Title: Consultation on a market-based mechanism for low-carbon heat
IA No: BEIS017 (C)-21-CH
Lead department or agency: BEIS
Other departments or agencies: None

Impact Assessment (IA)

Date: 19 October 2021

Stage: Consultation

Source of intervention: Domestic

Type of measure: Primary legislation

Contact for enquiries:
heatmarketmechanism@beis.gov.uk

Summary: Intervention and Options

RPC Opinion: Not Required

Cost of Preferred (or more likely) Option (in 2020 prices, 2020 present value)			
Total Net Present Social Value	**Business Net Present Value**	**Net cost to business per year**	**Business Impact Target Status**
-£500m	N/A	N/A	N/A

What is the problem under consideration? Why is government action or intervention necessary?

As the Heat and Buildings Strategy sets out, we have an ambition to grow the market for heat pumps to approximately 600,000 installations per year by 2028. This level of heat pump deployment is strategically important for any of the potential routes to net zero and is essential for ensuring an electrification-led route remains viable. Heat pumps are largely unable to compete on cost with established fossil fuel and less efficient heating options, such as natural gas, oil and direct electric heating. This is partly due to the emerging nature of low-carbon heating, which means that it does not benefit from economies of scale or from mature supply chains to the same degree as conventional technologies. Additionally, the full societal costs of fossil fuel combustion are not reflected in their market prices, including for example impacts on health and climate change. In the absence of an effective policy framework, including regulatory policies such as this, the heat pump market would not be expected to grow at the targeted rate. This would result in lower greenhouse gas emissions reductions from buildings than targeted in near-term carbon budgets and would also mean that the target of net zero emissions by 2050 could not be reached in a cost-effective manner.

What are the policy objectives of the action or intervention and the intended effects?

The consultation on a market-based mechanism for low-carbon heat sets out plans to establish a platform for an industry-led transformation of the heating appliance market, through the introduction of a market obligation. This mechanism will create a market incentive to grow the numbers of low-carbon heating appliances installed each year, providing industry with a clear, long-term policy framework for investment and innovation. The aims are to:

- *Support development of the UK heat pump market in line with the targeted growth trajectory in the Heat and Buildings Strategy (~600,000 installations p.a. by 2028);*
- *Contribute to decarbonising heating in the UK and to meeting carbon budgets.*

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

The policy options considered in this impact assessment are:

- *Option 0 (counterfactual): do nothing.*
- *Option 1 (preferred option): introduce an obligation on the manufacturers of gas and oil boilers sold on the UK market to achieve the sale of a certain number of heat pump, proportional to their boiler sales over a given period.*

As the market mechanism consultation document sets out, there are a range of models that a mechanism such as this could take, and we expect to consult on more detailed design proposals in due course. This policy is also expected to form part of a wider policy framework supporting heat decarbonisation; the combination of policies in this overall framework will have a bearing, for instance, on how policy costs are distributed across different groups.

In this initial Impact Assessment, we have estimated only the quantifiable social costs and benefits associated with the heat pump deployment ambition targeted. Further stages of consultation and Impact Assessments are expected in due course as detailed design of this policy and the wider policy framework continues over the next 1-2 years.

The principal alternative to option 1 would be to pursue only regulatory and/or subsidy-based measures without an accompanying market obligation. Such alternatives are less likely to reach the policy goals and would be likely to lead to higher overall social costs; they have been therefore disregarded from analysis.

Will the policy be reviewed? It will be reviewed**. If applicable, set review date:** N/A

Does implementation go beyond minimum EU requirements?		N/A		
Is this measure likely to impact on international trade and investment?		N/A		
Are any of these organisations in scope?	**Micro** No	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** 3	**Non-traded:** -22	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister: _____ Date: 19/10/2021

Summary: Analysis & Evidence - Policy Option 1

Description: To introduce an obligation on the manufacturers of gas and oil boilers sold on the UK market to achieve the sale of a certain number of heat pumps, and potentially other low-carbon heating appliances, proportional to their boiler sales in each period.

FULL ECONOMIC ASSESSMENT

Price Base Year 2020	**PV Base Year** 2024	**Time Period Years** 24	**Net Benefit (Present Value (PV)) (£m)**		
			Low: N/A	**High:** -1,500	**Best Estimate:** -600

COSTS (£m)	**Total Transition** (Constant Price) Years		**Average Annual** (excl. Transition) (Constant	**Total Cost** (Present Value)
Low	N/A		N/A	N/A
High	N/A		600	11,400
Best Estimate	N/A		300	5,100

Description and scale of key monetised costs by 'main affected groups'

The largest societal costs are the additional capital costs associated with installing clean heating technologies, followed by long run variable costs.

Other key non-monetised costs by 'main affected groups'

There is likely to be some cost of compliance with the obligation for the obligated parties, for instance administrative overheads in relation to reporting. Estimating/monetising possible compliance costs will depend upon more detailed policy design and scheme administration considerations in due course as well as the further development of the wider policy framework for low-carbon heat.

BENEFITS (£m)	**Total Transition** (Constant Price) Years		**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	N/A		N/A	N/A
High	N/A		600	9,900
Best Estimate	N/A		300	4,600

Description and scale of key monetised benefits by 'main affected groups'

The largest monetised benefits are the carbon emissions savings in the non-traded sector, followed by air quality improvements.

Other key non-monetised benefits by 'main affected groups'

Innovation benefits, reduced technology costs due to learning from wider deployment leading to future decarbonisation being more cost effective. Development of competitiveness in UK's clean goods and services related to heat. Alignment with net zero strategy. Reduction of risks in other future policies. Growth in the market for low-carbon heating appliances and the businesses that produce, sell and install them, produce or operate ancillary goods (e.g. heat batteries) and services (e.g. smart energy management and flexibility services), etc. Policy framework stability, with market-wide application, enabling strategic confidence to invest in supply chains, training, etc.

Key assumptions/sensitivities/risks	
Deployment level, costs and performance of heating systems (actual in-situ performance of heating system), future fuel costs and carbon savings. This IA presents the uncertainty through sensitivity analysis in the Modelling Approach and Results section of this report.	

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:**
Costs: N/A	**Benefits:** N/A	**Net:** N/A	N/A

Executive Summary

This impact assessment is part of the consultation on a market-based mechanism for low-carbon heat. It aims to appraise the impact of the proposed scheme and illustrates the analysis that has supported key policy proposals.

Under the lead proposal in the consultation, we propose to introduce an obligation on the manufacturers of fossil fuel boilers (including gas, oil and LPG boilers) sold on the UK market to achieve the sale of a certain number of heat pumps, and potentially other low-carbon heating appliances, proportional to their boiler sales in each period. This mechanism will create a market incentive to grow the numbers of heat pumps installed each year, providing industry with a clear, long-term policy framework for investment and innovation. As set out in the Heat and Building Strategy document, we are aiming to develop the UK heat pump market to reach around 600,000 heat pumps installations by 2028. This scale of heat pump deployment is strategically important for any of the routes to net zero, including a hydrogen-led scenario, and is essential for ensuring an electrification-led route remains viable. An electrification-led route will require substantial further growth in annual installations by the early-2030s.

To assess the impact of the scheme, we have developed deployment ambitions consistent with the strategy set out in the Heat and Building Strategy documents. We have estimated the potential level of additionality of the proposed policy (the market-based mechanism) and the associated profiles for policy costs and carbon savings. These estimates have been produced by drawing on a range of sources, including market intelligence. A range of policies will contribute to achieving the overall ambition for heat pump market growth including, notably, planned regulations on phasing out fossil fuel heating off the gas grid and regulations on low-carbon heating in new-build properties, as well as various spending policies such as the new Boiler Upgrade Scheme. In practice, the market-based mechanism is expected to complement many of these policies, but the focus of this impact assessment is only on the *additional* deployment beyond that anticipated from other policies.

We anticipate that the scheme could deliver 1.2 and 5.5 MtCO2e of non-traded carbon abatement over carbon budgets 4 and 5, respectively. There is considerable uncertainty about these impacts, which are explored in more detail in the Risks and uncertainties section of this report.

There are also significant uncertainties in the Social Net Present Value (SNPV) of the scheme. Our central estimate of the SNPV is -£500m. We have carried out sensitivity analysis to show the impact on the SNPV when several modelling assumptions are changed.

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Introduction & Background

Background

1. The UK was the first major economy in the world to set a legally binding target to achieve net zero greenhouse gas emissions by 2050. To achieve this, we need to transition to low-carbon ways of heating our homes, businesses and public buildings across the board.
2. Currently, heat in buildings is responsible for 23% of the UK's greenhouse gas emissions[1]. Meeting our legally binding target of a 78% reduction in carbon emissions by 2035, and to reach net zero emissions by 2050, means decarbonising virtually all heat in buildings and most industrial processes. This is a critical decade for action on the decarbonisation of heat and upgrading the energy efficiency of homes and other buildings.
3. Published alongside the market mechanism consultation, the government's Heat and Buildings Strategy sets out the policy action we are taking now to accelerate this transformation and our plans to go further.
4. There are several strategic pathways to full decarbonisation of heat by 2050 with a range of low-carbon technologies and systems that may have an important role to play, including a potentially leading role for hydrogen. However, the electrification of heating is the only currently proven option for the decarbonisation of buildings at scale and highly efficient electric heat pumps must form a major part of how we heat our buildings in all future scenarios.
5. As the Heat and Buildings Strategy sets out, this means we need to grow the market for heat pumps to approximately 600,000 installations per year by 2028. This level of heat pump deployment is strategically important for any of the potential routes to net zero, and it is essential for ensuring an electrification-led route remains viable. This would require further growth to much higher numbers of annual heat pump installations by the early-2030s. This scale of market growth over the 2020s is also expected to directly support around 40,000 jobs by 2030.

Rationale for intervention

6. The current market for heat pumps is relatively small: only around 35,000 heat pumps were sold in the UK in 2020, in comparison to 1.7 million fossil fuel boilers. Heat pumps are largely unable to compete on cost with established fossil fuel-based and less energy-efficient heating options, such as natural gas, oil and direct electric heating. This is partly due to the emerging nature of low-carbon heating, which means that it does not benefit from economies of scale or from mature supply chains to the same degree as conventional technologies.
7. A key element of the rationale for this intervention is the market failure with respect to the uncaptured negative externalities of conventional heating technologies, which renders their market price too low compared to the price of heat pumps. The full societal costs of heating based on fossil fuel combustion should consider the impacts on health (related to the air quality impacts) and the emission of greenhouse gases, leading to climate change. The need to deliver advancements in the decarbonisation of heating requires more urgent government action to correct the effects of this market failure within the UK heating system.
8. Likewise, the relative positive effect of heat pump deployment on air quality and emissions, and thus their lower societal cost, is not captured in their price. This is likely to result in

[1] BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019) and BEIS (2021) 'Energy Consumption in the UK' (https://www.gov.uk/government/statistics/energy-consumption-in-the-uk).

under-investment in this technology, due to a lower expected payoff than what would be provided by a market price reflecting the full range of social and private costs and benefits.

9. Some further reasons for intervention related to the above include:
    a. Intervention in this market is needed to reduce the cost of decarbonising heat use in buildings, as well as meeting legally binding carbon targets. Given the price effects of market failures set out above, support for the heat pump market, through a clear market growth trajectory underpinned by a market-wide obligation, is likely to improve investor certainty and generate growth and development of the supply chain.
    b. Additional R&D and economies of scale are also expected to follow a successful intervention in the heat pump supply chain. This will result in spill-over benefits to society, which are not currently reflected in the price of low-carbon heating.
    c. Consumer research has shown that consumers are unfamiliar with heat pumps as an alternative to fossil fuel heating systems. This introduces information asymmetry by reducing the ability of consumers to choose the heating appliance based on merit, and thus constraining the technology's ability to compete in the market. An intervention in the market would raise consumer awareness, addressing this market failure.

Policy objective

10. The consultation sets out plans to establish a platform for an industry-led transformation of the heating appliance market, through the introduction of a market-based mechanism for low-carbon heat. Through introducing a market obligation, this will create a market incentive to grow the numbers of low-carbon heating appliances installed each year, providing industry with a clear, long-term policy framework for investment and innovation.
11. This scale of heat pump deployment is needed to make an electrification-led pathway to net zero a viable option at least-cost, which will require substantial further growth in annual installations by the early-2030s and is a strategic level of deployment even in a hydrogen-led transition.
12. The market mechanism proposal aims to:
    a. Develop the UK heat pump market in line with the targeted growth trajectory in the Heat and Buildings Strategy (towards ~600,000 installations p.a. by 2028), with a focus on the retrofit market, working alongside other policies; and so
    b. Contribute to decarbonising heating in the UK and to meeting carbon budgets.

Outline of policy options

13. The policy options considered in this impact assessment are:
    a. **Option 0 (counterfactual)**: do nothing.
    b. **Option 1 (preferred option):** introduce an obligation on fossil fuel boiler manufacturers to achieve the sale of a certain number of heat pumps, and potentially other low-carbon heating appliances, proportional to their boiler sales over a given period.
14. As the market mechanism consultation document sets out, there are a range of models that a mechanism such as this could take, and we expect to consult on more detailed design proposals in due course. Therefore, in this initial Impact Assessment we have estimated only the quantifiable social costs and benefits associated to the level of heat pump deployment consistent with the levels set in the Heat and Buildings Strategy, without analysing the impact of specific design options. We have not quantified how costs and benefits of the policy will be spread across society, in part because this is highly dependent on the wider policy framework of which the market mechanism is only part, which is still in development.

Further stages of consultation and Impact Assessments are expected in due course as detailed policy design continues over the coming years.

15. The proposed market-based mechanism is intended to work alongside targeted spending (e.g. the Boiler Upgrade Scheme) and regulatory measures (e.g. regulations on heating installations off the gas grid[2]) as part of an overall policy framework to support the development of the market in low-carbon heating. Future policies within this broader framework are currently at different stages of development. The principal overall policy alternative would therefore be to pursue either the same or further regulatory and/or subsidy-based measures alone without an accompanying market obligation. Doing so would both reduce confidence of achieving the targeted deployment outcome and reduce the incentives for an industry-led transformation of the market to achieve downward pressure, through competitive market efficiencies, on the overall social cost. Such alternatives are less likely to reach the policy goals and would be likely to lead to higher overall social costs; they have been therefore rejected.
16. Policy alternatives with different overall heat pump deployment targets have not been evaluated since they would not be consistent with government's Heat and Buildings Strategy.

Option 0 (counterfactual): do nothing

17. In this impact assessment, the quantified costs and benefits of an obligation on fossil fuel boiler manufacturers (option 1) are estimated against a counterfactual where no policy is introduced.

Option 1 (preferred option): introduce an obligation to support deployment of low-carbon heating technologies

18. We propose to introduce a new market-based mechanism from 2024, which will create a market incentive to grow the numbers of low-carbon heating appliances installed each year. This mechanism will work alongside a range of subsidy-based and regulatory policy approaches, targeted where most appropriate, to establish an overall policy framework capable of supporting a transformation of the market.
19. Under our lead option, this mechanism would create an obligation on the manufacturers of fossil fuel heating appliances (i.e. gas and oil boilers) to achieve the sale of a certain level of heat pumps, or potentially alternative low-carbon appliances, proportional to their fossil fuel boiler sales over a given period.
20. In response, we would expect obligated parties to take a range of steps, both directly and in partnership with other market actors, to find and build consumer demand for heat pumps. In this way, we expect the policy to help create the conditions for rapid innovation across the market, for example, in consumer journeys and marketing, in products and product bundles, in service-based or consumer finance offerings, in the efficiency of or approach to surveys and installations, etc.
21. As the Heat and Buildings Strategy sets out, there remain important choices as to how the costs of the transition to low-carbon heating and buildings are met across society, but the government is committed to ensuring affordability through addressing market distortions, providing near-term financial support, and working with and creating the conditions for industry to rapidly drive down costs. We share the ambitions of leading businesses for 25-50% reductions in the installed costs of heat pumps by 2025 and approaching parity with boilers by the end of the decade.

[2] https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid

22. At the heart of the government's approach to reviewing and developing the overall policy framework will be ensuring that the costs of decarbonising the energy system are fair and affordable for all energy users.
23. As a result, while the overall potential social costs of this policy can be assessed at this stage, assessing how such costs may in practice be met by different groups of consumers, businesses, and taxpayers will depend upon the development of the wider policy framework and on wider market developments. Further Impact Assessments will be needed in due course, as the overall policy framework for heat decarbonisation, including but not limited to this policy, is further developed.

Scope of the scheme

24. The market mechanism consultation sets out the rationale for the proposed scope of the scheme. The government's intention is that the proposed obligation should apply throughout the UK and would apply to manufacturers of fossil fuel heating appliances (i.e. gas and oil boilers).
25. The heating appliances in scope are electric hydronic heat pumps that provide both space and water heating and can be retrofitted to the majority of domestic properties in the UK. Therefore, 'air-to-water', 'ground-to-water' or 'water-to-water' heat pumps up to a capacity of 45kW would be within scope, with 'air-to-air' heat pumps out of scope. Low-temperature air-to-water heat pumps can deliver high levels of energy efficiency, emissions and energy demand reductions and thermal comfort and generally have lower running costs than many other low-carbon heating systems, including high-temperature heat pumps. It is therefore the development of the market in low-temperature heat pumps that the market mechanism is primarily aiming to incentivise. While certain other low-carbon heating technologies could in principle be included in scope of the market mechanism, in the central scenario of this impact assessment we have made the modelling assumption that all the installations under the obligation to be air-to-water heat pumps.
26. Whether and to what extent hybrid heat pumps (systems combining an electric heat pump with a combustion boiler) will be included in the scope of this policy is still being considered. Due to this uncertainty, this impact assessment has excluded hybrid heat pumps but has performed a sensitivity analysis to show the impact of the deployment of some hybrid heat pumps.
27. Heat pump installations in non-domestic properties are expected to be allowed under the policy, provided that the other installation and appliance criteria (such as on maximum appliance capacity) are met. Many non-domestic properties with energy use and floor area similar to domestic properties use the same or similar heating systems and therefore the installer base and supply chains often overlap.
28. Heat pump installations in new-build properties will not be in the scope of this policy to qualify towards meeting the obligation, since the forthcoming Future Homes Standard will be seeking to ensure that new-build homes are constructed zero-carbon-ready from the mid-2020s.

Obligation design

29. The market mechanism consultation explores options for differentiation in the incentives under the obligation for different types of heating system or installation. For this impact assessment we have assumed that:
    a) obligated parties will meet the deployment targets as the penalties associated with the obligation will be designed to deter non-compliance.
    b) the obligation will apply to all manufacturers of appliances sold in the UK, including imported goods.

c) in principle, the obligation allows for a secondary market to emerge in qualifying heat pump installations, allowing appliances not sold directly by the obligated party to qualify towards meeting their obligation. A secondary market will not affect the total number of heat pumps installed so has not been explicitly modelled for this impact assessment.

Analytical approach

30. This section outlines the evidence base on which impacts of the policy proposals have been modelled and the overall analytical approach undertaken to assess the costs and benefits of the proposed market mechanism. The impact assessment presents the evidence of the impacts of the proposals for households, the business sector and wider society. It follows the principle of the Green Book guidance in identifying the key direct costs and benefits for these groups. The changes are compared with a counterfactual scenario and then monetised using standard Green Book appraisal values. Net present values are derived by comparing the aggregate costs and benefits which are discounted by the social discount rate.
31. Assumptions are varied to produce sensitivity analysis to show the sensitivity of Social Net Present Value (SNPV) and carbon savings with respect to changes in the assumptions used.
32. A cost-benefit approach is limited in assessing non-marginal change, such as the creation of markets and accelerated innovation, which are among the objectives of the proposal. As such, the impact assessment is supplemented by a qualitative discussion on non-monetised costs and benefits which sets out the relevant evidence to wider strategic considerations. Therefore, the calculated SNPVs are not intended to be viewed in isolation but should be assessed in combination with the strategic considerations.

Evidence base

33. The appraisal values used in the analysis include:
    a. Carbon values - HMT Green Book supplementary guidance on valuation of energy use and greenhouse gas (GHG) emissions is used to value greenhouse gas savings.
    b. Electricity and fossil fuel air quality damage costs – Values from Department for Environment, Food and Rural Affairs (Defra) are used to measure air quality damage costs.
    c. Electricity and fossil fuel carbon emissions factors - HMT Green Book supplementary guidance is used to measure carbon emissions from electricity and fossil fuels.
    d. Long-run variable costs of energy supply - HMT Green Book supplementary guidance is used to value the long-run variable costs of energy supply (LRVCs).
34. All prices in this analysis have been converted into 2020 prices using the GDP deflator.
35. The Green Book social time preference rate ('discount rate') of 3.5% has been applied for social present values.

Monetised costs and benefits

36. Analysis has been conducted to estimate the costs and benefits associated with low-carbon heating technologies, relative to the counterfactual. The quantified costs and benefits contributing to the SNPV are:
    a. **Additional upfront capital costs** - these are the total additional upfront costs of the purchase and installation of low-carbon heating technologies (excluding VAT), compared to the purchase and installation costs of the counterfactual heating system. This includes additional ancillary costs such as new radiators for heat pumps.
    b. **Generation costs and benefits** – Low-carbon heating appliances displace the use of the fuels currently used to heat buildings. The value of the change in fuels is valued using the long-run variable costs.
    c. **Carbon savings** – the estimated value of the carbon abated in both the traded and non-traded sectors due to heat from low-carbon sources replacing heat from fossil fuels.

d. **Air quality impacts** – the estimated value of the public health impacts of changes to emissions of nitrogen oxides and particulate matter.
e. **Maintenance** - the difference between the annual costs to maintain the different heating system. Different technologies sometimes require different levels of maintenance costs.

Non-monetised costs and benefits

37. There are several non-monetised costs and benefits that are not captured in the cost-benefit analysis, including:
    a. **Supply chain development** – by incentivising additional deployment of low-carbon heat technologies relative to the counterfactual, the scheme will support the development of low-carbon heat supply chains. This will provide a base for the mass roll-out of low-carbon heating in the 2020s and subsequent decades, which will be needed to achieve the government's target of net zero carbon emissions by 2050. It will also help create green jobs and create opportunities for UK manufacturers. If monetised, this would have a positive impact on the SNPV.
    b. **Innovation and cost reductions** – BEIS expects that supporting low-carbon heat deployment will reduce costs and possibly increase performance over time, as supply chains develop and barriers that customers currently face are reduced through technologies being deployed successfully. The cost reduction and performance improvement benefits from low-carbon heating technologies installed after the period in scope of the market mechanism are not quantified in this impact assessment. If monetised, they would have a positive impact on the SNPV.
    c. **Health benefits** – switching away from fossil fuels can lead to improved indoor air quality for occupants, improving their health. If monetised, this would have a positive impact on the SNPV.
    d. **Consumer familiarity and perception towards renewable heat** - the BEIS Public Attitudes Tracker indicates that 43% of the public are unfamiliar with air source heat pumps, having never heard of them[3]. However, customers who have installed renewable heating technologies have expressed high levels of satisfaction[4]. Heat pumps would require consumers and businesses to operate their heating systems in an unfamiliar way compared to conventional heating systems. The installation of hundreds of thousands low-carbon heating appliances will improve the familiarity of the public with technologies essential to reach the net zero target. If monetised, this would have a positive impact on the SNPV.
    e. **Grid reinforcement** - electrification of heat increases the demand for electricity, potentially increasing the amount of electricity grid reinforcement needed (as well as costs and disruption associated with it). If monetised, this would have a negative impact on the SNPV.

[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/959601/BEIS_PAT_W36_-_Key_Findings.pdf Figure 15

[4] https://www.gov.uk/government/publications/rhi-evaluation-interim-report-applicant-reaction-to-reform-announcements

Modelling approach and results

38. We have estimated the aggregate costs and benefits of clean heat installations over the period between 2024 and 2028, appraised until 2047, when all the appliances installed are assumed to have reached the end of their lifetime.

Deployment assumptions

39. The Heat and Building Strategy sets out the ambition of growing the heat pump market from the current 35,000 per year to 600,000 per year by 2028[5]. The Heat Pump Manufacturing Supply Chain Research Project[6] shows that manufacturers do not consider meeting such deployment levels to present significant difficulties in terms of manufacturing capacity.
40. The Future Homes Standard will come into force from 2025. All new-build homes built to this standard will be 'zero-carbon-ready' with low carbon heat and high levels of energy efficiency. We expect most new-build properties to install heat pumps; as an indicative estimate, this could add up to around 200,000 installations per year from 2027. This is consistent with MHCLG estimates of around 250,000 annual net new-build completions from 2023 to 2029.[7]
41. By setting an obligation for the retrofit market, the market mechanism will help to ensure that heat pump installations meet the overall ambition. This would imply setting a target of around 400,000 heat pumps installations by 2028. The indicative targets between 2024 and 2027 support a smooth growth of heat pump installations from the estimated deployment in 2023 and the 2028 target, giving enough time to build the supply chain and train installers.
42. In this Impact Assessment we have assumed that the obligated parties would meet the deployment targets as the penalties associated with the obligation will be designed to deter non-compliance. By changing the obligation targets we would be able to reach the same level of deployment (and therefore costs and benefits) in scenarios with compliance rates lower than 100%. Therefore, at this stage we are not considering optimism bias per se, but are planning to take it into account in future Impact Assessments.
43. By 2024, there will be either in place or shortly coming into force a suite of policies supporting or regulating deployment of low-carbon heating appliances, mostly acting on the demand-side. This includes the regulations to phase out high-carbon fossil fuel heating in existing homes, businesses and public buildings off the gas grid as set out by the published consultations. The low-carbon heating retrofit installations performed in the years between 2024 and 2028 will count towards the obligation target set for the year.
44. We expect the market mechanism to support or enable part of this deployment, but it is very difficult to estimate its additionality. For simplicity in this assessment, in the counterfactual scenario we have assumed that other policies would maintain the same level of low-carbon heating appliance deployment as in the absence of the market mechanism. Therefore, in the policy scenario of this impact assessment we have estimated only the impact of the additional deployment not primarily driven by (and therefore attributed to) other policies. This has been calculated as the difference between the target and the deployment already taking place because of other policies (the counterfactual). Costs and benefits of the deployment of low-carbon heating appliances in households off the gas grid,

[5] BSRIA (2020), 'Heat pumps market analysis' https://www.bsria.com/uk/product/rg76mr/world_market_for_heat_pumps_2020r2019_8a707622/

[6] Heat pump manufacturing supply chain research project, https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project

[7] Future Homes Standard consultation impact assessment, Appendix A https://www.gov.uk/government/publications/the-future-homes-standard-consultation-impact-assessment These estimates of new build completions are produced by an independent consortium. They are indicative and should be used for appraisal purposes only and do not represent an official forecast of changes in housing supply.

for example, have been separately estimated in the Impact Assessment for the regulations to phase out fossil fuel heating off the gas grid, to which this deployment would be primarily attributed.

45. The 'market mechanism additional deployment' therefore depends on the deployment levels of other policies. Estimating this level of deployment is challenging and subject to a high degree of uncertainty at this stage, especially since the installation of low-carbon heating appliances is only one of the possible outcomes for certain policies in consideration.

46. In this impact assessment, we have considered two illustrative deployment scenarios corresponding to different levels of such 'additional' deployment from the market mechanism.

Table 1: central market mechanism additional deployment scenario

	2024	**2025**	**2026**	**2027**	**2028**
Deployment from other policies	150k	150k	190k	190k	190k
Market mechanism additional deployment	30k	50k	80k	120k	210k
Overall market mechanism obligation target	180k	200k	270k	310k	400k

Table 2: high market mechanism additional deployment scenario

	2024	**2025**	**2026**	**2027**	**2028**
Deployment from other policies	50k	50k	70k	70k	70k
Market mechanism additional deployment	130k	150k	200k	240k	330k
Overall market mechanism obligation target	180k	200k	270k	310k	400k

47. The two different levels of deployment from other policies are based on modelling estimates in different scenarios; the wide range has been chosen to illustrate the high degree of uncertainty in the deployment driven by other policies. We assume deployment from other policies to target mostly off-gas-grid areas, driven by policies like the domestic and non-domestic Off-Gas-Grid Regulations. In the first scenario we assume significant deployment driven by other policies both in buildings currently heated by direct electric appliances and in buildings currently using fossil fuel boilers; in the second scenario we assume a reduced number of heat pump installations, mostly replacing fossil fuel boilers in buildings off the gas grid.

Household characteristics assumptions

48. The design of the obligation leaves the obligated parties (and their consumer base) a high degree of freedom to choose in which buildings to install low-carbon heat appliances. There is, therefore, a high degree of uncertainty around the precise mix of building-types where heating systems primarily attributable to the market mechanism will be installed; however, it is reasonable to expect that the majority of this *additional* deployment will take place in households connected to the gas grid, since:

a) Approximately 85%[8] of UK households are connected to the gas grid and use natural gas for heating and around 63% of non-domestic floor area is heated by gas[9]. Therefore, it is more likely that obligated parties will largely find a consumer base for voluntary uptake of heat pumps in this largest market segment.
b) Other policies will largely target buildings off the gas grid and so deployment in this sector is largely attributed to those other policies. For example, the Off-Gas Grid Regulations impact assessment published alongside this document estimates the impact of phasing out fossil fuels from off-grid homes from 2026.
c) Before 2026, we expect a package of policy measures to be the main driver of heat pumps installations in buildings off the gas grid.

Therefore, as a modelling assumption in the core scenario of this impact assessment we have assumed that the additional deployment from the market mechanism will take place in the average domestic building connected to the gas grid. The policy impact is very sensitive to this assumption, so we have tested alternative deployment assumptions in the Risks and uncertainties section.

49. We expect most of the heat pump deployment to take place in domestic buildings, but in practice it is possible that some installations may be in small non-domestic buildings. As only non-domestic buildings with the same characteristics (in terms of heat demand and installation costs) of domestic properties are within the policy scope, the proportion of non-domestic installations does not affect the quantifiable policy costs and benefits.

50. Current evidence suggests that heat pumps are technically suitable for most buildings. BEIS modelling suggests around 90% have sufficient energy efficiency and internal electrical connection capacity to accommodate a heat pump system. Other factors, such as space constraints, might reduce the proportion of buildings suitable for heat pumps in practice; however, it is unlikely that the obligated parties will target segments of the building stock where extensive new energy efficiency (e.g. insulation) measures are needed or where other factors could make the installation challenging. Therefore, in this impact assessment we have not included the cost of any energy efficiency measures. We do however include the cost of in-home changes which we expect to be required in most buildings, such as hot water storage and larger radiators.

51. We expect some households to deploy energy efficiency measures, which will reduce their heat demand, between now and 2024. However, low-carbon heating installations under the market mechanism will be on a voluntary basis so it is difficult to accurately predict the possible level of heat demand reduction in households benefitting from the market mechanism. Therefore, as a modelling assumption in this impact assessment we have assumed the average heat demand of buildings to remain at today's levels, both in the counterfactual and in the policy scenario. This assumption carries the risk of overestimating both costs and benefits of the policy; a lower heat demand would lead to reduced heat pump installation costs and reduced carbon savings potential.

52. The model uses assumptions which draw on evidence which is discussed in Annex I **– full list of modelling assumptions and risks**.

[8] Based on the results of the most recent housing surveys that took place in England, Scotland, Wales, and Northern Ireland.

[9] 'Building Energy Efficiency Survey (BEES)', Figure 2.12, https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees

Impact appraisals

53. This section of the impact assessment quantifies the costs and benefits of the market mechanism. In the table below we have summarised the key results in a central and high scenario, consistent with the central and high deployments described in Table 1 and Table 2.

54. The capital cost shows the total difference between the heat pump capex and the capex of the counterfactual heating appliance. The market-based and market-wide nature of the policy should help to keep overall costs as low as possible, with obligated parties competing to develop the heat pump market in the most efficient ways possible. Published evidence suggests that deployment and R&D could bring down the total capital cost of heat pumps, including both appliance and installations costs, by around 20% in a mass market scenario[10]. In this impact assessment we assume that this level of cost reduction is achieved by 2030. In practice, several businesses believe that significantly higher cost reductions can be achieved significantly faster; government shares this ambition.

Table 3: Results

2020 prices, Present Value base year of 2024	**Central deployment scenario**	**High deployment scenario**
SNPVs	**- £0.6bn**	**- £1.5bn**
Capital costs	- £2.9bn	- £6.3bn
Carbon savings	+ £3.9bn	+ £8.3bn
Long Run Variable Costs	- £1.7bn	- £3.6bn
Air quality benefits	+ £0.1bn	+ £0.2bn
Lifetime Carbon savings 2024-2047	**19 MtCO2e**	**41 MtCO2e**
Carbon Budget 4 savings 2023-2027	1 MtCO2e	4 MtCO2e
Carbon Budget 5 savings 2028-2032	6 MtCO2e	12 MtCO2e
Lifetime non-traded CCE	**228 £/tCO2e**	**236 £/tCO2e**

10 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf

55. In both deployment scenarios, the SNPVs of the monetised costs and benefits described in this IA show that the impacts of the proposed policy would lead to a net cost overall. The main driver for this is the capital costs of heat pumps which outweigh the capital costs of conventional technologies, namely gas boilers which are assumed to be the main technology being replaced by heat pumps under the market mechanism. This is followed by long-run variable costs: households switching to heat pumps experience higher long-run variable costs because although heat pumps use less energy to heat homes, at present, electricity unit prices are much higher than gas prices.

56. The net benefits include the carbon savings and air quality benefits. As households switch to heat pumps, in this IA we assume most of this additional deployment will replace gas boilers. As heat pumps are more efficient than gas boilers and use less energy, overall switching from a lower-efficiency technology to a more efficient technology results in a net carbon saving and air quality benefit.

Risks and uncertainties

57. The quantified impacts are sensitive to changes in the underlying assumptions. Sensitivities around the scenarios are conducted on the key factors, which are discussed here. The full list of sensitivity assumptions is included in Annex I **– full list of modelling assumptions and risks**.

58. Supplementary guidance to the Green Book on valuing energy use and greenhouse gas emissions[11] suggests that when capital is tied up in a specific project, alternative profitable use of such capital is ruled out and there is a foregone social benefit. The opportunity cost of capital where private funds are used to achieve social aims vary and is subject to final policy design. At this stage this has not been monetised and this will be reviewed ahead of the final Impact Assessment.

S1: Deployment assumptions – replacement of direct electric appliances

59. In the central scenario we have assumed that all the additional market mechanism deployment will take place in buildings connected to the gas grid. Here (S1), however, we assume that a proportion of the heat pump installations will be installed in households currently heated by direct electric heating appliances. This has an impact on the total carbon savings and the proportion of savings which are 'non-traded' as well as an impact on costs.

S2: Deployment assumptions – higher-income households targeted

60. Installation costs and emissions savings depend on the type of buildings which will install low-carbon heating appliances under the market mechanism. It is very difficult to predict what buildings the obligated parties will target. This sensitivity test (S2) estimates the impact of assuming that households with a higher-than-average income are targeted (or that heat pump demand is higher in this consumer segment). Income level might be associated with a higher ability to pay for low-carbon heating appliances. Households with higher income tend to occupy larger than average homes and therefore have higher installation costs and heat demand.

S3: Low-carbon appliances installed

61. The market mechanism consultation document includes questions on the inclusion and treatment of hybrid heat pumps under the policy proposals. Compared to standalone heat pumps, hybrids imply lower emissions savings as fossil fuels are used to meet part of the

[11] Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

heat demand. The level of emissions savings for each fossil fuel hybrid installation is proportionate to the level of heat demand met by the heat pump component.

62. In this scenario (S3), we assume that a proportion of total low-carbon heating installations are hybrid heat pumps and that measures will be in place to ensure that they operate in a way consistent with our emissions reduction targets (i.e. with the heat pump bearing the large majority of the heat load). If such measures were not implemented the carbon savings could be much lower, with potentially significant impact for our emissions targets.

S4: Future capital cost reduction for heat pumps

63. Published evidence suggests that deployment and R&D could bring down the capital cost of heat pumps by 20% in a mass market scenario[12] with the majority of the reduction associated with non-equipment costs (e.g. labour associated with installation) – in the central scenario we assumed this reduction to take place by 2030. In this sensitivity analysis (S4) we explore scenarios with 10% and 50% cost reductions by 2030.

S5: Efficiency of heating system

64. The efficiency of a low-carbon heating system has an impact on fuel consumption and running costs. This is expected to vary with weather condition, quality of the building stock, and level of innovation. The low and high end of the assumption range is tested here (S5). This sensitivity test is also intended to reflect uncertainty with future improvement of clean heat system performance.

S6: Energy prices

65. Low and high fuel price projections are used to test the sensitivity on energy prices, which are expected to be highly uncertain.

S7: Carbon prices

66. Low and high carbon value projections in the Green Book guidance are used for this sensitivity test.

12 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf

Table 4: Sensitivity results

2020 prices, Present Value base year of 2024	Central deployment scenario		High deployment scenario	
	NPV (£bn)	**CB5 savings (Mt)**	**NPV (£bn)**	**CB5 savings (Mt)**
Central scenario	- £0.6bn	6 MtCO2e	- £1.5bn	12 MtCO2e
S1: Deployment 1	+ £0.0bn	4 MtCO2e	- £0.1bn	8 MtCO2e
S2: Deployment 2	- £0.2bn	7 MtCO2e	- £0.8bn	16 MtCO2e
S3: Low-carbon appliances installed	- £0.6bn	5 MtCO2e	- £1.7bn	11 MtCO2e
S4: Future capital cost reduction for heat pumps – higher	+ £0.2bn	6 MtCO2e	+£0.0bn	12 MtCO2e
S4: Future capital cost reduction for heat pumps – lower	- £0.8bn	6 MtCO2e	- £2.0bn	12 MtCO2e
S5: Efficiency of heating system - lower	- £1.1bn	6 MtCO2e	- £2.8bn	12 MtCO2e
S5: Efficiency of heating system higher	+ £0.2bn	6 MtCO2e	+ £0.3bn	12 MtCO2e
S6: Energy prices - lower	- £0.8bn	6 MtCO2e	- £2.0bn	12 MtCO2e
S6: Energy prices - higher	- £0.3bn	6 MtCO2e	- £0.8bn	12 MtCO2e
S7: Carbon values-higher	+ £1.4bn	6 MtCO2e	+ £2.7bn	12 MtCO2e
S7: Carbon values-lower	- £2.5bn	6 MtCO2e	- £5.6bn	12 MtCO2e

Distributional impact

67. The scale of consumer costs associated with this policy, and the distributional allocation and impact of those costs across different groups, will depend in large part upon the wider policy framework for heat decarbonisation of which it is part, which will be continuing to develop in parallel to the further development of this policy, as well as wider market developments.
68. As the Heat and Buildings Strategy sets out, the government will be reviewing the overall policy framework for net zero, including how costs associated with the transition to low-carbon heating are distributed across different consumer groups. At the heart of this will be efforts to help ensure that low-income and fuel-poor households are not disproportionately affected and that there is support where it is needed to make sure the transition is accessible and affordable across society.

69. Further stages of consultation and Impact Assessments are expected in due course as the development of the overall policy framework for heat decarbonisation, including but not limited to the market-based mechanism policy, continues over the next 1-2 years.

Equality impact

70. We have not identified any specific impacts on equalities arising from the policy proposals for the market-based mechanism. However, we are seeking views on this in consultation and will continue to assess and take this into account during the course of more detailed policy design over the coming years.

Equivalent Annualised Net Direct Cost to Business (EANDCB)

71. We have not quantified the EANDCB in this Impact Assessment. The impact of this policy on businesses, both in the heating appliance sector and more broadly, will depend in large part upon the wider policy framework for heat decarbonisation of which it is part, which will be continuing to develop in parallel to the further development of this policy. As policy development continues, it will be more possible in future impact assessments to assess the net costs (and benefits) to businesses of the policy framework as a whole.

Competition Impact

72. We will continue to assess the potential impacts this policy could have on competition and competitiveness throughout the development of both this and the wider policy framework of which it will be part. At this stage, we do not assess that the policy would lead to significant negative impacts on competition in terms of range of suppliers in the market, suppliers' ability to compete, suppliers' incentives to compete vigorously, or the choice and information available to consumers. Rather, our assessment at this stage is that the fossil fuel appliance market will remain highly competitive and that the low-carbon heating appliance market is likely to become more competitive as a result of this policy, with benefits for consumers. However, we will continue to keep any potential implications for competitiveness across the market under review as policy development and consultation continues and are confident at this stage that policy design choices, such as secondary market flexibilities and potential *de minimis* conditions, will be able to limit risks on this front effectively.

Small and Micro Business Assessment (SaMBA)

73. A quantified SaMBA has not been undertaken for this initial Impact Assessment. At this stage, we do not expect that micro businesses will be directly affected by the regulatory measures proposed in the market mechanism consultation. During the course of consultation and further policy development, we will continue to explore the possible impacts on small businesses and means of ensuring through policy design that the impacts of the policy are proportional, including the potential role of *de minimis* conditions to limit the impacts on small enterprises (e.g. small specialist fossil fuel appliance manufacturers). A full SaMBA will be included in future Impact Assessments as development of this policy and the wider policy framework continue.

Monitoring and Evaluation

74. We plan to implement a robust monitoring and evaluation plan, to investigate and demonstrate the impact and outcomes of the proposed policy. A thorough evaluation plan will be developed in advance of the implementation of the regulations and will be integral

into the delivery of the policy. It is expected that the evaluation will seek to answer questions such as:

- To what extent has the regulation achieved its aims?
- How has the design of the regulation influenced the impacts that were achieved?
- To what extent has the regulation been complied with by the sector?
- What is the quality of installations?

More information on our monitoring and evaluation strategy will be provided in the final impact assessment. This will include proposed timelines for evaluation.

Annex I – full list of modelling assumptions and risks

General assumptions

Table 5: Appliances characteristics in central scenario

	Capex (average price today exc. VAT)[13]	Capex reduction by 2030	Maintenance costs (annual)	Average annual efficiency[14]	Lifetime (years)
Heat Pump	See Table 6 below	20%	£100	244%[15]	20
Hybrid Heat Pump	£9,900	20%	£100	244% for the HP and 84% for the gas boiler	20
Gas boilers	£2,600	-	£100	84%[16]	15
Storage heaters	£5,700	-	£0	100%	15

Table 6: Heat demand and HP Capex costs of households installing HPs

	Households on the gas grid (OnGG) - Average	Households heated by direct electric appliances (for S1 sensitivity analysis only)
Average heat demand (kWh)[17]	10,300	7,200
Space heating demand increase after HP installation	10%[18]	10%[18]
Capex costs of installing a HP (average price today exc. VAT)[19]	£10,800	£11,800[20]

Sensitivity analysis assumptions

S1: Deployment assumptions – replacement of direct electric appliances

In this sensitivity, we assume 30% of the "market mechanism additional deployment" takes place in buildings currently heated by direct electric appliances; the remaining 70% are installed in buildings connected to the gas grid. 30% is the proportion of heat pump installations supported by the

[13] BEIS' analysis of the National Housing Model results.
[14] We assumed no improvement over time on the efficiency performance of fossil and low-carbon technologies. This is also applied as a conservative assumption in both the policy scenario and in the counterfactual.
[15] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/606818/DECC_RHPP_161214_Final_Report_v1-13.pdf
[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/180950/In-situ_monitoring_of_condensing_boilers_final_report.pdf
[17] BEIS' analysis of the National Housing Model results. Includes space and hot water heating
[18] https://discovery.ucl.ac.uk/id/eprint/1566603/

[19] BEIS' analysis of the National Housing Model results. Heat Pumps capex costs are for air source heat pumps. This includes the cost of the unit, fixtures, buffer tank and hot water cylinder, controls, labour and upgrade to radiators.
[20] Including the cost of installing a wet distribution system. Households currently heated by direct electric appliances tend to be smaller than average which partly offsets the increase in price due to the installation of a wet distribution system

Renewable Heat Incentive scheme that have replaced direct electric heating systems.[21] The heat demand and cost assumptions from Table 5 and Table 6 are used.

S2: Deployment assumptions – able-to-pay households targeted

"Market mechanism additional deployment" takes place in households connected to the gas grid whose annual income is higher than £50,000, representing 13% of all households connected to the gas grid. Homes in this segment are larger than average households and therefore both heat demand and heat pumps installation cost are higher.

Table 7: Heat demand and heat pumps cost in able-to-pay households

	Average for households OnGG	**Average for households OnGG with an income > £50k**
Average heat demand (kWh)	10,300	13,900
Cost of installing HPs (average price today exc. VAT)	£10,800	£12,100

S3: Low-carbon appliances installed

Half of the market mechanism additional installations are hybrid heat pumps, in which a heat pump works together with a gas boiler. The heat pump component is assumed to meet 80% of the heat demand with the gas boiler meeting the remaining 20%. Cost and performance assumptions on hybrids heat pumps are provided in Table 5. Heat demand assumptions are the same as those for OnGG households shown in Table 6.

S4: Future capital cost reduction for heat pumps

In this sensitivity analysis we explore scenarios with 10% and 50% cost reductions by 2030. The higher cost reduction sensitivity assumption is dependent on innovation in the equipment as well as economies of scale benefits in heat pump installations. We have assumed a linear cost reduction from 2023 to 2030 as shown in Table 8 below.

Table 8: Heat pumps cost reduction

	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
HP capex - central cost reduction (20% by 2030)	£10,800	£10,400	£10,100	£9,800	£9,500	£9,200	£8,900	£8,600
HP capex - high-cost reduction (50% by 2030)	£10,800	£10,000	£9,200	£8,400	£7,700	£6,900	£6,100	£5,400

21 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/928221/RHI_monthly_official_stats_tables_Sep_20_final.xlsx

	2023	2024	2025	2026	2027	2028	2029	2030
HP capex - low-cost reduction (10% by 2030)	£10,800	£10,600	£10,400	£10,300	£10,100	£10,000	£9,800	£9,700

S5: Efficiency of heating system

We tested a low and a high scenario, with average heat pumps efficiencies of 2.15 and 3.00 respectively. The low efficiency of 2.15 represents the 25th percentile of data from the RHPP trial[22], while 3.00 is closer to the design efficiency of current heat pumps on the market (the average design efficiency of the heat pumps supported by the RHI is 3.2).

S6: Energy prices

Low and high fuel price projections come from the HMT Green Book supplementary guidance.[23]

S7: Carbon prices

Low and high carbon values series comes from the HMT Green Book supplementary guidance.[24]

[22] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/606818/DECC_RHPP_161214_Final_Report_v1-13.pdf

[23] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

[24] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal