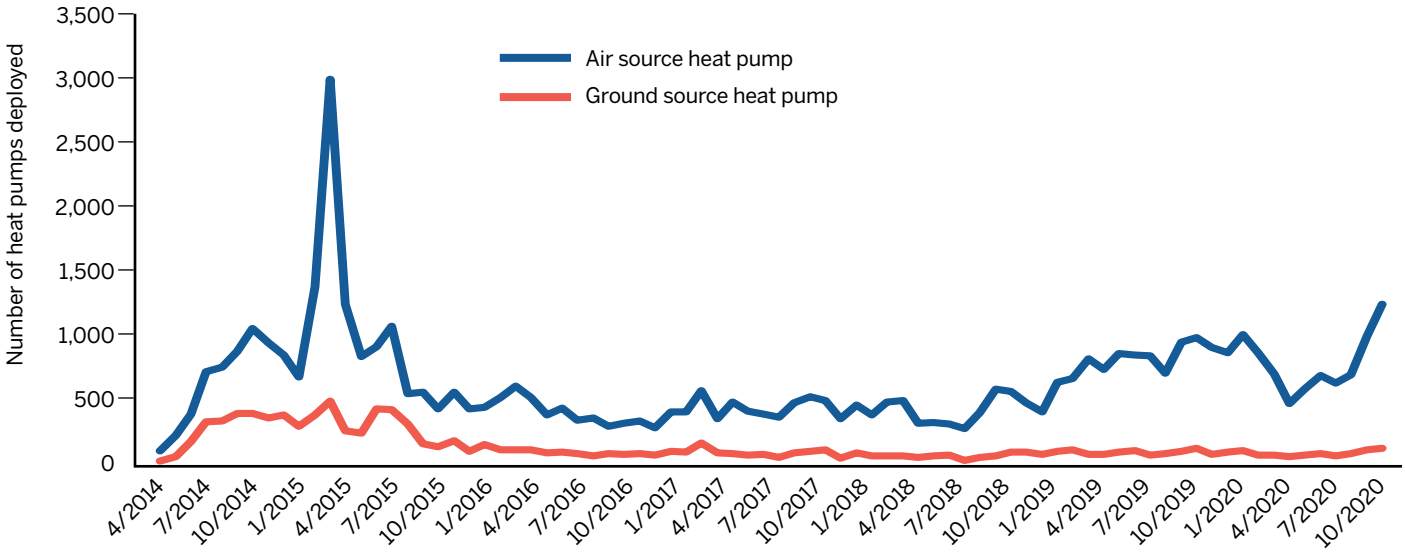
13 Department of Energy and Climate Change. (2013). *RHI Impact Assessment.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211978/Domestic_RHI_Impact_Assessment.pdf

14 BEIS. (2017). *RHI deployment data: April 2017.* https://www.gov.uk/government/statistics/rhi-deployment-data-april-2017; BEIS. (2015/2021). *Renewable Heat Incentive statistics.* https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

15 BEIS, 2020 a.

16 BEIS. (2021 a). *Household Energy Efficiency Statistics, headline release.* https://www.gov.uk/government/statistics/household-energy-efficiency-statistics-headline-release-january-2021

Figure 2. Domestic heat pumps accredited under the Renewable Heat Incentive scheme based on Department for Business, Energy and Industrial Strategy (BEIS) deployment numbers



Source: Department for Business, Energy and Industrial Strategy (BEIS). (2020). *RHI deployment data*.
Note: Spike in 2015 is caused by households registering who had previously received RHPP finance.

Expected near-term policy falls short

The Green Homes Grant (GHG) scheme, part of the government's summer 2020 Covid-19 stimulus package, is providing upfront capital to those who install heat pumps (among other measures), although recipients of this support receive an equivalent reduction in RHI income.[17] The GHG scheme provides up to £5,000 per household or up to £10,000 for low-income households.

Whereas the GHG proved to be popular among households from the outset,[18] the performance of this scheme so far is not meeting expectations, with only 5% of funds being spent so far.[19] This is due in part to anticipated availability limits of TrustMark and Microgeneration Certification Scheme accredited tradespeople[20] relative to demand, which the GHG is supposed to address. Instead, however, contractors' appetite to invest in expansion has been limited by the short-term availability of the grant and further compounded by poor administration of the scheme, resulting in contractors facing overdue payments and laying people off.[21] The proposed extension and additional funding for the scheme in the prime minister's 10-point plan should be carried out. It will provide upfront capital for longer and give some limited market foresight.

Both the RHI and the GHG are expected to close in March 2022.[22] Based on consultation documents, the proposed successor policy — the Clean Heat Grant — looks only likely to support similar numbers of heat pumps as delivered with domestic RHI support,[23] albeit with upfront financial support, and would represent a significant fall in funding

17 BEIS. (2020 b). *Green Homes Grant: Make energy improvements to your home.* https://www.gov.uk/guidance/apply-for-the-green-homes-grant-scheme

18 69,151 households applied for vouchers in the first four months following its launch at the end of September 2020. BEIS. (2021 b). *Green Homes Grant voucher release, February 2021.* https://www.gov.uk/government/statistics/green-home-grant-vouchers-release-february-2021

19 Laville, S. (6 February, 2021). Less than 5% of green homes grant budget paid out, Labour reveals. *The Guardian.* https://www.theguardian.com/environment/2021/feb/06/government-green-homes-grant-budget-labour

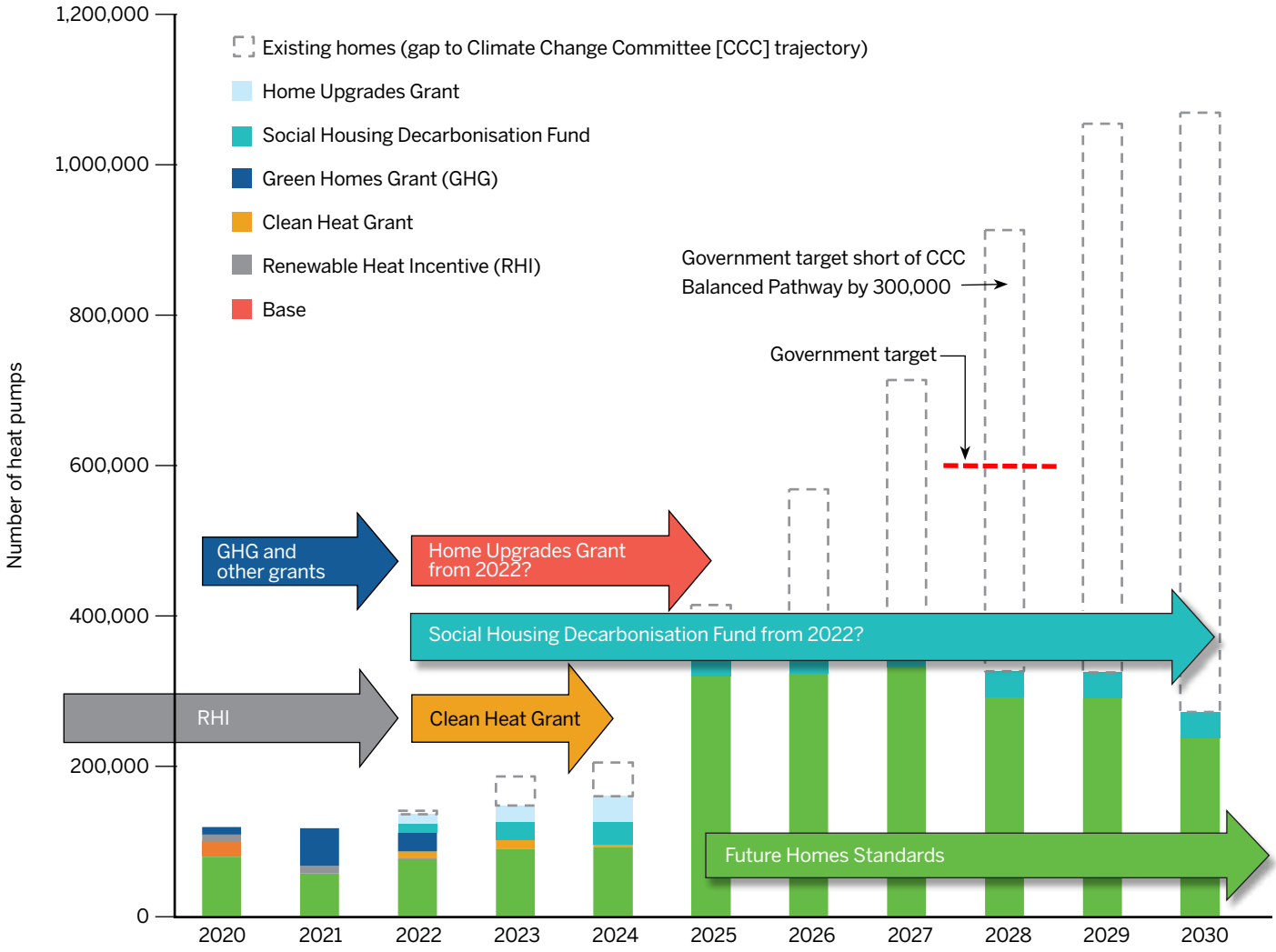
20 Brignall, M. (9 October, 2020). Green Homes Grant: Homeowners frustrated by lack of installers. *The Guardian.* https://www.theguardian.com/environment/2020/oct/09/green-homes-grant-installers-scheme-government

21 Laville, S. (26 January, 2021). Government plans to turn England homes green 'in chaos' with debt and job losses. *The Guardian.* https://www.theguardian.com/environment/2021/jan/26/government-plans-to-turn-england-homes-green-in-chaos-with-debt-and-job-losses

22 BEIS. (2020 c). *Notice on changes to RHI support and Covid 19 response.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896387/Gov_Response_-_Notice_on_Changes_to_RHI_Support_and_Covid-19_Reponse_FINAL.pdf

23 Lowes, R. (5 May, 2020). *Heat: A policy chasm on the route towards net-zero.* Exeter Energy Policy Group blog. http://blogs.exeter.ac.uk/energy/2020/05/05/881

Figure 3. Potential annual heat pump deployment under confirmed and planned policy



available compared to the current combinable support of the GHG and RHI.

Figure 3 highlights the scale of the gap which exists between required deployment and current policy as confirmed and planned. It sets the government's 600,000 target (indicated by the red dotted line) against the backdrop of the CCC's Balanced Pathway to meeting the sixth carbon budget on the way to net zero by 2050.

Financial and capital support programmes — including the RHI, the GHG and the Clean Heat Grant — are expected to support fewer than 50,000 heat pumps per year in existing homes, with support ending in 2024 under current government proposals for the Clean Heat Grant. If Conservative Manifesto commitments on green homes and energy efficiency[24] are delivered fully, then from 2022 — on the illustrative assumption that one third of funds committed go towards heat pump installations[25] with levels of support comparable to the GHG — we estimate that:

- A further 26,000 heat pumps could be deployed per year with the Home Upgrades Grant for low-income households off the gas grid to 2025.
- An additional 30,000 heat pumps could be deployed per

24 These comprise a £2.5bn Home Upgrade Grants scheme over five years, and a £3.8bn Social Housing Decarbonisation Fund over 10 years. Conservative and Unionist Party. (2019). *Costings document. Manifesto 2019*. https://assets-global.website-files.com/5da42e2cae7ebd3f8bde353c/5ddaa257967a3b50273283c4_Conservative%202019%20Costings.pdf

25 This illustrative one-third split is predicated on the assumption that heat pumps will be a popular element of the GHG scheme and that this would be mirrored by capital provided under the Social Housing Decarbonisation Fund and Home Upgrades Grant, which are being set up to support heat pumps.

year with Social Housing Decarbonisation Fund support to 2030.

The Future Homes Standard sets carbon and energy performance standards for new buildings in the UK through regulation and will provide an important lever to end the installation of fossil heating systems in new buildings, including those on the gas grid. On the basis of the CCC's assumptions for heat pump deployment in new build, this would go nearly halfway towards meeting the government's 2028 target but would contribute just one third of the deployment seen in 2028 under the CCC's Balanced Pathway.

An important factor to note is that the CCC's projections for new construction (and therefore heat pumps in new homes) are high in comparison to the current rate of new build. If new homes aren't delivered at these high levels, clearly the contribution of heat pumps in new homes to the overall target will be limited, meaning that greater numbers of retrofitted heat pumps will be required to build a mass market at the pace required.

Assuming high ambitions for new homes are met, the policy gap between required deployment support that can be reasonably expected based on current commitments (and illustrated in Figure 3) is as follows:

- UK government target of 600,000 heat pumps per year by 2028: gap of just under 300,000 heat pumps per year — all in existing homes.
- CCC Balanced Pathway deployment level of approximately 900,000 heat pumps per year by 2028: gap of just under 600,000 heat pumps per year — all in existing homes.[26]

Current, proposed and pledged policy will not support the deployment of heat pumps at the levels required for any of the scenarios laid out by the CCC.

The need for a whole market approach

Alongside new build, the initial focus of heat decarbonisation has been on higher carbon off-gas grid homes due to the relatively low cost of carbon abatement. Adding to the suite of policies above, in the government's recent Energy White Paper, BEIS will consult early this year on new regulations to phase out fossil fuels in off-gas grid buildings.[27] These regulations could include a date ending replacement fossil heating systems and a backstop date after which fossil fuel boilers would be removed, alongside an end to gas grid connections for newly built homes. Extremely tight decarbonisation timescales, however, linked to carbon budgets — and in-part due to a lack of progress over the past decade[28] — highlight the need to now simultaneously focus on all homes, including those currently using gas.

The CCC's Balanced Pathway sees 1.7 million heat pumps installed in existing homes by 2028. This includes 0.7 million homes on the gas grid.[29] This is due to the limited stock and therefore (timely) carbon saving potential of off-gas grid homes. Based on combined housing survey data,[30] there are approximately 1.7 million UK households with oil heating,[31] 200,000 using liquid petroleum gas and 170,000 using solid mineral fuel as their primary heating fuel, i.e., approximately 2.1 million UK homes using high-carbon, non-mains gas heating.

Regulatory intervention at trigger points, such as heating system replacement in off-gas grid properties, would drive deployment, but is limited by churn. Assuming a boiler lifetime of 15 years[32] and no early boiler stranding, even if high carbon off-gas-grid replacement systems were banned in 2022 (for context, the CCC have suggested this should be in 2028), the government would not meet its 2028 target, let alone achieve the CCC's rate of deployment. To install a total

26 Comprising 56% air source heat pumps, 23% in homes connected to communal heat pump systems, 14% hybrid heat pumps, and 7% ground source heat pumps. Climate Change Committee. (2020 b). *The sixth carbon budget dataset.* https://www.theccc.org.uk/wp-content/uploads/2021/02/The-Sixth-Carbon-Budget-Dataset.xlsx

27 HM Government, 2020 a.

28 UKERC. (2020). *Review of Energy Policy, December 2020.* https://d2e1qxpsswcpgz.cloudfront.net/uploads/2020/12/UKERC_Review_of_Energy_Policy_2020.pdf

29 Climate Change Committee. (2020 c). *The charts and data behind the 6th carbon budget reports.* https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-Charts-and-data-in-the-report.xlsb

30 Synthesised by the authors.

31 Around a third of these are in Northern Ireland.

32 As assumed by the Climate Change Committee, 2020 a.

of 1.7 million heat pumps by 2028 requires retrofitting heat pumps in homes on the gas grid.

The government could theoretically introduce a back-stop date for off-gas homes for 2028, mandating the removal of high carbon fossil fuel heating before boilers have reached the end of their useful lives. Although we see this policy as quite drastic, it could potentially support the meeting of the CCC's trajectory to 2028 and surpass its own target through off-gas retrofits alone. The early stranding of heating systems, however, could lead to sub-optimal policy and consumer outcomes and would also mean that heat pump deployment and market growth was solely located in off-gas grid areas, leaving a steeper challenge to build the market for homes on the gas grid.

To achieve sensible and sustainable scale-up of the market for heat pump retrofit, its growth in homes on the gas grid needs to be driven now in parallel with off-gas homes, requiring a fuller and longer-term set of policy interventions than can be reasonably expected based on government plans to date.

Chapter 2: What has worked elsewhere?

Although there are various UK specific policy and regulatory options that may support deployment of heat pumps, we first turn our attention to more general recommendations and ideas.

It is first worth noting that a transition of the shape and speed envisaged for United Kingdom is not unprecedented. Between 2000 and 2018, heat pumps reached around a third of all homes in Finland — 930,000 — by 2018,[33] something made possible through a combination of expertise and policy coordination, involving a carbon tax on heating fuels, stringent building codes, tax-deductible labour costs and capital subsidies.[34] The current installation rate is reaching approximately 3% of Finnish homes per year,[35] still likely to be dominated by first-time installations, which is at the level the CCC envisages in its Balanced Pathway for the UK.

In analysis for the CCC, UKERC[36] considered the best practice for heat decarbonisation policy. Specifically on heat pump deployment, they suggested that international best practices required policy stability for market confidence — itself a function of strong governance — alongside thorough packages of measures.

The analysis highlights specific best practice policy measures, including:

- Measures to support consumer confidence, including cross-sector heat pump associations and promotional campaigns.
- Technical standards and skills, including European Heat Pump Quality label with minimum coefficient of performance.
- The use of building regulations.
- Grants.
- Tax reductions.
- Carbon taxes.

Similarly, in an analysis for the Danish Energy Agency, Delta-EE highlights the critical nature of setting up cross-sector heat pump associations; which include industry, government and wider expertise; and using these bodies to provide and lead quality assurance programmes for households and installers.[39] Delta-EE also highlights the importance of publicity and awareness raising.

But heat pump policy also needs to be embedded in the energy transition more broadly. Alongside heat pumps — and as other parts of the economy, particularly transport,

The value of energy efficiency

Fabric energy efficiency measures, including insulation and better doors and windows, can directly reduce emissions associated with heating, make homes more comfortable and play a central role in a cost-effective heat decarbonisation strategy. The Energy Efficiency Infrastructure Group explains that unless there is a step change in energy efficiency deployment, the government will put 'net zero emissions out of reach, and incur unnecessary costs on public and private budgets.'[37] Independent analysis has highlighted that improved energy efficiency could reduce total system costs by £6.2bn/year in 2050.[38]

33 Sovacool, B. K. & Martiskainen, M. (April 2020). Hot transformations: Governing rapid and deep household heating transitions in China, Denmark, Finland and the United Kingdom. *Energy Policy, 139*(111330). https://www.sciencedirect.com/science/article/pii/S0301421520300872?via%3Dihub

34 BEIS, 2020 a.

35 Sovacool & Martiskainen, 2020.

36 Hanna, R., Parrish, B., Speirs, J., & Gross, R. (2016). *UKERC Technology and Policy Assessment: Best practice in heat decarbonisation policy: A review of the international experience of policies to promote the uptake of low-carbon heat supply.* https://d2e1qxpsswcpgz.cloudfront.net/uploads/2020/03/heat-what-works-scoping-note-v-1_2.pdf

37 Energy Efficiency Infrastructure Group. (2019). *The Net Zero Litmus Test: Making energy efficiency a public and private infrastructure investment priority.* https://www.theeeig.co.uk/media/1063/eeig_net-zero_1019.pdf

38 Strbac, G., Pudjianto, D., Sansom, R., Djapic, P., Ameli, H., Shah, N., Brandon, N., Hawkes, A. & Qadrdan, M. (2018). *Analysis of Alternative UK Heat Decarbonisation Pathways.* Imperial College London. For the Committee on Climate Change. https://www.theccc.org.uk/wp-content/uploads/2018/06/Imperial-College-2018-Analysis-of-Alternative-UK-Heat-Decarbonisation-Pathways.pdf

39 Black, K. (2013). *Delta-ee report for Danish Energy Agency Policy – measures for heat pump market growth.* Delta EE. https://www.delta-ee.com/downloads/1-research-downloads/39-heat-research/1046-delta-ee-report-for-danish-energy-agency-policy-measures-for-heat-pump-market-growth.html#form-content

move towards electrification — a package of measures should be considered to provide optimal consumer outcomes including:[40]

- Energy efficiency to reduce overall demand and therefore support good heat pump performance to minimise heating requirements and reduce running costs.
- Heat demand flexibility should be encouraged to extract further value from time of use tariffs.
- Similarly, the emission impacts of flexible heat demand should be considered.

Thinking about the impacts of heat decarbonisation policy on other sectors includes finance. The report by the Green Finance Institute, 'Financing Zero Carbon Heat'[41] published in December 2020 expressed a need for long-term delivery frameworks and clear regulatory standards to drive investment from private sources alongside supporting measures.

Overall, best practice for the deployment of heat pumps appears to be formed of the following elements, the integrated delivery of which is likely to rest on strong governance arrangements:

- A coordinated set a policies, regulations and softer market creating elements.
- Policy stability.
- Financial support that includes grants, alongside financial penalties for the use of fossil fuels.
- A direct focus on skills and consumer awareness.

40 Rosenow, J., & Lowes, R. (2020). *Heating without the hot air: Principles for smart heat electrification.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/heating-without-hot-air-principles-smart-heat-electrification

41 Green Finance Institute. (2020). *Financing zero carbon heat: Turning up the dial on investment.* https://www.greenfinanceinstitute.co.uk/wp-content/uploads/2020/12/Financing-zero-carbon-heat-turning-up-the-dial-on-investment_Green-Finance-Institute.pdf

Chapter 3: Further policy options to support heat pumps in the UK

The review above shows that there is no single silver bullet policy that can deliver what is required. It will be necessary to create a well-governed package of measures to deliver the required deployment rate.

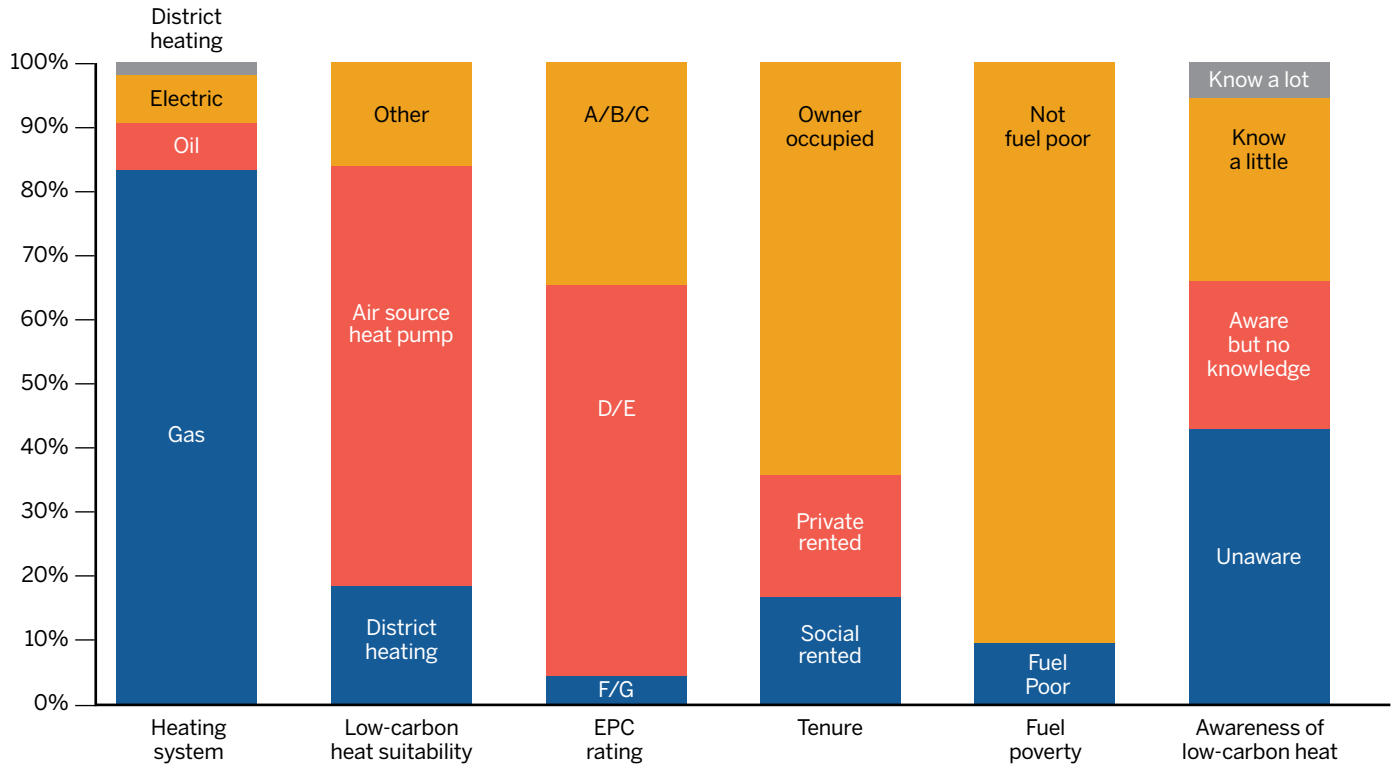
Alongside the policy and regulatory measures considered below, softer interventions, such as the development of a coordinating body or council is likely to be of major value. This is to support consumer awareness raising and protection, technical standards and best practice and supply chain development.

With different tenures, levels of household income, vulnerability and affordability, age and type of existing heating systems, varying levels of efficiency levels and low-carbon-heat awareness (see Figure 4),[42] the policy or regulatory measures needed to support heat pumps will vary. Combinations of policy measures, along with careful consideration of who pays and who benefits, are also likely to be a requirement for each segment.

The heat pump market could behave similarly to other markets where decarbonisation has already happened at scale. Typically, market transformation follows an S-curve of deployment with policy and regulation accelerating uptake during the different market transformation phases. This same relationship can be seen in other sectors, for example electric vehicles, where initial financial support has encouraged early adopters until more attractive running costs and the eventual phase-out of petrol and diesel vehicles bring about a mass transition away from the internal combustion engine.

The economics of solar photovoltaics and electric vehicles, however, are now becoming favourable even in the absence of specific or significant carbon support. The same cannot be said for heat pumps, which are currently more expensive to install than fossil fuel boilers and likely to incur higher running costs than gas unless a variable time-of-use tariff is applied.

Figure 4. Key Great Britain housing metrics



Source: Climate Change Committee. (2020). *Policies for the Sixth Carbon Budget and Net Zero.*

42 Climate Change Committee, 2020.

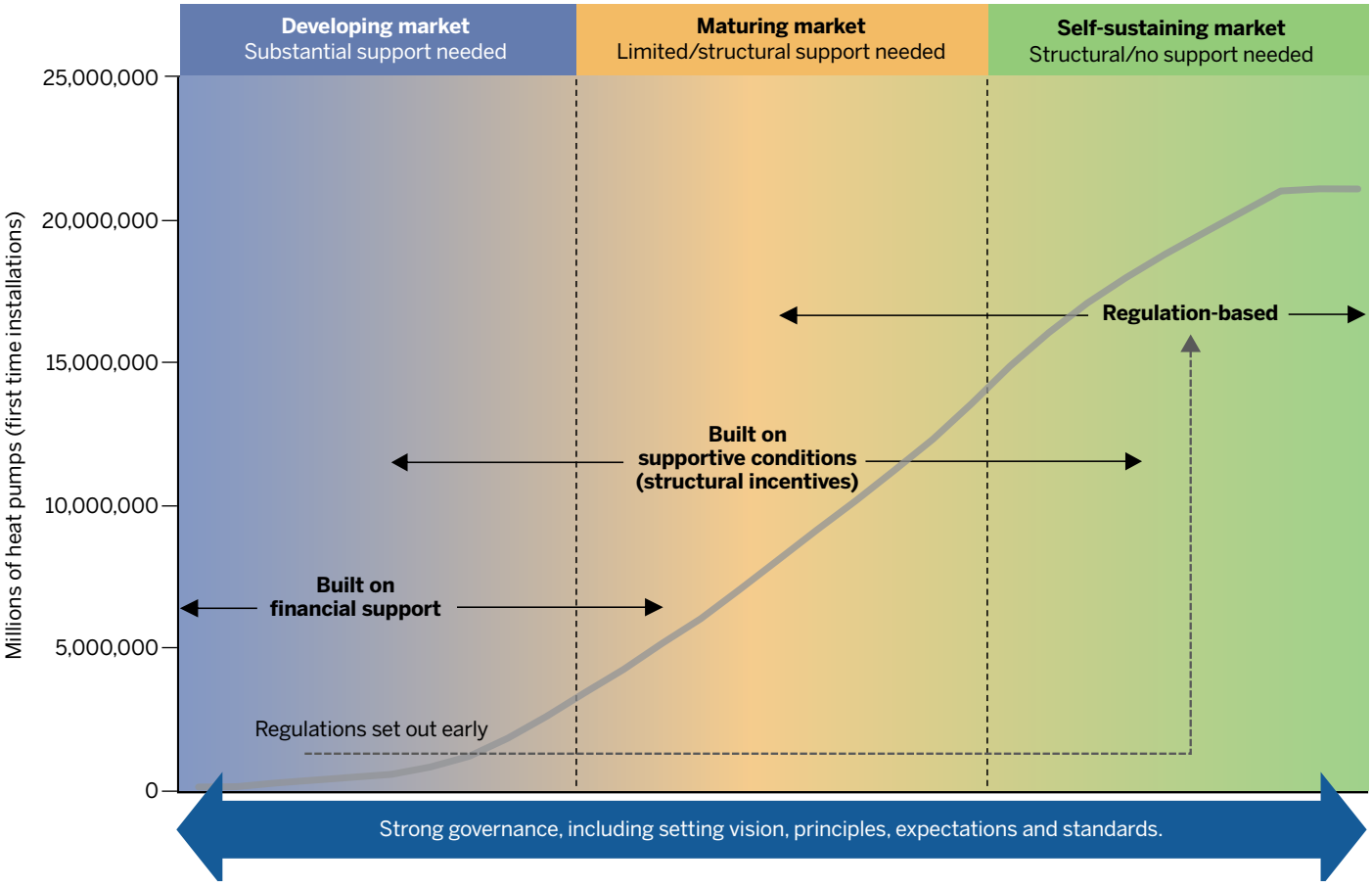
There are specific constraints that make heating decarbonisation particularly challenging, such as complexity, heterogeneity of the housing stock, that it happens where people live, and the need for speed. It is entirely possible that persistent, active government intervention will be necessary alongside the harnessing of market forces to achieve policy goals on time. For example, encouragement of early adoption by willing and able households needs to occur alongside support for low-income households to meet fuel poverty targets and support a just transition. Deployment in on-gas homes will need to happen in parallel with — not subsequent to — deployment in off-gas, even though the latter faces more favourable energy cost and carbon economics.

Regardless of the balance and timing of policy options pursued, a strong governance framework and institution(s) at all appropriate levels will therefore be necessary to manage complexity while ensuring the delivery of good outcomes. This includes, but is not limited to, setting vision, principles, and expectations of different actors and standards (e.g., for consumer protection and quality assurance), innovation frameworks, market observation and progress tracking, and continuous evaluation to derive lessons and apply them to course-correct and improve results.[43] The UK's previous transition to fossil gas central heating shows that rapid change is possible. This programme, however, was carried out in a centrally directed and coordinated manner, a fact that must drive planning for rapid heat decarbonisation.[44]

Within such a framework, there are various policy and regulatory options, suitable across overlapping stretches of time, which can be used to support heat pumps. Key options are outlined in this section in advance of a proposed heat pump policy package. First, we consider financial incentives to build the market, then structural incentives to ensure the market becomes self-sustaining and finally regulation to ensure certainty of outcome.

In Figure 5, we set out for each of the three overlapping phases of market transformation how a transformation towards mass market can be achieved.

Figure 5. Heat pumps market transformation



Note: S-curve from Climate Change Committee Balanced Pathway for heat pumps in existing homes.

43 Hanna et al., 2016.

44 Hanmer, C. & Abram, S. (December 2017). Actors, networks, and translation hubs: Gas central heating as a rapid socio-technical transition in the United Kingdom. *Energy Research & Social Science, 34*, 176-183. https://doi.org/10.1016/j.erss.2017.03.017

Financial incentives to build the market

In at least the initial phase of deployment, financial support programmes will be needed to incentivise homeowners to install heat pumps. This is because the current upfront costs of heat pumps are significantly higher than fossil fuel alternatives, such as gas boilers, and the running costs compared to existing fossil fuel heating do not constitute a clear business case of cost savings. But given the scale of the challenge, it is unlikely that there will be sufficient subsidy to support all homeowners to switch.

On top of financial support over the medium to long term, the relative costs of owning and running a heat pump compared to fossil fuel heating will need to become much more attractive to support market reshaping by reflecting the damage costs of carbon. In Sweden, carbon taxes have been a particularly important driver in the growth of heat pumps.[45] We return to market reshaping in the following section.

The financial incentives listed below are measures that either provide direct capital support for households in the form of subsidy or allow households to borrow money in order to manage financial impacts of heat decarbonisation. They can be combined in various configurations, for example grants and subsidised loans. Early signals of future expectations and regulations are necessary to help drive demand and supply chain investment for heat pumps, alongside the incentives presented by financial support mechanisms alone.

- **Grants** can help overcome the additional upfront costs associated with heat pumps compared to fossil fuel heating systems. Grant levels can be higher for low-income households[46] (and may need to be sustained considerably longer than for others) and levels of support linked to the energy and carbon performance achieved.
- **Subsidised loans** may also have value in that they can remove issues associated with household access to capital and reduce the cost of capital for households. Clearly, loans will not be appropriate for all households. One approach to delivering loans could be via energy bills, although the previous Green Deal scheme was unsuccessful.[47]
- **Stamp Duty rebates** have been suggested as a potential fiscal measure to encourage the installation of energy efficiency before and/or after the sale of a house.[48] A similar model could be used to offer stamp duty reductions for houses with low carbon heating such as heat pumps.
- **Tax reductions** could encourage the uptake of heat pumps. VAT could be removed from heat pump purchase and installation costs. Income tax rebates or credits (such as those seen in France and Italy[49]) could also be offered to installers or households for fitting heat pumps,[50] as could capital allowances for landlords.

Structural incentives to sustain the market

These policy options would reshape the UK energy market to make low-carbon heating the cost-effective option for households.

- **Rebalanced energy costs** could be a key enabler of heat pumps. Currently, electricity is subject to higher policy costs than gas, not all of which are electricity related, a structure that disincentives heat pumps.[51] Relevant policy costs could be moved towards gas bills.
- **Carbon taxes** could shape the economics of heating away from fossil fuels towards lower carbon alternatives. It is worth noting that currently the UK's electricity is subject to a carbon price mechanism, whereas gas and oil used for heating is not. Designed to incentivise power decarbonisation, this carbon pricing approach has created a contrary disincentive for heat electrification.

45 Hanna et al., 2016.

46 Frerk, M. & Maclean, K. (2017). *Heat Decarbonisation: Potential impacts on social equity and fuel poverty.* NEA. https://www.nea.org.uk/wp-content/uploads/2020/11/Heat-Decarbonisation-Report-2017.pdf

47 Rosenow, J. & Eyre, N. (November 2016). A post mortem of the Green Deal: Austerity, energy efficiency, and failure in British energy policy. *Energy Research & Social Science*, *21,* 141-144. https://www.sciencedirect.com/science/article/abs/pii/S2214629616301803?via%3Dihub

48 Committee on Climate Change. (2016). *Next Steps for UK heat policy.* https://www.theccc.org.uk/wp-content/uploads/2016/10/Next-steps-for-UK-heat-policy-Committee-on-Climate-Change-October-2016.pdf

49 *Le crédit d'impôt pour la transition énergétique (CITE)* in France, and *Superbonus 110* in Italy.

50 Lowes, R., Rosenow, J., Qadrdan, M. & Wu, J. (2020). Hot stuff: Research and policy principles for heat decarbonisation through smart electrification. *Energy Research & Social Science*, *70* (101735). https://www.sciencedirect.com/science/article/pii/S2214629620303108?via%3Dihub

51 Barnes, J. & Bhagavathy, S. M. (March 2020). The economics of heat pumps and the (un)intended consequences of government policy. *Energy Policy*, *138* (111198). https://www.sciencedirect.com/science/article/abs/pii/S0301421519307839?via%3Dihub#!

A carbon tax could be applied to fossil fuels used for heating at the point of sale for final consumption. A carbon tax could also be applied further upstream.

- **Energy taxes** have the potential to drive a similar outcome. In the Netherlands, where energy taxes are already high, but offset by a commensurate reduction in income tax,[52] the burden of energy taxation will begin shifting from electricity towards gas to support the switch to other forms of heating.[53]
- **Carbon standards** could be placed on energy retailers or distributors to encourage them to support the installation of heat pumps. The Energy Systems Catapult highlights one option of 'Setting Carbon Standards,' and firms that outperform their set standards could sell credits to other firms,[54] a scheme reminiscent of the now defunct Renewables Obligation for electricity.
- **Stamp Duty reflecting energy and carbon performance** could be designed to be revenue-neutral. This could potentially be an evolution from an initial Stamp Duty rebate (above) and would serve as a permanent structural incentive to embed heat decarbonisation and energy efficiency in homebuyer decision-making. This measure could also (along with regulations on the horizon) lead to energy and carbon performance impacting property values.
- **Requirements for metered energy performance** on government-supported installations of heat pumps and other home energy upgrades can facilitate the capture of new value streams and drive technical and financial innovations. Through maximising heat pump performance and reducing running costs, heat pumps can be used more flexibly, potentially reducing running costs even more.
- **Innovations in service and delivery** are more likely to become widely available in a maturing, increasingly confident market. Their development can also be programmatically driven by public bodies and could include:
- **Heat as a service (HAAS)**, which is not in itself a policy but a deployment model that policy could support. Under HAAS approaches, households or businesses would pay for units of heat rather than paying for appliances and units of fuel separately.[55] This approach could, like some of the previously mentioned financial tools, resolve issues associated with access to capital to pay for initial heat pump costs. As demand for cooling rises, HAAS approaches could encompass cooling as a service, or 'cooling readiness,' taking advantage of the potential for heat pumps to supply air conditioning as well as heat. Electricity suppliers could be mandated to offer 'thermal comfort as a service' models.
- **Green mortgages**, whereby borrowing against the building, or for a new purchase, could also be used to resolve the issue associated with upfront capital. These could provide low-cost financing, especially if mortgage lenders are required to disclose or improve the energy and carbon performance of their property portfolios.[56]

Regulatory measures to secure outcomes

- **Technology bans** are one approach which can drive market transformations with the previous ban on non-condensing boilers being a good example, something that was opposed by some boiler manufacturers but has been extremely successful in deployment.[57] Interventions, such as the upcoming ban on the sale of new fossil fuel passenger vehicles from 2030 and on fossil fuel heating in new homes by 2025, have the potential to reshape entire markets and can be delivered through existing regulatory levers, such as building regulations. Regulations can be applied at the point heating systems or appliances are replaced and to all

52 Government of the Netherlands. (n.d.). *Energy tax.* https://www.government.nl/topics/environmental-taxes/energy-tax

53 London Climate Action Week. (24 November, 2020). *Decarbonising heat: Anglo-Dutch perspectives* [Webinar]. https://www.youtube.com/watch?v=yaLM8BT_1MA&list=PLsoaDIHpvRiBbuY57QvuNmT7RXwmGLbIA&index=6

54 Day, G. & Sturge, D. (2019). *Rethinking Decarbonisation Incentives: Future carbon policy for clean growth.* Energy Systems Catapult. https://es.catapult.org.uk/wp-content/uploads/2019/07/Rethinking-Decarbonisation-Incentives-Future-Carbon-Policy-for-Clean-Growth.pdf

55 Energy Systems Catapult. (2019). *Heat as a Service: An Introduction.* https://es.catapult.org.uk/wp-content/uploads/2019/06/SSH2-Introduction-to-Heat-as-a-Service-1.pdf

56 Green Finance Institute, 2020.

57 Lowes, R. (2019). *Power and heat transformation policy: Actor influence on the development of the UK's heat strategy and the GB Renewable Heat Incentive with a comparative Dutch case study.* University of Exeter. https://ore.exeter.ac.uk/repository/bitstream/handle/10871/38940/LowesR.pdf?sequence=1&isAllowed=y

systems at a later date. Regulation can also affect the supply of fossil fuels, which has the potential to drive investment in cleaner (including heat pump-driven) district heating systems; Norway for instance has introduced a ban on fuel oil sales for heating.

- **Point-of-sale** and point-of-renovation requirements for homes to have low carbon heating may be able to drive the heat pump market in advance of wider technology bans. Such an approach is being considered by the Scottish Government for meeting energy efficiency standards at point-of-sale[58] and could be designed to encompass carbon intensity. Low carbon heating requirements could also be introduced at point-of-renovation or extension-to-homes, a variation on so-called 'consequential improvements' previously considered by government for building regulations but never implemented.
- **Requirements on landlords** for low carbon heating could be used in a similar way as they are currently used for energy efficiency. For example, homes could not be rented unless they were fitted with low-carbon heating. An option to require improvements in both the energy and carbon performance of rental properties is being considered by the government. Social landlords could be regulated in advance of private landlords.
- **Heat zoning** or 'local area energy planning'[59]— also a governance issue — may be required to deal with expected geographical variations in low carbon heating. Some high-density areas are expected to be converted to district heating (possibly using heat pumps), and there may be potential for hydrogen heat in areas nearby industrial clusters. If areas are deemed unsuitable for hydrogen or district heating, electrification, most likely via heat pumps, appears to be the key option.

58 Scottish Government. (2019). *Future of low carbon heat for off gas buildings – call for evidence: Analysis of responses.* https://www.gov.scot/publications/future-low-carbon-heat-gas-buildings-analysis-responses-call-evidence/

59 Centre for Sustainable Energy & Energy Systems & Catapult. (2020). *Local Area Energy Planning: The Method.* https://es.catapult.org.uk/wp-content/uploads/2020/08/LAEP-method-final-review-30-July-2020.pdf

Chapter 4: Outlining a heat pump policy package for the United Kingdom

The speed and scale of the UK's heat pump challenge mean that existing and proposed measures appear inadequate. Although proposed measures may go some way to support heat pump deployment, it seems likely that regulatory measures will be needed in advance of the appliance bans proposed by the CCC. We propose the following five interlocking principles to guide policy decisions for the strategic rollout of heat pumps:

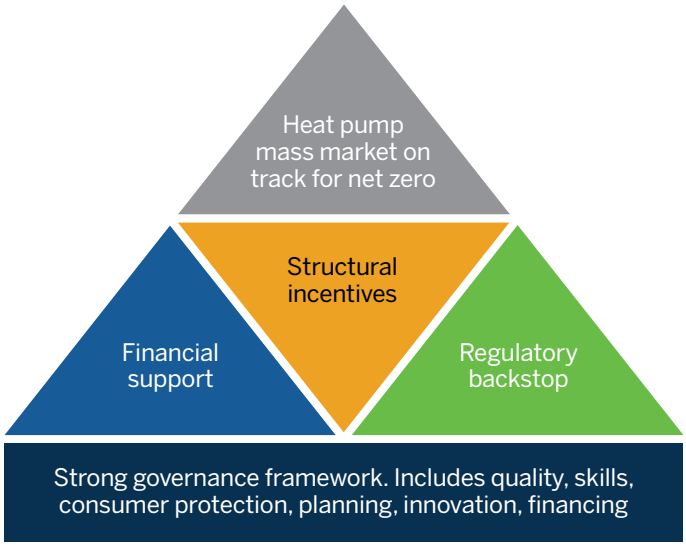
1. **Consumer-centricity and fairness**, focused on awareness, advice, protection and fair access for all — where the inclusion of low-income households helps to accelerate acceptance and deployment.
2. **Transparency** in aligning with carbon budgets on the way to net zero, for which the government's 2028 deployment target represents a first, if still insufficient step.
3. **A need for speed**, which requires substantial government support to build the market, complemented by early signalling of regulatory requirements to drive down capital costs and increase private investment over and in time.
4. **A level playing field** in which heat pump systems are attractive in terms of their investment cost, asset value and running costs.
5. **Flexibility and coherence** in governing the rollout to ensure innovation and best practice can deliver the best outcomes for individual households and communities within a robust national framework.

Emulating successful market transformations in other parts of the energy system requires strong governance guided by the above principles.

Building on this, we propose a combination of policy measures from the three core pillars explored in section 4 (as illustrated in Figure 6).

1) **Financial support:** Financial support is based on the approach of providing early public funding to support a switch to heat pumps. This will initially need to be offered to all customers, but eventually becomes means-tested alongside low-cost government loans. This approach is already used by the Scottish government.
2) **Structural incentives:** The economics of different heating solutions are currently stacked against heat pumps. Shifting the existing tax and levy burden from electricity to fossil fuels used for heating is one way to bring down the relative running costs of heat pumps but is unlikely to be entirely sufficient. A carbon tax of some kind and other pricing signals will also be needed.
3) **Regulatory certainty:** Similar to the phase-out of petrol and diesel cars, a medium- to long-term regulatory backstop will be required to enable a market-led approach rather than relying on government subsidy.

Figure 6. Key elements of the policy package



Each of the following sections sets out in greater detail the interventions needed in each pillar.

Initiate governance infrastructure this year

Strong governance will need to include, but not be limited to, setting visions, goals, expectations and standards for different actors; supporting consumer protection, skills and quality assurance; pursuing mission-driven innovation; observing the market; tracking progress; evaluating

continuously for lessons then applied to course-correct and improve results. Crucially, these elements combined will ensure a seamless experience for households.

A heat pump council — comprised of national and local government, regulators, industry, consumer groups and civil society — could drive many of these functions and needs to link coherently to a broader governance architecture for the energy system and net-zero transitions. It should be established this year.

The council would need to prioritise quality assurance, consumer awareness, engagement and protection, and training — all critical for a successful transition towards heat pumps. The council would also need to support a seamless conversion process involving electricity, gas and heat networks, and suppliers. Priority elements of a governance framework therefore include:

- A coordinating body that includes the heat pump industry, government, independent experts to focus on skills, delivery and communication to consumers.
- A consumer redress and protection body which consumers can contact in case they are unhappy with the standard of installation they received.
- Regulatory incentives placed on electricity networks and suppliers to support the heat pump rollout and encourage time-of-use pricing and HAAS offerings.
- Heat zoning analysis carried out at a local level, which can support decisions around the location of heat networks and potential hydrogen areas, and measures to support local and planning authorities to support deployment.
- An independent test centre for heat pumps, following the model of the Swiss Heat Pump Test Facility to collect and disseminate robust information on heat pump performance.
- The use and continuous improvement of the Microgeneration Certification Scheme or a similar standard to ensure high quality installations.

Beyond this, the wider institutional context needs to be considered and leveraged to support the rollout and its governance. This includes the role of UK Research and Innovation and Innovate UK in supporting strategic innovation around heat pump technologies, skills, business and financing models, and developing a potential export base for these. At the intersection of governance and finance, a pivotal role should also be played by the new National Infrastructure Bank in absorbing initial investment risk to draw in private investment at scale,[60] and providing technical assistance to local governments to plan and raise capital for heat pumps deployment in social housing and beyond.

Begin scaling up financial support this year

In the early years of deployment some level of financial support is necessary to offset the higher investment costs and protect households on low incomes. Existing financial support programmes such as the RHI, the GHG and the planned Clean Heat Grant provide insufficient support and will end in 2024.

A continuation and expansion of financial support programmes is needed for heat pumps until at least 2030, with sustained support for low-income households and tapering support for the able-to-pay sector. Expansion should start this year. Support needs to target existing homes rather than new homes where the installation of low carbon heating systems will be made mandatory.

We make the following assumptions in our calculation:

- Building on the CCC's projection of domestic heat pump deployment in its Balanced Pathway we calculate the total amount of financial support needed over time.[61]
- We assume the average cost of an air source heat pump to be £10,000[62] in 2021, falling by 25% by 2030 due to innovation impacts as the market scales.[63]
- The level of support per installation for low-income customers needs to be close to 100%, i.e. on average

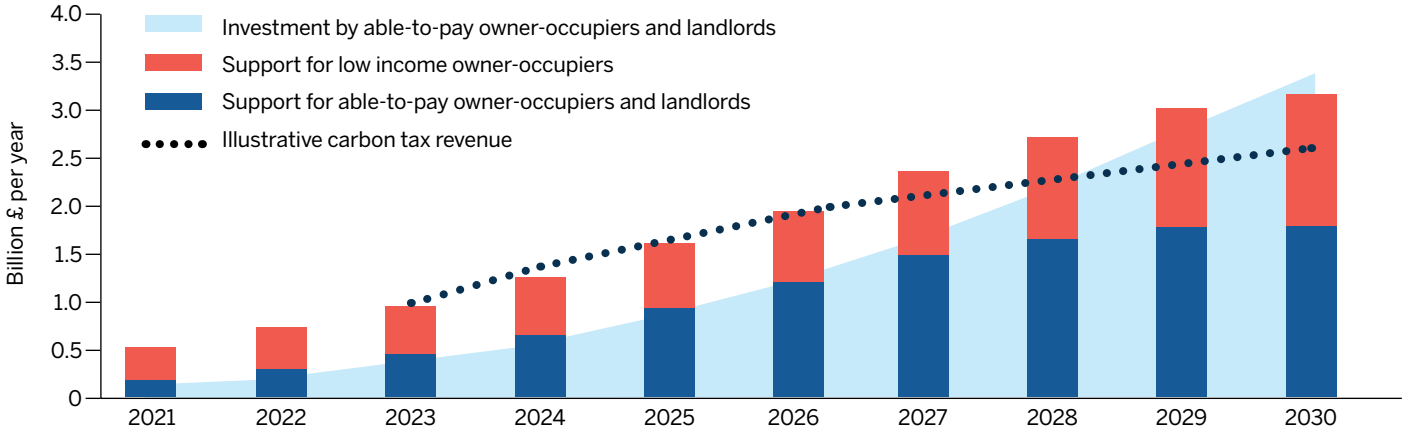
60 E3G. (2021). *National infrastructure bank design: Building a public bank fit for the future*. https://9tj4025ol53byww26jdkao0x-wpengine.netdna-ssl.com/wp-content/uploads/NIB-design-briefing_February-2021.pdf

61 We assume a somewhat smoother deployment curve compared to the CCC but reach similar numbers of homes converted by 2030.

62 Based on an air-source heat pump cost of £9,000-11,000. Energy Saving Trust. (n.d.). *Air source heat pumps.* https://energysavingtrust.org.uk/advice/air-source-heat-pumps; Carbon Trust. (2020). *Heat pump retrofit in London.* https://www.london.gov.uk/sites/default/files/heat-pump-retrofit-in-london-v2.pdf. A £10,000 average can be viewed as comprising a mix of installations that include/don't include hot water cylinders, immersion heaters and radiator upgrades, as well as smaller numbers of higher cost ground source heat pumps and lower cost per home communal systems.

63 BEIS. (2016 b). *Potential cost reductions for air source heat pumps: The scope for a mass market.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf

Figure 7. Suggested amount of financial support to install heat pumps following the Climate Change Committee trajectory



£10,000.[64] We assume that until 2030, 28% of heat pumps deployed and financially supported are installed in low-income, owner-occupied households to ensure sufficient conversion rates in this sector.[65]

- For the able-to-pay sector, including rented homes, similar levels of support as offered in other countries need to be provided, equivalent to about £6,000 per home in the beginning, with differentiation depending on the installed technology and size of the property. We assume that the amount of support offered can be gradually reduced to £1,250 per installation by 2030 with rising deployment, falling equipment costs, lower running costs relative to fossil heating systems, increasingly attractive financing offers and regulation this decade.
- Overall investment costs borne by government plateau around 2030 as the required deployment levels are reached, costs of the equipment come down and regulatory measures increasingly begin to have an effect on the market.

Figure 7 provides an illustrative trajectory of the public investment needed, alongside private investment, based on the assumptions above. Of the total public investment, 42% goes towards supporting the 28% of heat pumps that are deployed in low-income, owner-occupied households. Uncertainties abound, but this gives an indication of the amount of financial support needed.

To illustrate the trajectory's scale, the proposed public investment to 2030 would be lower than the expected build cost of Hinckley Point C.[66] Also for comparison, the dotted line indicates the potential revenues from a carbon tax on fossil fuel use in homes if it were introduced in 2023 at £15/tCO2, rising to £50/tCO2 by 2030.[67] This would match the level of public capital investment in heat pumps illustrated in Figure 7 quite closely through the mid-2020s. The impact of a carbon tax on the economics of heat pumps for individual households is explored further on pages 24-25.

The trends inherent in the trajectory, relative to 2021, are shown in Figure 8. Against the backdrop of an 11-fold increase in heat pumps installed per year, public capital support for able-to-pay households begins to level off in 2028, earlier than support for low-income, owner-occupiers does. In the able-to-pay sector, the ratio of public-to-private investment evolves from 60%/40% in 2021 to 17%/83% by 2030. Also not shown on the chart, the volume of private

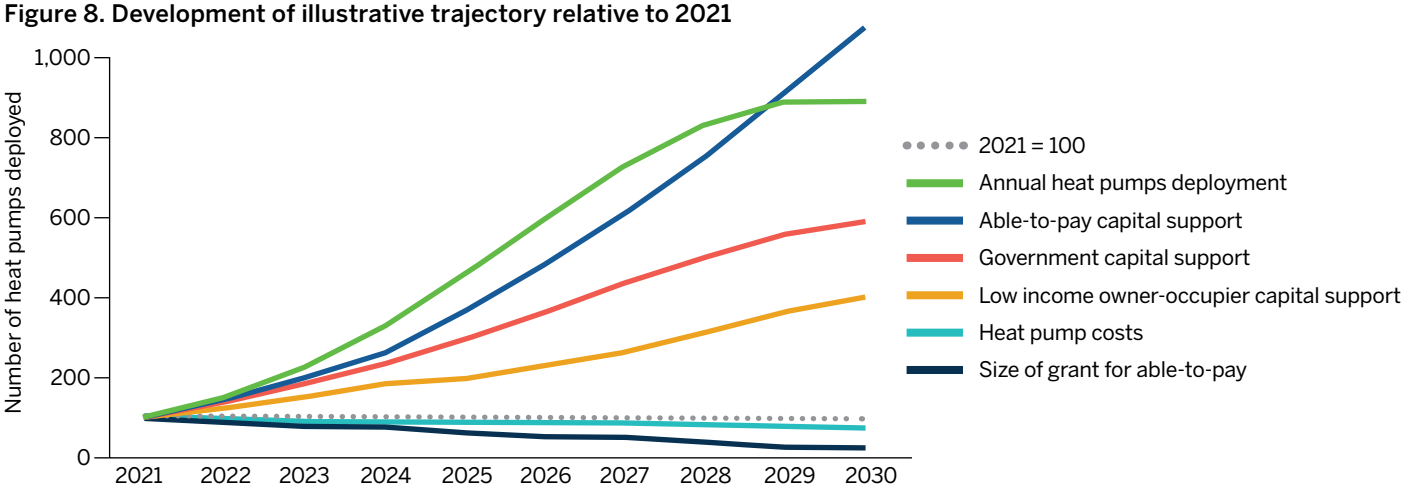
64 This is the same amount as currently being offered to low-income households under the GHG.

65 One in five households falls into the low-income category but in order to ensure the poorest households can see a benefit and are protected we assume a disproportionally higher rate of deployment in the low-income segment. Devine, B. F. (2020). *Poverty in the UK: Statistics.* House of Commons Library. https://researchbriefings.files.parliament.uk/documents/SN07096/SN07096.pdf

66 De Beaupuy, F. & Morison, R. (27 January, 2021). British Hinkley Point Nuclear Plant Delayed with Higher Costs. *Bloomberg.* https://www.bloomberg.com/news/articles/2021-01-27/edf-sees-delay-and-rising-bill-in-british-nuclear-plant-project#:~:text=missed%20milestones%20here-,The%20project%20completion%20cost%20at%20Hinkley%20Point%20C%20is%20now,said%20in%20a%20statement%20Wednesday.

67 CO_2 emissions profile assumed in Figure 7 to derive potential carbon tax revenues is from the CCC's Balanced Pathway scenario. Climate Change Committee, 2020.

Figure 8. Development of illustrative trajectory relative to 2021



investment rises more than 25-fold relative to 2021, compared with a nine-fold increase in public capital support for the sector.

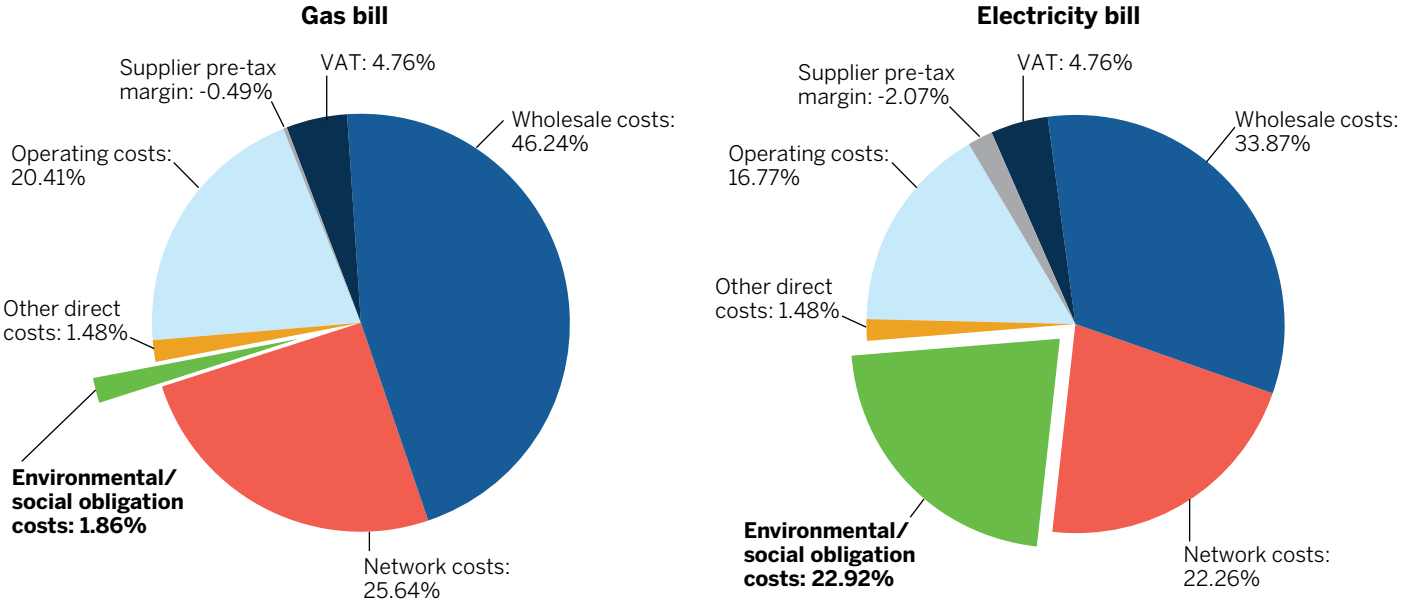
Implement structural incentives by the end of this parliament

Rebalancing environmental and social levies and costs

Residential electricity prices per kWh are currently around five times higher than gas prices. Some of that difference in price is driven by legacy policy costs. Most of levy-funded energy and climate policies are presently paid for through electricity bills (Figure 9).[68] Legacy policy costs should be moved from electricity onto gas bills to reflect the falling carbon intensity of electricity and the need to incentivise fuel switching away from gas to heat pumps driven by increasingly clean power. These costs include the costs for policies such as the Energy Company Obligation, feed-in tariffs, the Carbon Floor Price, Contracts for Difference, the Renewables Obligation and the Warm Home Discount.

For the average dual fuel bill, this would make no difference if the same number of levies were recouped. For lower income households that heat electrically — and are

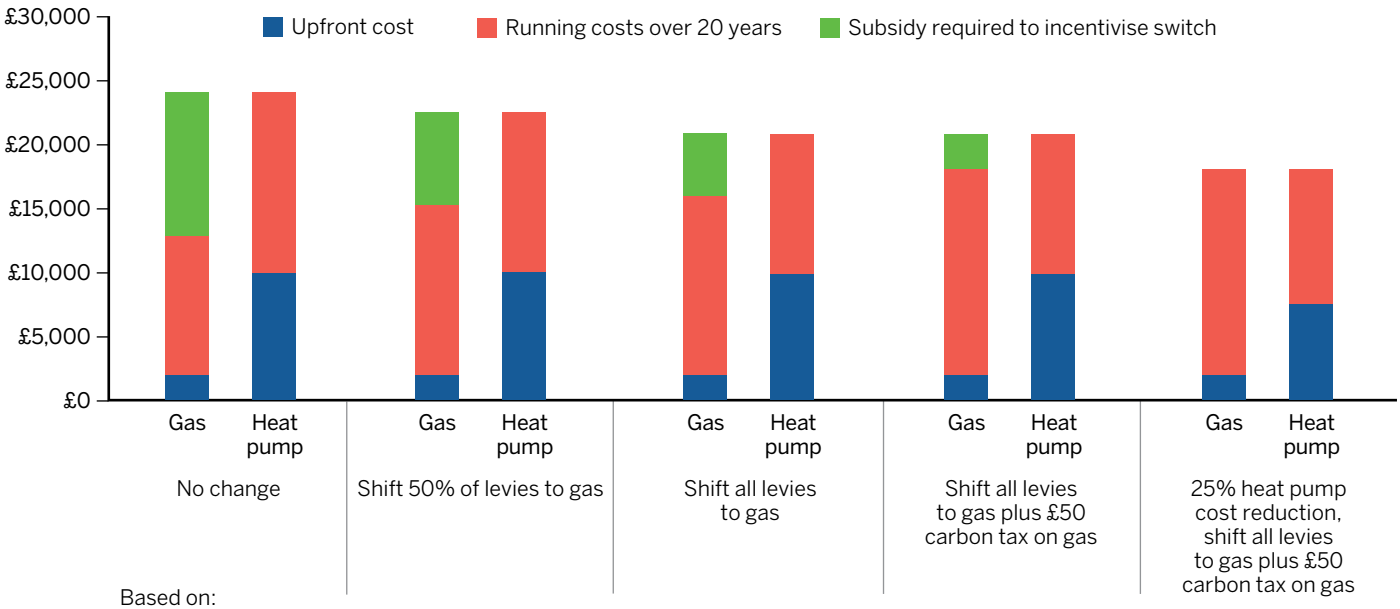
Figure 9. Breakdown of average gas and electricity bill



Source: Ofgem. (2021). Infographic: *Bills, prices and profits.*

68 Ofgem. (n.d.). *Infographic: Bills, prices and profits.* https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits

Figure 10. Total cost of ownership (maintenance not included) with current average electricity prices



Based on:
- assumed average gas use of 12,000 kWh;
- assumed heat demand of 10,800 kWh delivered heat;
- 85% gas boiler efficiency based on in-situ field trials; and
- assumed average coefficient of performance of three

twice as likely to be in fuel poverty[69] — energy bills would come down, helping to meet statutory targets. For above-average gas users, costs will rise. Some low income and fuel poor households fall into this group, which stresses the importance of providing adequate financial support to help them switch from gas heating and upgrade the energy efficiency of their homes.

Over time, as the amount of gas consumed for heating falls and the number of homes heated with gas declines, the environmental and social levies will fall on fewer customers and fewer units of gas. Concurrently, legacy policy costs will decline over time, once past commitments have been paid off. Further analysis around the precise mechanisms for shifting levies from electricity to gas is needed to determine a practicable pathway. Alternatively, levies could be transferred away from energy bills and funded through general taxation, an approach currently under consideration in Germany.[70]

Carbon taxation

Shifting levies alone may not be sufficient to make heat pumps cost-competitive with gas heating as Figure 10 demonstrates. This assumes an initial air source heat pump retrofit system typically costs £10,000[71] (versus a cost of £2,600 for a replacement gas boiler[72]) and runs using electricity at the UK marginal retail price of 17.2p/kWh, with gas costing 3.6p/kWh.[73] Following the examples of other countries such as Sweden and Finland, the UK could introduce a carbon tax for heating fuels. We do not propose a specific carbon tax level, but for the purpose of illustration, assume that this could eventually be set at around £50 per tonne of CO_2. Even if all levies, however, were shifted away from electricity, and with a £50/tCO_2 carbon tax, the total cost of ownership of a heat pump over a 20-year timespan would still be higher than a gas boiler. For customers on a standard electricity tariff, a reduction in first-time heat pump

69 BEIS. (2019). *National statistics: Fuel poverty detailed tables 2019.* https://www.gov.uk/government/statistics/fuel-poverty-detailed-tables-2019

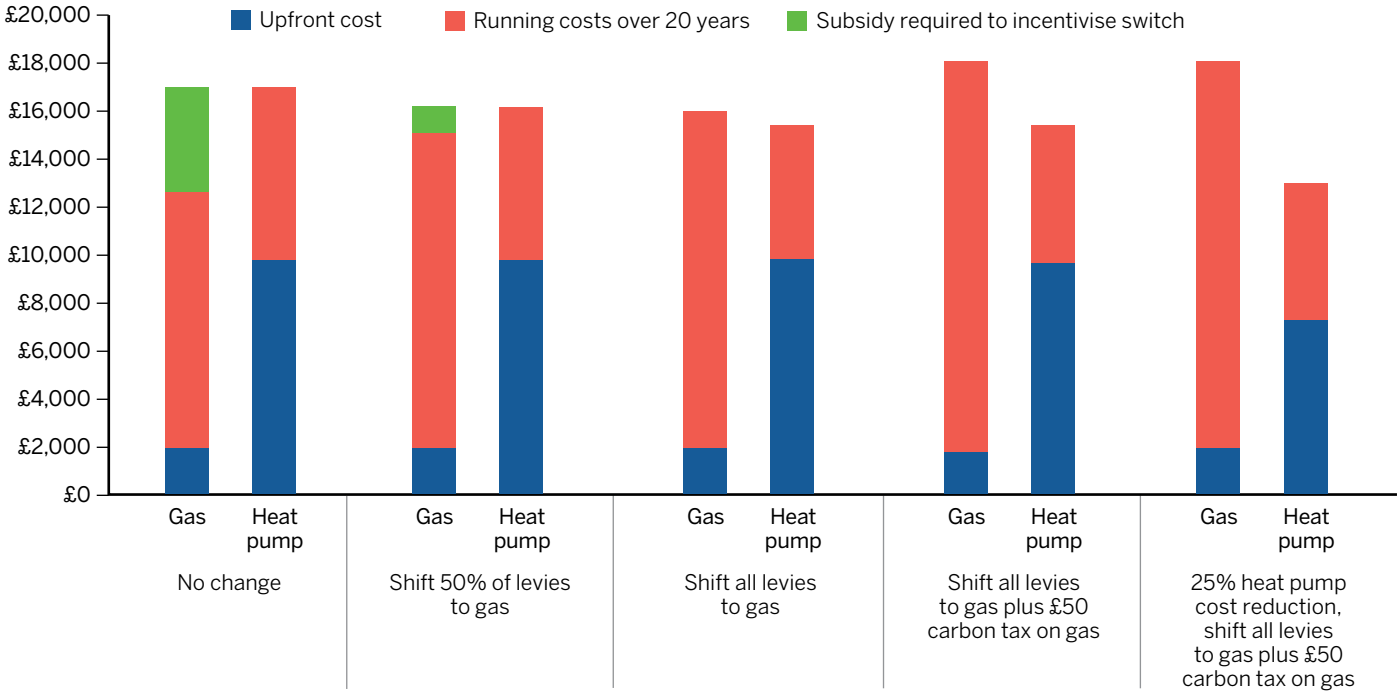
70 Amelang, S. (17 February, 2021). Debate on scrapping renewables levy gathers pace in Merkel's conservative party. *Clean Energy Wire.* https://www.cleanenergywire.org/news/debate-scrapping-renewables-levy-gathers-pace-merkels-conservative-party

71 A significant element of this cost which is associated with heat emitters and pipework is only required once. Actual costs of the heat pump tend to be relatively limited.

72 Knight, M. (15 February, 2021). How much does a new boiler cost? *Which?* https://www.which.co.uk/reviews/boilers/article/buying-a-new-boiler/boiler-prices-how-much-does-a-new-boiler-cost-aK2dh2j3Cabo

73 The average standing charges in 2020 for gas (£96.15) and electricity (£84.09) respectively have been assigned to heating costs proportionate to the share of each fuel used for heating: 97% for a gas boiler and 49% for a heat pump. BEIS. (2013). *Statistical data set: Annual domestic energy bills.* https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics; BEIS. (2012). *National Statistics: Energy consumption in the UK.* https://www.gov.uk/government/statistics/energy-consumption-in-the-uk

Figure 11. Total cost of ownership with time-of-use electricity prices (assumed average 10p/kWh)



installation costs of around 25% or a subsidy of the same scale would be needed to make heat pumps cost competitive.[74]

It is important to understand this analysis as a snapshot in time. Longer-run, energy efficiency improvements will lower running costs for both gas and electricity, therefore limiting longer term bill impacts. In addition, first-time heat pump system installations will eventually give way to heat pump appliance replacements, significantly reducing subsequent capital costs.

As indicated in Figure 7 on page 22, a carbon tax on fossil fuels for heating on the CCC Balanced Pathway's deployment trajectory for heat pumps (with falling gas demand) could generate £1bn revenue if introduced at £15t/CO_2 in 2023, rising to £2.6bn by 2030 if the tax were to rise to £50t/CO_2 over time. This revenue could be recycled to offset any negative impacts, especially on low-income households, both through targeted energy efficiency investments as well as carbon rebates.[75] This income could also offset some of the costs associated with the required heat pump grant support as it is in a similar range of the public investment levels shown in Figure 7.

Time-varying pricing

Time-varying tariffs can significantly lower the running costs of heat pumps. Such tariffs can be designed as simple time-of-use tariffs (well-known as Economy 7 in the UK), or take the form of more sophisticated tariffs that follow wholesale market prices. The available evidence shows that by automatically running heat pumps flexibly on a time-varying tariff, savings of more than 50% can be achieved with minimal need for the household to manage the heat pump's operation.

For homes using a time-of-use tariff averaging 10p/kWh of electricity used for heating, shifting all levies to gas would be sufficient to achieve cost-parity over a 20-year period. With falling installation costs, the economic case for heat pumps becomes stronger. If time-of-use tariffs are taken up by a growing number of households, the relative difference between peak and off-peak costs is likely to come down over time. The value from electricity-demand flexibility, however, will persist with the diffusion of other technologies such as battery electric vehicles. Given the low uptake of time-of-use tariffs so far and low penetration of heat pumps, we expect there to be significant potential for time-of-use tariff-based savings in the near-to-medium term (see Figure 11).

74 Previous research suggested a cost reduction of 30-50% might be achievable if heat pump production is scaled. BEIS, 2016 b.

75 This approach has been followed in Canada, for example.

Stamp Duty reform

The selling or purchasing of a home represents a critical trigger point for making refurbishments to a property. Linking Stamp Duty rates to the energy performance of buildings and/or the carbon emissions from heating can provide an important stimulus for triggering heat pump investment. Alongside regulation, this could lead to property values reflecting heating carbon performance, and in turn stimulate attractive financing offers from mortgage lenders and other finance providers. This can be achieved through variable Stamp Duty rates or rebates in case a heat pump is installed within a specified time window after property purchase. The concept has been described elsewhere in detail and can play a complementary structural role to energy pricing reform that could see heat pump investment reflected in higher asset values.[76]

Signal regulatory backstop for all homes this year

Although offering financial support and reducing the relative running costs of heat pumps over time, there is a need for medium-to-long-term regulatory signals, communicated early and similarly to the 2030 end date for petrol and diesel car sales, to drive towards a market-led approach that will not rely on public capital support.

Existing plans for building regulations can be used to tighten up consumer standards and minimum heat pump performance levels (2024), to mandate low carbon heating in new homes (2025).

For existing homes, no such mandate exists yet but would be needed to support the oil and coal, and gas phase-out dates — requiring non-fossil heating when appliances are replaced — as proposed by the CCC for 2028 and 2033 respectively. It is important that such changes to regulation are made early to give a strong market signal.

Low carbon heat mandates can be phased in by starting for example with house sales or heating system replacement, followed by an end date to replace the remaining stock. The government may also consider a ban of the most carbon-intensive heating fuels, such as heating oil, an approach adopted by countries like China, Denmark, France, Germany and Norway, as well as individual states and municipalities in the USA.

76 Jahn, A. & Rosenow, J. (2017). *Property transfer tax reform – a game changer for energy efficiency retrofits?* In: Proceedings of ECEEE Summer Study 2017, pp. 1351-1358. https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/6-buildings-policies-directives-and-programmes/property-transfer-tax-reform-a-game-changer-for-energy-efficiency-retrofits/

Conclusions

The decarbonisation of heating in the UK should be considered as nothing short of a multi-decadal transformation. The scale of the challenge and the required speed implied by greenhouse gas reduction targets mean that thorough and responsive governance is necessary. It is not clear, however, that the scale and urgency of the challenge is generally appreciated, and current and proposed UK Government policy will fall short of the Government's own targets.

The deployment of heat pumps at mass market levels across the UK's housing stock is needed by the end of this decade, with a ban on replacement fossil fuel heating systems by the early 2030s. Because of the speed of decarbonisation required by UK carbon budgets and heating appliance turnover rates, immediate progress in heat pump deployment is required for on-gas grid homes.

This paper shows that it will not be enough to rely on individual policy drivers to deploy heat pumps at the rate required. Instead, a highly coordinated package of measures is required and we have proposed a three-pillar approach that includes:

- **Financial incentives** to enable and encourage households to switch.
- **Structural reform** of the energy market over the longer term to reshape market economics towards low carbon heating options.
- **Regulatory backstops** to ban high carbon heating.

These three pillars need to be bound together with a very **robust governance and coordination framework** in order to ensure that the transition can be delivered smoothly and consumers are protected.

Although multiple measures will be needed and must be strongly coordinated, the balance of interventions, and where investments and incentives fall, is ultimately a matter of political choice. We suggest that policymakers play close attention to concerns over equity and the view of the general public when making these decisions. What is abundantly clear is the need for major decisions soon on governance and the choices within and across each of the three pillars.

Early decisions can unlock multiple long-term benefits and the success of the UK's heat transition depends on what happens in the first part of this decade. We have been deliberately conservative in our cost estimates and used UK data based on a small and subsidised market that likely means prices are not as competitive as they should be. Although the challenge is significant, decisive action now could drive or harness the following dynamics early, which our analysis has not attempted to quantify:

- With a **growing supply chain to meet demand**, encompassing small- and medium-sized companies, comes greater competition and more competitive pricing.[77]
- **Local authorities, social housing providers and communities** securing the learning and cost- reduction effects of bulk procurement or reverse auctions that have been used successfully for other technologies.[78]
- **Greater cost reductions** than assumed here, alongside performance improvements, are possible with global technological innovation and the development of a mass market in the UK. To name a few, these can derive from better performing, cheaper compressors and other components, the use of natural refrigerants enabling more efficient heat transfer, and a modular approach to installation and servicing.[79]
- The **potential for falling electricity costs** associated with the reduced marginal generation costs of an increasingly renewable power system.[80]

77 BEIS, 2016 b.

78 E.g., Solar Together. https://solartogether.co.uk

79 BEIS, 2020 a.

80 BEIS. (2020 d). *BEIS 2019 updated energy & emissions projections.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931212/Annex-M-price-growth-assumption__EEP2019_.ods

- Digitalisation of performance monitoring, increased investor confidence, aggregation of investments, driving the volume of private capital up and cost of capital down.[81]
- Alongside jobs in the supply chain, the potential for inward investment in manufacture and assembly, including the potential for exports of heat pump products and services.[82]

In light of the clear benefits of early action, we urge HM Government to set out a detailed heat policy roadmap as part of the upcoming Heat and Buildings Strategy, and a complementary pathway for structural reforms needed through the Treasury's Net Zero Review, taking into account our proposed framework. The forthcoming budget and this year's spending review need to scale up public investment, including through the new National Infrastructure Bank. Such a policy and financing roadmap will provide a clear signal this year to the heating market which could drive the development of supply chains, skills, innovation and support inward investment.

The fundamental reshaping of heating in the UK will of course also include the deployment of fabric energy efficiency and heat networks. These elements will also require shared governance and policy reform in concert with the drive for heat pump deployment. Although the scale of the policy challenge may appear significant, the potential prizes beyond net zero are great. Reduced energy imports, increased inward investment, jobs, lower bills and increased spending power across the long term, along with reinforced international climate standing, are all outcomes of heat decarbonisation done well. Only a carefully coordinated and well-delivered package of major policy decisions can secure this.

81 Rathmell, A., Oreszczyn, T., Phillips, J., Thomas, S., & Jofeh, C. (2021). *Towards a protocol for metered energy savings in UK buildings.* Green Finance Institute. https://www.greenfinanceinstitute.co.uk/wp-content/uploads/2021/02/Towards-a-protocol-for-metered-energy-savings-in-UK-buildings.pdf; Green Finance Institute, 2020.

82 BEIS, 2020 a.

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