Title: Phasing out the installation of fossil fuel heating systems in businesses and public buildings off the gas grid **IA No: BEIS016(C)-21-CH** **RPC Reference No: N/A** **Lead department or agency:** Department of Business Energy and Industrial Strategy **Other departments or agencies:**	Impact Assessment (IA) Date: **19/10/2021** Stage: Consultation Source of intervention: **Domestic** Type of measure: **Secondary Legislation** **Contact for enquiries:** nondomesticheat@beis.gov.uk

Summary: Intervention and Options

RPC Opinion: Not applicable

Cost of Preferred (or more likely) Option			
Total Net Present Social Value (£2020, discounted base year 2021)	**Business Net Present Value (£2020, discount base year 2021)**	**Net cost to business per year (EANDBC - £2020, discount base year 2021)**	**Business Impact Target Status** N/A
£100m	-£1,643m	£83m	

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

Deployment of low carbon heating technologies is currently low due to significant market and system barriers, including negative externalities and system lock-in. Government action is required to prevent the continuing reinstallation of high carbon fossil fuel systems and to create the conditions for market expansion, cost reduction, and innovation to enable transition towards cleaner heating fuel.

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

The policy is intended to drive large scale adoption of cleaner heating fuels in non-domestic buildings off the gas grid, in England. This will contribute towards meeting our legally binding carbon budgets. The intended effects are to: reduce carbon emissions from heating systems; create and expand markets for low carbon technologies; to drive down costs and accelerate innovation; to deliver air quality benefits; and avoid the disruption of removing large numbers of fossil fuel boilers before the end of their natural life if we do not act now.

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

For off the gas grid non-domestic buildings:

- Option 0: Do nothing. Oil, liquefied petroleum gas (LPG) and coal boilers will continue to be reinstalled, but some energy efficiency measures are installed due to other policies.
- Option 1: Phase out new installations of high carbon fossil fuel heating systems (oil, LPG or coal) from 2026.
- Option 2: Phase out new installations of high carbon fossil fuel heating systems (oil, LPG or coal) for the largest buildings (>1,000m^2) from 2024 and the remaining stock introduced from 2026.

The Government has historically used a non-regulatory policy, the Non-Domestic Renewable Heat Incentive, to encourage a transition to clean heat through the provision of financial support. This has not, however, led to mass transition. Given the remaining barriers to deployment, the government is proposing a new regulatory framework for heat in non-domestic buildings. The preferred option is 2 because it brings some carbon savings forward and ensures larger buildings, which tend to have longer lasting heating systems (15+ years), are on track to decarbonise by 2050.

Does implementation go beyond minimum EU requirements?		N/A		
Is this measure likely to impact on international trade and investment?		No		
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** 0.42	**Non-traded:** -8.93	

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

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 SELECT SIGNATORY: ______________ Date: 15/10/21

Summary: Analysis & Evidence

Policy Option 1

Description: Phase out the installation of fossil fuelled heating systems in non-domestic buildings off the gas grid from 2026.

FULL ECONOMIC ASSESSMENT

Price Base Year	PV Base Year	Time Period	Net Benefit (Present Value (PV)) (£m)		
2020	2021	**Years:** 24	**Low:** Optional	**High:** Optional	**Best Estimate:** £76m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price 2020)	Total Cost (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			£95m	**£1,858m**

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

The largest societal costs are the capital costs associated with transitioning to clean heating technologies. Capital costs contribute a present value of £1,851m and include preparatory work, installation, completion work and sundries.

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

Retraining costs associated with the upskilling of fossil fuel system installers and maintainers.
Hassle and disruption costs incurred by businesses and public buildings when installing low carbon technologies.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price 2019)	Total Benefit (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			£143m	**£1,935m**

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 contributing a present value of £1,348m, followed by air quality improvements and reduced running costs**.**

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

Innovation benefits, reduced technology costs due to economies of scale, learning from wider deployment leading to future decarbonisation being more cost effective. Development of markets for clean goods and services related to heat in the UK. Building the supply chain for technologies that are key to the decarbonisation of buildings.

Key assumptions/sensitivities/risks	Discount	3.5

Cost and performance of heating systems (actual in-situ performance of heating system), deployment rate assumption, future fuel cost, assumption on rate of compliance, and technologies deployment under regulations. This Impact Assessment (IA) presents the uncertainty through sensitivity analysis.
Risks include late compliance, electricity grid not decarbonising as expected, statistical uncertainty and deliverability through regulation.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m - £2020, discount base year 2021:			Score for Business Impact Target (qualifying provisions only) £m:
Total Costs: **£1,690m**	**Total Benefits:** **£132m**	**Net (EANDBC):** **£79m**	£395m

Policy Option 2

Description: Phase out the installation of fossil fuelled heating systems in non-domestic buildings off the gas grid from 2024 for buildings over 1,000m^2 and 2026 for buildings less than 1,000m^2.

FULL ECONOMIC ASSESSMENT

Price Base Year 2020	**PV Base Year** 2021	**Time Period Years:** 26	**Net Benefit (Present Value (PV)) (£m)**		
			Low: Optional	**High:** Optional	**Best Estimate:** £100m

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price 2020)	**Total Cost** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			£99m	**£1,974m**

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

The largest societal costs are the capital costs associated with transitioning to clean heating technologies. Capital costs contribute a present value of £1,967m and include preparatory work, installation, completion work and sundries.

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

Retraining costs associated with the upskilling of fossil fuel system installers and maintainers.
Hassle and disruption costs associated with installing new type of technologies.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price 2020)	**Total Benefit** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			£150m	**£2,074m**

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 contributing a present value of £1,434m, followed by air quality improvements and reduced running costs.

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

Innovation benefits, reduced technology costs due to economies of scale, learning from wider deployment leading to future decarbonisation being more cost effective. Development of markets for clean goods and services related to heat in the UK. Building the supply chain for technologies that are key to the decarbonisation of buildings.

Key assumptions/sensitivities/risks	**Discount rate**	3.5

Cost and performance of heating systems (actual in-situ performance of heating system), deployment rate assumption, future fuel cost, assumption on rate of compliance, and technologies deployment under regulations. This IA presents the uncertainty through sensitivity analysis.
Risks include late compliance, electricity grid not decarbonising as expected, statistical uncertainty and deliverability through regulation.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m £2020, discount base year 2021:			**Score for Business Impact Target (qualifying provisions only) £m:**
Total Costs: **£1,780m**	**Total Benefits:** **£137m**	**Net (EANDBC):** **£83m**	£416m

Contents

Section A

Problem under consideration and context for heat decarbonisation

1. Heat is the largest energy consuming sector in the UK, accounting for 44% of final energy consumption[1]. Emissions from heat are the single biggest contributor to UK emissions (37%), 23% of which comes from heat in buildings[2]. We need to decarbonise virtually all heat to meet our legally binding target of net zero emissions by 2050 and our Nationally Determined Contribution (under the Paris Climate Agreement) to reduce greenhouse gas emissions by a minimum of 68% by 2030 compared to 1990 levels.[3]

2. Given that heating appliances typically last more than 15 years, and we believe significantly longer in larger non-domestic systems[4], actions need to be taken in the 2020s to avoid further lock-in of fossil fuel heating systems.

3. While we continue to conduct further research and development before making the strategic decision on the most effective measures to decarbonise buildings connected to the gas grid, for the estimated 100,000 buildings that are off the gas grid with heating systems fuelled by oil, liquefied petroleum gas or coal, it is clear we can act now.

Policy objective

4. In the Clean Growth Strategy [5], the Government committed to phasing out high carbon fossil fuel heating installations in non-domestic buildings off the gas grid during the 2020s. We need to decarbonise heat in all buildings by 2050 to meet our net zero commitment. Given heating systems typically last 15 years, and larger systems potentially significantly longer, we need to start acting in the 2020s to avoid the disruption of removing recently installed systems from buildings later. As hydrogen does not offer a realistic option for buildings off the gas grid due to the challenges of transporting the fuel in the absence of a pipe network, transitioning them first represents a low-regret strategy.

5. In accordance with the Green Book, we have detailed the primary objective of our policy as a SMART objective:

   S (Specific). This policy aims to phase out the use of high-carbon fossil fuel heating systems (those fuelled by oil, LPG, or coal) in businesses and public buildings. These will be replaced by low carbon alternatives, mostly heat pumps, at the end of their natural life cycle.

   M (Measurable). Approximately 8,000 buildings will transition annually once all buildings are brought into scope.

   A (Achievable). Research for BEIS suggests that the use of low carbon heating systems in most buildings is feasible (installing alternative low carbon heating systems where heat pumps are not suitable) and this has already been demonstrated by early adopters.

   R (Results). This policy principally intends to reduce the carbon emissions from heating systems in off the gas grid non-domestic buildings. Eliminating the use of oil, LPG and coal in these heating systems also leads to air quality improvements. Additional benefits to this phase out include increased innovation and market growth

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[1] ECUK (2018) https://www.gov.uk/government/statistics/energy-consumption-in-the-uk

[2] 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)

[3] Department for Business, Energy and Industrial Strategy (2017), Clean Growth Strategy, https://www.gov.uk/government/publications/clean-growth-strategy

[4] Research conducted by Verco on behalf of BEIS (2020).

[5] Clean Growth Strategy: https://www.gov.uk/government/publications/clean-growth-strategy/clean-growth-strategy-executive-summary

for clean heating technologies and cost reductions of low carbon heating technologies due to economies of scale.

T (Time-bound). All suitable non-domestic buildings using high-carbon fossil fuel heating systems should have transitioned to low carbon heat by the end of the policy period (2040).

6. Deploying low carbon technologies through the 2020s, in particular heat pumps, through this policy will also increase the size of the electrification market to support the future decarbonisation of other segments of the building stock. This is essential to keep the electrification option open for buildings that are on the natural gas grid, should low carbon hydrogen boilers prove unviable.
7. The key affected groups by this policy are those that own or occupy buildings off the gas grid, both businesses and the public sector. It will also impact the manufacturers, installers, maintainers and wider supply chains of both fossil fuel and low carbon systems. Those who produce, process and deliver fossil fuels to off-gas grid buildings are also affected, as well as stakeholders involved in the generation and delivery of electricity through the network.
8. The policy covers England only as this is an area of devolved responsibility in Wales, Scotland, and Northern Ireland.

Rationale for intervention

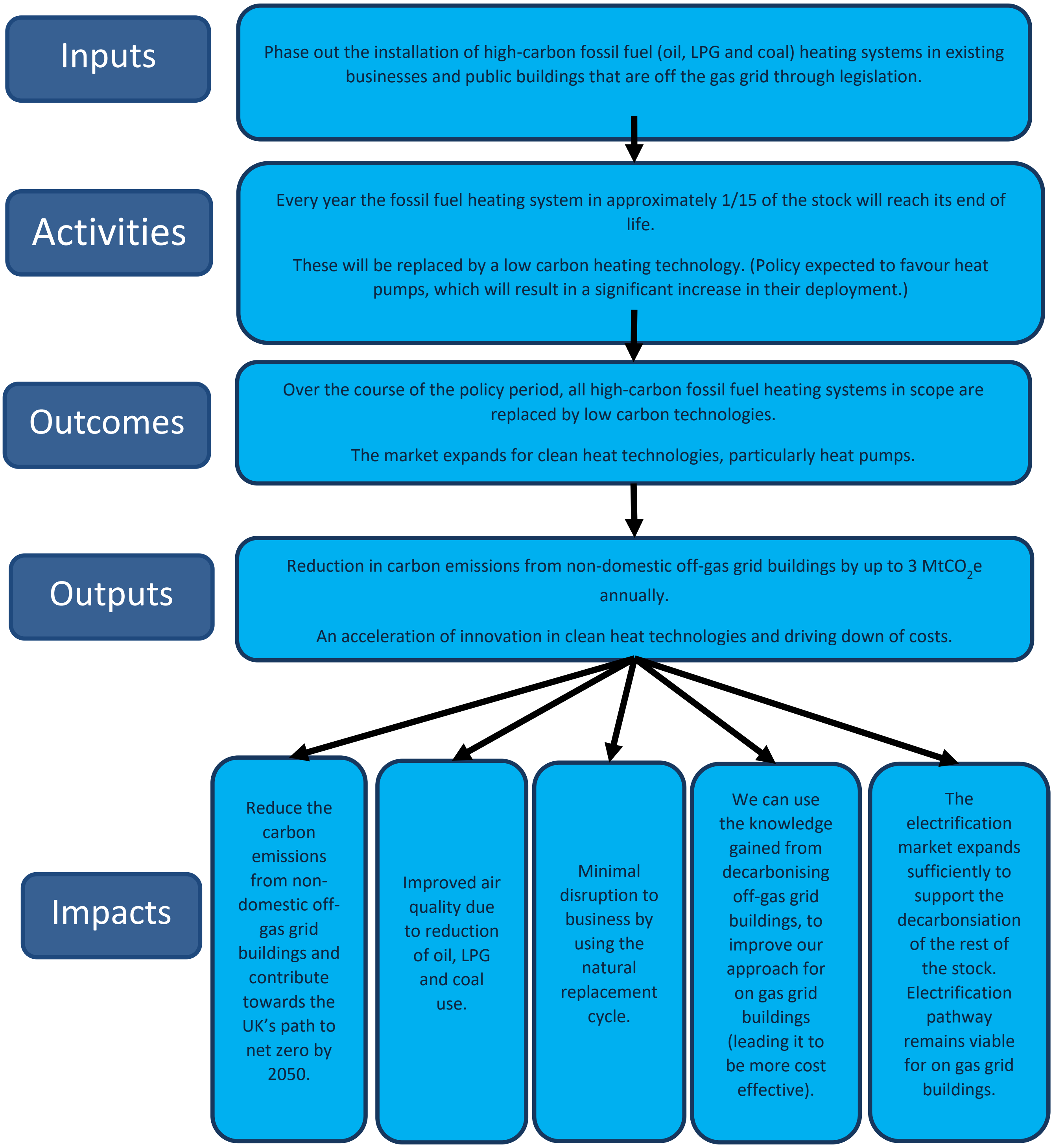
9. Significant market and system barriers exist, which has led to continued low uptake of low carbon heating technologies. Without government action fossil fuels will likely continue to dominate the UK's heating systems, providing limited incentive for low carbon innovation, and act as barriers for the growth of clean goods and services. The key barriers to accelerating the mass roll-out of clean heating systems are:
    a. **Cost**: Fossil fuel heating systems are more prevalent in off-gas grid non-domestic buildings largely due to their lower capital costs compared to low carbon alternatives. Current government subsidies and financial incentives for low carbon technologies have not proven sufficient to lead to widespread behaviour change. Therefore, further action is needed to enable the transition of these buildings to low carbon heat. Clean heating technologies struggle to compete with the current system comprising of extensive infrastructure, skills, and engineering. It is worth noting that due to their long lifetimes, once installed these systems will likely remain for at least 15 years.
    b. **Externalities**: Most off-gas grid non-domestic buildings have a high carbon fossil fuel heating system, and we are yet to see a significant shift away from their re-installation. Each new installation of a fossil fuel heating system adds to the social costs of carbon and air quality, and this is not reflected in the price of the technology. Deploying clean heating in off-gas grid non-domestic buildings is a necessary step towards the government's net zero target by reducing the building sector's carbon emissions. The phase out of these high carbon fossil fuel heating systems would also result in improved air quality and consequently public health.
10. Other rationales for government intervention include:
    a. **Minimise the risk of future forced replacement**: Meeting the net zero target will mean that fossil fuels must be phased out from almost every off-gas grid building. This means either taking action to increase clean heating deployment in the 2020s in line with the natural replacement cycle of heating systems, or to removing fossil fuel systems more rapidly later. The latter will increase transition costs to businesses as existing systems are replaced just before the regulations start. Mandating the transition on the natural replacement cycle in the 2020s will ensure value for money of existing systems and allow enough time for the whole stock to transition.
    b. **Behavioural barriers**: Awareness of low carbon heating technologies is low amongst consumers. This coupled with the hassle of changing heating system and the personal preference many may have for their current heating technology, means that even with an improvement in the price signal the uptake of these technologies will likely be low in the absence of government action. In addition to the hassle, there is likely to be disruption costs for installing a new low carbon heating system over a like for like replacement.

11. We acknowledge there is a risk business will attempt to "beat the ban" by either replacing their boiler just before the policy is introduced or patching up their existing boiler to prolong its lifetime. We will consider the role of Government communication prior to the introduction of this policy to advise non-domestic off-gas grid consumers of the upcoming change. This messaging could provide consumers with information on the benefits of transitioning to clean heat, but also the risks of keeping a fossil fuel system as the market begins to contract: obtaining parts is likely to become more difficult and there will be uncertainty on how fossil fuel prices will change as demand drops. Through our consultation, we are seeking views on whether we should consider introducing an end date by which all buildings must have transitioned to low carbon heating; for example, in the early 2040s. In addition, we are also considering whether policies designed around other significant points in a building's lifecycle, such as the point of let or sale, could deliver this goal. Sensitivity analysis on late compliance has been used to understand the impact.

12. Ahead of implementation, we intend to launch a further consultation and IA on the technical changes to existing regulations or guidance, or other legislation, needed to deliver this policy. This will enable stakeholders to provide their views on the technical details of the policy in advance of its introduction.

Policy Overview

Below is a light-touch logic model, giving a visual representation of our policy and demonstrating the intended relationships between our intervention and the objectives stated above. It is included to give an understanding of the logic underpinning the policy and the path we expect the policy to take.

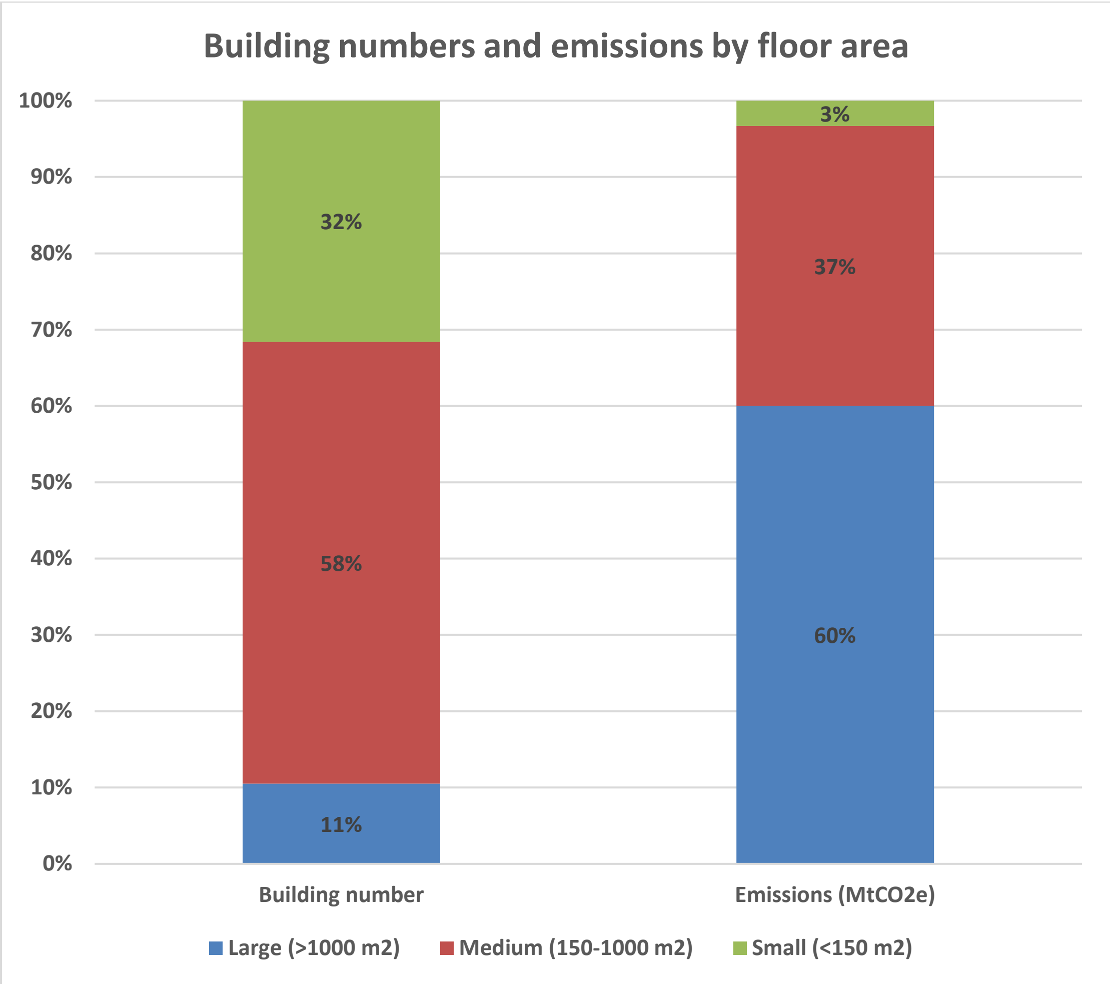


Non-Domestic stock and analytical approach

The characteristics of the buildings in scope of this policy:

13. There are approximately 280,000[6] non-domestic off-gas grid buildings across England and Wales and approximately 100,000[7] use oil, liquefied petroleum gas or coal to fuel their heating systems. Transitioning the systems used to produce heating and hot water in these buildings to low carbon technologies can deliver approximately 0.5 MtCO2 of annual savings[8]. A significant portion of these carbon emissions come from a relatively small number of large buildings; those with floor area of 1,000m^2 and above account for 60% of the potential carbon savings across the non-domestic off-gas grid building stock[9].
14. We see a much larger number of buildings with a floor area between 150m^2 and 1,000m^2 accounting for approximately 35% of the carbon emissions. The remaining stock (buildings less than 150m^2) contribute 5% of the carbon emissions. The average carbon emissions per building drop significantly for the smallest non-domestic buildings; many of these will have similar characteristics, including size and energy use, to domestic properties. This spread of carbon emissions in different sized buildings is a key reason that we consider Option 2 (introducing the policy for the largest buildings first) will achieve significant carbon savings from a relatively small number of buildings.

Figure 1 - Non-domestic off-gas grid stock.



[6] Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED. This does not include buildings that are on the gas grid but choose not to be connected.

[7] Table 1 in this document.

[8] Non-Domestic Buildings Model – figure 2.

[9] BEES survey data https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees.

15. In addition to varying levels of carbon emissions, it is also important to recognise that other characteristics in the building stock may have a bearing on the approach we take to decarbonising its heating system:
    a. There is roughly an even split between businesses and public organisations that own the building they occupy and those that rent it[10]. We recognise that there may be specific challenges to consider for buildings that are rented, depending on how responsibility for the heating system is set out in the lease. We are conducting research to consider how the costs associated with this policy would be distributed between tenants and landlords.
    b. SMEs occupy around 80% of the buildings in scope. Our modelling suggests approximately half of large off-gas grid buildings with a floor area of 1,000m2 and above are occupied by businesses with over 250 employees. Of all non-domestic buildings, less than 5% are both large and occupied by an SME. Within this large floor area segment, there are very few, if any, occupied by micro businesses (under 9 employees)[11].
    c. Of the estimated 100,000 buildings that use oil, liquefied petroleum gas or coal to fuel their heating systems, the public sector occupies around 5%, of which around half are 1,000m^2 or above [12]. The use of these large public buildings is incredibly varied, ranging from hospitals to prisons, meaning they are likely to present significant challenges to decarbonise.

Evidence base and Analytical approach

16. The IA analysis was carried out using BEIS's Non-Domestic Buildings Model (NDBM). The NDBM uses building stock characteristics and potential energy efficiency measures information from the Business Energy Efficiency Survey (BEES)[13] dataset. BEES provide a snapshot of the non-domestic building stock in England and Wales in 2014–15. The BEES building stock for off-gas grid buildings has been supplemented with updated internal analysis of the Non-domestic National Energy Efficiency Data-Framework (ND-NEED)[14].

17. The BEES building stock and energy efficiency measure data has been supplemented with updated cost and efficiency assumptions for Heating Ventilation and Cooling (HVAC) technologies in non-domestic buildings[15]. These updated assumptions allow the NDBM to estimate the costs associated with switching non-domestic heating systems from conventional systems to low carbon technologies such as air or ground source heat pumps (ASHPs or GSHPs), and biomass.

18. The NDBM estimates the aggregate costs and benefits related to a list of policy options, by cost-optimising an overall energy or emissions reduction target across the entire non-domestic building stock, or for particular segments, subject to parameter constraints such as payback.

    The model outputs are extracted to give energy consumption, emission and cost changes as the policy develops. These are used to conduct a cost benefit analysis, calculating the monetised cost, benefits, and running sensitivity analysis. The model map below illustrates how the various assumptions and evidence bases feed into results.

[10] BEES survey data https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees.

[11] Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED.

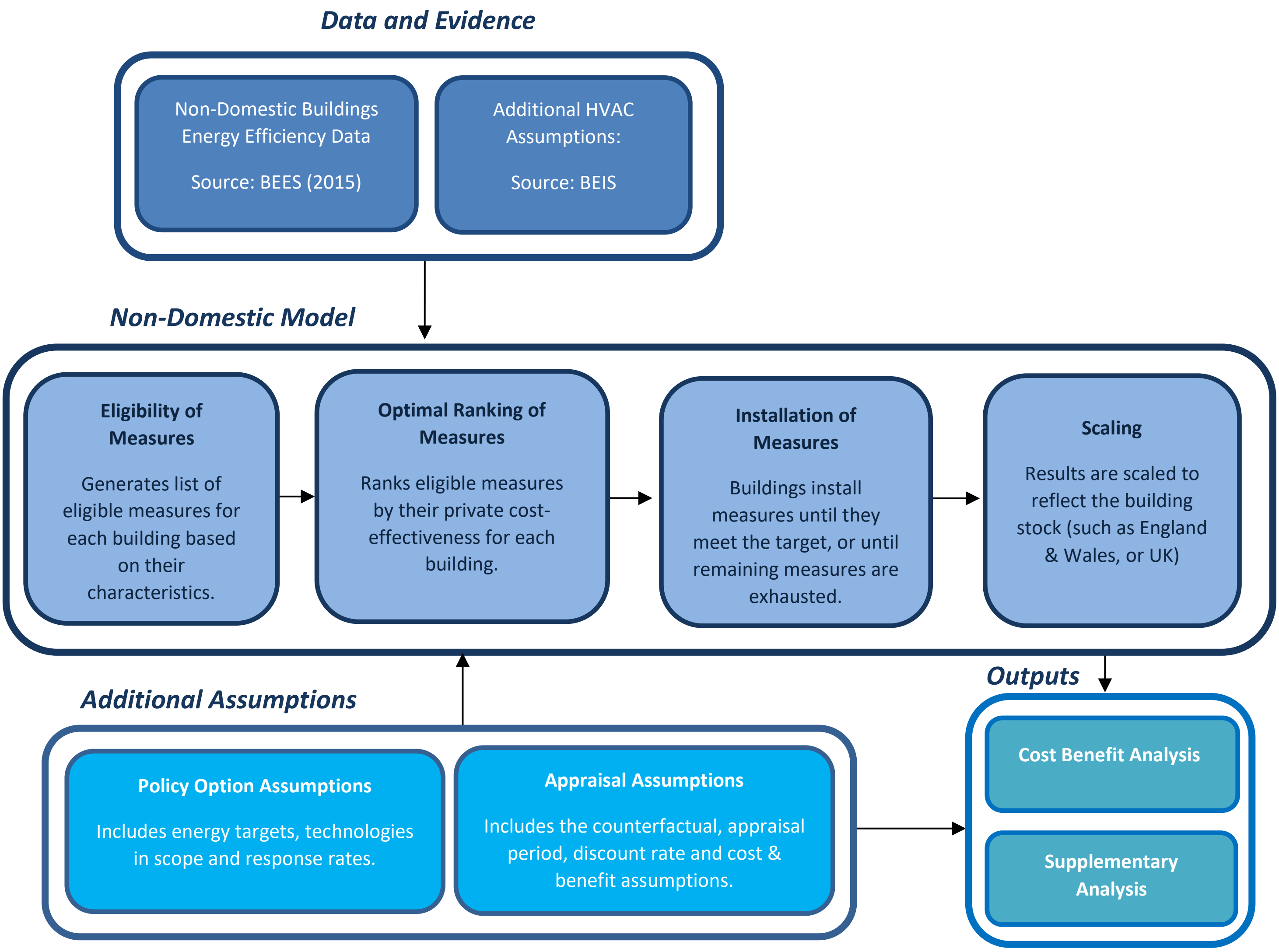
[12] BEES survey data https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees.

[13] https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees.

[14] Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED.

[15] Research conducted by Verco on behalf of BEIS (2020). Low carbon HVAC technologies in non-domestic buildings report – Publication date due Q3/4 2021.

Figure 2 - Non-domestic buildings model map.



19. A cost benefit approach is limited in assessing non-marginal change, such as the creation of markets and accelerated innovation, which are the objectives of the proposal[16]. As such, the IA is supplemented by a qualitative discussion on wider impacts which sets out the evidence that are relevant to wider strategic considerations. The calculated NPVs are therefore not intended to be viewed in isolation and they are not recommended to be compared directly across the options.

20. Existing buildings with electric heating, biomass and heat networks as their main heating source are out of scope for the analysis as they will not be directly affected by the proposed regulation.

Key limitations of analysis and risks

21. Below is a summary of the limitations and risks, with full detail presented in the annex:

    a. **Statistical uncertainty:** As the exact end-use of oil, LPG and coal in the non-domestic sector is uncertain we have used ND-NEED[17] to estimate oil, LPG and coal consumption by buildings. Although

[16] The Green Book states that CBA is ‘generally most appropriate where the broader environment (e.g. the price of goods and services in the economy) can be assumed to be unchanged by the intervention’, and working ‘less well where there are potential non-marginal effects or changes in underlying relationships.’

[17] Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED.

ND-NEED does not have data on the consumption of these fuels, we can estimate non-electric fuel consumption in off-gas grid buildings by comparing the intensity of energy consumption levels in natural gas heated buildings with off-gas grid properties. There is some uncertainty in this estimated consumption, as we are estimating consumption indirectly. The key risk comes from a consumption cut-off point set whilst determining if an off-gas grid building uses electricity or oil, LPG, or coal for heating. Other risks come from removing outliers, scaling a sample of the stock to the whole of ND-NEED and from assuming that the energy consumption profiles are similar between on gas grid and off-gas grid buildings. However, flexing these assumptions does not substantially alter the level of consumption.

Table 1 - Description of Oil, LPG, and Coal Consumption and Building Number Estimates.

- The ND-NEED dataset has electricity meter data for around 700,000 non-domestic buildings and gas consumption data for just under half of those. However, ND-NEED does not have data on oil, LPG or coal consumption, nor how many buildings use these as their heating fuel. So, we infer the figures from the gap they leave behind in the data.
- Firstly, we compare the electricity intensity of off-gas grid buildings (no gas consumption) with similar on-gas grid buildings with known gas consumption which are assumed to be using gas for heating.
    - If the electricity intensities are similar, it is inferred that the off-gas grid building is also using a non-electric fuel for heating, and therefore is using oil/LPG/coal/biomass.
    - If the off-gas grid building has substantially higher electricity intensity, we infer that it is using electricity for heat.
- For the buildings identified as using oil/LPG/coal/biomass for heating, we match on the gas intensity of the similar on-gas grid buildings. We use this intensity as an indication of the off-gas grid buildings' heating fuel energy intensity. This allows us to estimate the total oil/LPG/coal/biomass consumption.
- We then used the ratio of oil, LPG, biomass and coal consumption in the relevant DUKES sectors to estimate the consumption of each individual fuel.

b. **Cost assumptions:** Evidence[18] suggests that due to competition and technological improvements, the real cost of heat pumps could reduce by 20% in a mass market scenario. For the purposes of this IA, it is assumed that this reduction takes place by 2030. This decrease is assumed to start after the introduction of this policy.

The running hours of heating systems in non-domestic buildings are taken from BEES[19] and are low relative to domestic systems. The running hours are also assumed not to change when the low carbon heating system is installed. The low running hours of low carbon heating systems has a significant impact on capital costs and further research and analysis will be carried out ahead of the final stage impact assessment. To illustrate the impact of this assumption, sensitivity analysis is used to compare a run where the utilisation of low carbon system increases upon installation. Further detail can be found in the sensitivity analysis section.

c. **Compliance:** Our modelling assumes perfect compliance and enforcement. A sensitivity has been used to understand a back loaded deployment. In addition, compliance and enforcement has been addressed qualitatively in this IA through discussions with MHCLG.

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[18] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf
[19] https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees.

d. **Modelling assumptions:** Modelling assumptions including finance rates, loan lengths, technology mix, and energy efficiency in counterfactual are all subject to uncertainty. Sensitivity analysis is used to address the impact on each assumption.

e. **Costs not monetised:** Not all costs were able to be monetised, including hassle, disruption, and enforcement. These have all been addressed qualitatively and are dealt with in further detail within the IA.

f. **England and Wales:** The Government will legislate to introduce this policy and we are considering different options for doing so. This includes the use of performance standards in the Building Regulations, which are devolved. This Impact Assessment is therefore for England only. Our data does not separate out England from the building stock. To understand the impact of this we have identified the number of off-gas grid buildings in England and those in Wales. Wales accounts for <8%[20].

Section B off-gas grid non-domestic analysis of policy options

This section provides:

- Description of options considered and alternatives to regulations.
- Overview of analytical approach, key assumptions and counterfactual used in the IA.
- Cost benefit analysis of policy options.
- Risks and uncertainties in the analysis, and sensitivity analysis of central estimates of policy options.
- Distributional impacts of additional costs to varying building size and energy use.

Description of options considered

22. Considerations:

23. The Government has historically used a non-regulatory policy, predominantly the Non-Domestic Renewable Heat Incentive, although other schemes have also had an impact, to encourage non-domestic buildings to transition to clean heat through the provision of financial support. This has led to some buildings removing fossil fuel heating systems and a growth in the market for clean technologies, however we have not seen large scale transition. Continuing alternatives to regulation are unlikely to drive large scale displacement of fossil fuel heating due to system lock-in, the cost of fossil systems not reflecting the real social cost of carbon emissions, and behavioural barriers. Importantly, the financial cost to the taxpayer of supporting every building to transition would be unsustainable; one of our key principles is to prioritise taxpayer support to those who need it most, such as low income and fuel poor groups; areas without other means to accrue financial support, such as social housing and public sector buildings; and some businesses. We are confident providing long-term signals through a regulatory framework will facilitate further growth in the low carbon heating market and ensure businesses build in transitioning to clean heat as part of their decarbonisation journey.

24. That is why the Government committed to phasing out high carbon fossil fuel heating systems in off-gas grid properties in the Clean Growth Strategy, 2017. It subsequently consulted on the role a range of technologies can play in the decarbonisation of heat off the gas grid in our 2018 Call for Evidence - A Future Framework for Heat in Buildings. We applied the principle that technologies will be favoured that are energy efficient and compatible with net zero. It has been established that electrification offers the most realistic pathway to achieve this, as supported by the Committee on Climate Change and respondents to the Future Framework for Heat in Buildings consultation.

25. We recognise there may be a strategic role for other low carbon heating systems, including biofuels, hybrid heat pumps and heat networks; we expect a greater mix of technologies to be necessary for non-domestic buildings due to their varied uses of heat and hot water. This policy will be designed to discourage the

[20] Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED. This does not include buildings that are on the gas grid but choose not to be connected.

transition to direct electric heating systems as these are inefficient and are likely to increase energy costs for the business. Full policy design will be detailed in the final stage IA.

26. The consultation proposes delivering the Government commitment of phasing out high carbon fossil fuel systems, through legislation, at the point they reach their end of life. We believe this option offers the fairest, least disruptive, and highest likelihood of compliance than alternative methods of regulation or continuing to incentivise through financial support mechanisms. The consultation considers introducing the policy at a single point from 2026 or whether there is the case for beginning the transition to low carbon buildings for the largest buildings first. This is because it is apparent that larger buildings disproportionately account for a higher amount of carbon emissions and that heating systems in larger buildings tend to have longer natural lifespans than those in smaller buildings meaning earlier action is necessary to get them on the path to net zero by 2050. Responses to the consultation will enable us to assess which option is implemented and this will be set out in the Government response.

27. We intend to launch a further consultation on the technical changes to existing regulations, or guidance, or other legislation, needed to deliver this policy. We intend to use that exercise to review the heat pump market conditions and consider what additional support may be needed for businesses at that time.

Alternatives to Regulation

28. **Do nothing.** This would leave the market to address the growing need to reduce carbon emissions from heating in businesses. We expect oil, LPG and coal boilers would continue to be reinstalled as consumers lack the incentives and face significant barriers to transitioning to low carbon systems. Currently we see approximately 30,000 heat pumps installed a year across domestic and non-domestic buildings compared to over a million fossil fuel boiler installations. There is no evidence to suggest that without further Government intervention this position would change.
29. **Incentives.** The Government has historically used financial incentives, predominantly the Non-Domestic Renewable Heat Incentive (although other schemes have also had an impact) to encourage businesses to transition to clean heat. For publicly owned buildings, the Government has made over £1 billion worth of grants available through the Public Sector Decarbonisation Scheme[21]. This has led to some buildings removing fossil fuel heating systems and a growth in the market for clean technologies (and will be partially responsible for reaching 30,000 heat pump installations a year currently), however we have not seen large scale transition and the incentives come at a significant cost to the taxpayer. The evidence suggests that reaching mass market will lead to a decrease in the cost of low carbon heating systems. One of our key principles is to prioritise taxpayer support to those who need it most, such as low income and fuel poor groups; areas without other means to accrue financial support, such as social housing and public sector buildings; and some businesses.
30. **Tax.** We acknowledge the role taxation has in driving behaviour changes. However, responses to our consultations on decarbonising heating have highlighted a range of factors that are preventing the mass transition to low carbon systems, such as system lock-in, behavioural and technical barriers, which changes to the tax system alone will not overcome. We continue to consider the role taxation could have in moving to a low carbon economy.
31. **Communication**. We recognise there is a role for improving awareness in society about the negative impact fossil fuel heating systems have on the environment, however in isolation we do not believe this would drive consumers to transition to low carbon heating due to their existing familiarity with fossil systems, lock-in and price differential. There is, however, a need to accompany regulation with a communication package to ensure businesses are aware of the requirement to transition in the years to come.

Counterfactual and options for impact appraisal

32. This section covers key assumptions used in the modelling, the options for impact appraisal and the counterfactual (the baseline which reflects existing policies) to compare the scenarios against, i.e. what is the additional cost and benefits on a business as usual (BAU) world.

[21] Public Sector Decarbonisation Scheme (2020)

Table 2 - Modelling assumptions.

Description	Assumption
Counterfactual (baseline) reflection of existing policies	• The counterfactual assumes energy efficiency measures have been installed. This is because there are a mix of policies across the non-domestic building stock that are aiming to reduce hot water and space heat demand through energy efficiency measures. Including costs and benefits for energy efficiency measures in this analysis would double count from other policies. • Those policies include the Non-Domestic Private Rented Sector Regulations, the proposed performance-based energy rating scheme for large commercial and industrial buildings[22], and the proposed Small Business Energy Efficiency Scheme. • We expect some level of energy efficiency to be installed before installing a low carbon heating system, whether because of our policies or due to consumer choice. • The counterfactual will include BAU renewal of oil/LPG heating systems, renewal of these systems will come with higher efficiencies which will also contribute to energy savings. Therefore, energy reductions from energy efficiency measures and BAU renewal will be 19% by 2030 and 45% by 2040[23]. • This policy is designed to transition non-domestic buildings to low carbon heating appliances only.
Deployment profile	We assume a natural replacement cycle of 15 years in this modelling[24] (based on existing oil/LPG heating systems), although we intend to review this in advance of the final Impact Assessment using responses to the consultation and further work with industry to better account for larger systems having longer lifespans. This translates to ~7% of the stock transitioning each year.
Technologies available	Low and high temperature air to water heat pump, air to air heat pump, ground source heat pump, biomass boilers[25]. This policy will be designed to discourage the transition to direct electric heating systems as these are inefficient and are likely to increase energy running costs for the business.
Appraisal Period	The last heat pump gets installed in 2040 and given our 2050 net zero target, the appraisal period is 2024 to 2050. Capital costs are pro-rated to reflect the costs and benefits appropriate[26].
Finance	The proposed regulations do not stipulate how the measures will be funded, and therefore we do not include finance costs in our central estimates. However, to demonstrate the potential impact of different financing cost assumptions we apply sensitivities.
Fuel and carbon values	The data is drawn from Green Book[27] Supplementary Guidance as of March 2019. Sensitivity analysis will be used to test low and high estimates.

[22] https://www.gov.uk/government/consultations/introducing-a-performance-based-policy-framework-in-large-commercial-and-industrial-buildings

[22]Detailed of energy efficiency assumed can be found in annex III. Sensitivity analysis will be used to understand the impact of a world where no energy efficiency happens (in both the scenario and baseline).

[24] Research conducted by Verco on behalf of BEIS (2020).

[25] These are the technologies in scope of our policy and modelling. This list is not exhaustive of all possible low carbon alternatives.

[26] Our modelling assumes measures are re-installed at the point of expiry. This continues until the end of the appraisal window, at which point most measures would be part-way through their operational lifetime. Hence, to ensure we do not overestimate social costs by failing to include the full lifetime of benefits, the capital is prorated by lifetime assuming a linear amortisation and rebated in the cost-benefit analysis. In short, if a measure is only 60% through its lifetime in 2038, then 40% of the capital value is rebated.

[27]Green Book Supplementary Guidance (2020).

33. The proposed heat policy for non-domestic buildings will phase out the new installation of fossil fuel heating (those that use oil, LPG, and coal) in the non-domestic off-gas grid sector from the mid-2020s, with an end date by which all buildings must have transitioned to low carbon heating in the early 2040s (assuming buildings transition in line with the natural replacement cycle). The central scenario will start with the largest buildings (>1,000m2) from 2024 and the remaining stock introduced from 2026 (again based on the natural replacement cycle).

The policy options considered are:

34. **Option 0:** This is a "Do nothing" world in which business as usual fossil fuelled heating systems are re-installed. As mentioned above, this will assume energy efficiency measures have been installed to reflect existing polices and not to double count benefits.

35. **Option 1:** Phase out new installations of high carbon fossil fuel heating systems (those that use oil, LPG) for all non-domestic stock from 2026 based on the natural replacement cycle.

36. **Option 2 (Preferred):** Phase out new installation of high carbon fossil fuel heating systems (those that use oil, LPG) for the largest buildings (>1,000m2) from 2024 and the remaining stock introduced from 2026, based on the natural replacement cycle.

Category of quantified costs and benefits

37. This section explains the key costs and benefits considered in the quantitative analysis.

Quantified Costs to society

38. **Additional upfront capital costs**: This is 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 across the off-gas grid sector. This includes preparatory work, installation, post completion works and sundries. A detailed table of what these include can be found in annex III.

39. **Familiarisation costs:** Costs associated with building occupants getting used to the new equipment.

40. **Maintenance costs:** this covers the annual costs to maintain the heating system. Different technologies require different levels of maintenance costs.

Non-quantified Costs to society

41. **Enforcement costs:** We have not quantified policy enforcement costs. The Government recognises that this policy will require a degree of enforcement to ensure businesses comply. The exact nature of this will be shaped by the final design of the policy and the legislative vehicles used to deliver it. The use of the Building Regulations to implement this policy would place a responsibility on both the owners, and those who carry out the work to ensure it is compliant. Compliance will be overseen by either a building control body (either a local authority or Approved Inspector) or an installer under a competent person scheme, depending on the nature of the work. Local authorities have a duty to enforce the Building Regulations and can take formal action in line with Sections 35 and 36 of the Building Act. The creation of new powers to deliver this policy, if required, may necessitate the development of compliance measures separate to those used in the Building Regulations.

42. **Hassle and disruption costs:** We acknowledge businesses and public buildings may incur hassle and disruption costs, due to the additional time it may take to install a heat pump or low carbon alternative compared to a fossil fuelled boiler. However, we have not been able to quantify this in our analysis as the diverse nature of the non-domestic stock makes it particularly challenging to account for. For example, the range of disruption cost for the transition period will vary significantly from hospitals to retail, and so on. We are seeking evidence on these costs as part of the consultation.

43. **Power system impacts:** The electrification of heat where electric appliances such as heat pumps are mass deployed will have an impact on the wider energy system. The scale of the impact is highly uncertain and is subject to a range of complex variables, including the technologies installed, their performances, how consumers use them in the future, and the impact of moving to a smart and flexible energy system. The

impact on the low voltage distribution network and the network reinforcement requirement is uncertain at this stage and has not been quantified. It is possible that beyond the low voltage network, meeting additional peak electricity demand may require an expansion of electricity generation capacity, and a reinforcement of the high voltage network. If the additional electrical power demand is not met by low carbon electricity this would reduce the carbon benefits.

44. Installing a heat pump will add to the electricity demand of a business and, as we see significant growth in the electrification of heat, additional electricity generation and reinforcement of the electricity distribution network will be necessary for some buildings. We are working with Distribution Network Operators, the Energy Networks Association and Ofgem to consider the costs and timescales for local network reinforcement and to determine further actions necessary for electrification of heat. We assume many medium and large businesses already have a three-phase connection, although there may be some, particularly large buildings with multiple heat pumps and EV charge points, that will require an upgrade. Installing a heat pump and a standard 7kW EV charge point will require minor upgrades to at least 100-amp connections. The total upgrade costs, how they are going to be distributed and the timing of EV rollout in off-gas grid areas are uncertain at this stage. These have not been quantified in the impact assessment.

45. **Sustainability impact of biomass:** Due to the diverse nature of non-domestic buildings, we acknowledge the installation of a heat pump may not be technically feasible or cost effective compared to other low carbon heating systems in some buildings. We characterise these buildings as 'hard to treat', meaning the building experiences heat losses that cannot be effectively treated with energy efficiency improvements due to unreasonable costs, technical constraints or controls placed on the buildings, such as it being listed. In such instances it will be necessary to enable the use of alternative low carbon heating solutions, provided they are consistent with wider government objectives on net zero, environmental sustainability and air quality. We are also mindful of the consumer experience, so we must be confident that supply chains are able to meet demand and that there are sufficient competent installers for the relevant technology.

46. We recognise that solid biomass may have a niche and limited role in heating buildings in the future. The benefits associated with the use of biomass in heat depend on the availability of feedstock, the prioritisation of its use across the energy economy, the life-cycle emissions from production, and the indirect emissions or emissions savings from production.

Quantified benefits to society

47. **Net energy savings**: Some low carbon heating systems, such as heat pumps, are more efficient in producing heat, thus lowering the energy demand required. This is a benefit to society and is valued using the long-run variable cost of energy supply. HMT Green Book supplementary guidance is used to value the long-run variable costs of energy supply (LRVCs)[28].

48. **Carbon savings**: The replacement of fossil fuel will lead to a reduction in carbon emissions in the non-traded sector. This is monetised in accordance with appraisal values in HMT Green Book supplementary guidance.

    High carbon values have been used (similar to the CCC's analysis) with the existing central value tested as a sensitivity. This reflects the fact that the current central carbon values, which are under review and are set on a target consistent basis, are likely to undervalue greenhouse gas emissions given that they are consistent with the UK's old decarbonisation target of 80% reduction in emissions by 2050.

49. **Air quality benefits**: The displacement of fossil fuels will lead to an improvement in air quality. Values from the Department for Environment, Food and Rural Affairs (Defra) are used to monetise this benefit. Biomass air quality assumptions can be found in the Annex.

[28] Green Book supplementary guidance: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Unquantified benefits

50. **Market building:** The proposed regulatory framework is likely to lead to creation of new markets for clean goods and services that would otherwise be unable to compete with existing technologies. By one estimate, the size of the UK low carbon heating market has the potential to grow 3 times between 2015 and 2030[29].

51. The likely dynamic process of market expansion of clean technologies and cost reduction is not quantified in the cost benefit analysis but is supported by literature. With learning-by-doing and as markets expand, cost reductions occur with cumulative adoptions leading to a self-reinforcing phenomenon[30]. Many studies show the process recurrently follows logistic curves[31]. In addition, increased competition is likely to drive down margins for producers as the demand for low carbon products increase and the market scales up.

52. **Innovation:** Innovation impact is unlikely to be solely confined in technologies. Past examples include the transition towards low carbon electricity leading to new business models in the power sector. Analysis from the LSE gave examples of a wide scope for new products, processes, and systems that the low carbon economy (including low carbon heat) may generate, ranging from financial services to insurance and legal services[32].

Impact on protected characteristics:

53. The regulated phase out of high-carbon fossil fuel heating systems, replacing them with low carbon heating systems once they have reached the end of their life, leads to higher installation costs for businesses. Although we do not expect this measure to have a disproportionate impact on any specific group or individuals, we are exploring the extent to which the increase in upfront costs will impact those with protected characteristics. This is particularly difficult to determine as the ownership structure of most businesses is complex, not leading to clear links between compliance with the measures and a specific person or group. It is challenging to ascertain the impact in rented buildings as commercial leases vary in how they allocate the costs associated with a heating system between the landlord and tenant; the Government is undertaking targeted research to understand this area further.

54. We are carefully considering small businesses (especially those with under 10 employees, which occupy about 55% of the buildings in scope) where the measures could have a greater impact on their finances. The Government will take a fair and proportionate approach to supporting businesses on their path to net zero.

55. We are also mindful that compliance with this policy could impact the finances of public organisations and therefore the services they are able to offer, which could have an indirect impact on those with protected characteristics. Using the responses to our consultation, research, and engagement with stakeholders, we will continue to develop our analysis in this area to ensure we understand the impact of this policy on those with protected characteristics.

Modelling scenarios

56. This section describes the modelling scenarios for the cost benefit analysis. The counterfactual is used to baseline our runs, so the results will be the difference between our scenario and the counterfactual.

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[29] Ricardo Energy and Environment for the Committee on Climate Change (2017) UK business opportunities of moving to a low carbon economy https://www.theccc.org.uk/publication/uk-energy-prices-and-bills-2017-report-supporting-research/

[30] Ibid, Carbon Trust (2020) Policy, innovation and cost reduction in UK offshore wind https://www.carbontrust.com/resources/policy-innovation-and-cost-reduction-in-uk-offshore-wind

[31] Policy-induced energy technological innovation and finance for low carbon economic growth 2016 prepared for the European Commission, citing isher & Pry 1971; Grübler et al.1999; Mansfield 1961; Nakicenovic 1986; Marchetti & Nakicenovic 1978

[32] UK export opportunities in the low carbon economy, Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science, April 2017.

Table 3 - Modelling scenarios.

Option	Description	Modelling Scenario
Counterfactual	Deploy energy efficiency measures to represent baseline from existing policies.	Allow the model to deploy energy efficiency at the same transition rate as described in the policies[33]: • 7%[34] of the stock will have energy efficiency measures installed each year until the policy end date. Policies include: • The proposed performance-based energy rating scheme for large commercial and industrial buildings[35]. • Non-domestic Private Rental Sector minimum energy efficiency standards (MEES) Regulations.
1	Phase out new installations of high carbon fossil fuel heating systems (those that use oil, LPG) for all non-domestic stock from 2026 based on the natural replacement cycle.	Model the entire non-domestic stock fuelled by oil/LPG boilers: • Set a target of 100% non-traded emissions reduction. • Transition 7% of the stock to heat pumps or low carbon alternatives from 2026. • For example, 7% of the stock transition in 2026, 14% will have transitioned by the end of 2027 and so on until 100% is transitioned in 2040.
2 - Preferred	Phase out new installation of high carbon fossil fuel heating systems (those that use oil, LPG) for the largest buildings (>1,000m2) from 2024 and the remaining stock introduced from 2026, based on the natural replacement cycle.	First model the largest non-domestic off-gas grid buildings (>1000m2): • Set a target of 100% non-traded emissions. • Transition 7% of the stock to heat pumps or low carbon alternatives from 2024. The stock would transition by 2038. • Repeat for the remaining non-domestic off-gas grid stock (buildings <1000m2) with their transition starting in 2026. This stock would be fully transitioned by 2040. Bringing these together gives us option 2.

CBA results – core scenarios

57. This section outlines the key assumptions and results of the cost benefit analysis, as well as their implications for the policy options discussed. It also discusses the risks and uncertainties in the analysis and how these have been mitigated. Lastly, it addresses key sensitivities in the cost benefit analysis.

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33 Detailed of energy efficiency assumed can be found in annex III. Sensitivity analysis will be used to understand the impact of a world where no energy efficiency happens (in both the scenario and baseline).

34 Derived by dividing through by the existing system lifetime i.e. 1/15.

35 https://www.gov.uk/government/consultations/introducing-a-performance-based-policy-framework-in-large-commercial-and-industrial-buildings

Table 4 - Cost benefit analysis results.

Costs are in £m 2019 discounted to 2020.	Option 1	Option 2 – preferred option
Net present values	**76**	**100**
Benefits	**1,935**	**2,074**
Carbon savings	1,348	1,434
Energy savings	114	124
Air quality benefits	472	516
Costs	**1,858**	**1,974**
Capital costs	1,851	1,967
Running costs	4	5
Familiarisation cost	3	3
Lifetime non-traded carbon savings, MtCO2e	8.42	8.93
Non-traded cost effectiveness £/ton	146.04	145.89

58. Familiarisation costs have been quantified assuming an energy manager will be employed for each non-domestic building to familiarise the occupants with the new technology. More detail can be found in annex III.

59. Energy savings are delivered through the reduction in oil/LPG consumption but are offset with the increased electricity consumption. However, even though the electricity price is higher than the oil/LPG price, the model installs heat pumps which have an efficiency of ~280% which generates a saving.

60. The model mainly installs a mix of low and high temperature air to water heat pumps. These low carbon heating systems are capital intensive, although lower in cost than ground source heat pumps, and make up the majority of the costs.

Preference for Option 2

61. The current preference for option 2 is due to the additional benefits it provides in our effort to meet the legally binding 5th carbon budget and net zero emissions target by 2050. The largest off-gas grid buildings account for 60% of emissions, by targeting these earlier we increase our expected non-traded carbon saving during CB5 from 0.8 MtCO2e in option 1 to 1 MtCO2e in option 2. Transitioning them earlier also helps protect against the risk from larger heating systems potentially having a longer lifecycle than the estimated 15 years. By implementing the regulation earlier for larger buildings, we reduce the likelihood of this affecting the pathway to net zero by 2050 (or reduce the need for forced removal of the system before the end of its natural life). This current preference is subject to change as we seek more evidence to support either option during our consultation. Using the responses gathered we will continue the comparison between the options.

Table 5 - CB5 carbon savings

Scenarios	CB5 savings MtCO2e
Option 1	0.8
Option 2 - Preferred	1.0

62. Option 2 has a higher NPV than option 1, about £26m more, due to the greater benefits gained from carbon savings. As in option 1 large buildings are brought into the policy two years later, the lifetime non-traded emission savings of installing heat pumps benefit from two extra years. Option 2, while incurring the greater capital costs, has the greater net benefit and effectively meets the key objective of the policy (to reduce carbon emissions), so remains the preferred choice.

63. We envisage the legislative vehicle to implement the initial introduction of this policy for the largest buildings will be no earlier than 2024, to ensure businesses have time to prepare for the changes. The second phase of the policy, expanding to the wider building stock, is expected from 2026.

Sensitivity analysis

64. This section covers risks and uncertainties in the analysis and sensitivity analysis of central estimates of policy options. Sensitivities include:

65. **Technology and energy efficiency deployment:** The model typically deploys low/high temperature air to water heat pumps and small amounts of either biomass boilers or ground source heat pumps. While this is a feasible option, there is a risk that one of the technologies could fail. This could originate from market failure or lack of suitability. To address these risks, we ran a sensitivity test where certain technologies were not permitted to be installed (with other low carbon heating systems taking their place), to understand the impact of these not being available. See the sensitivity section for more detail.

    In addition, we assumed energy efficiency has happened in the counterfactual. A sensitivity will be used to understand an extreme scenario where energy efficiency potential is not realised. This will be implemented in the scenario and the counterfactual.

66. **Carbon and energy prices:** The low and high fuel price projections are used to test the sensitivity on energy prices, which are expected to be highly uncertain.

    The high carbon value projections in the Green Book guidance[36] are used for the sensitivity test. The low carbon value is not used in the sensitivity test as it is considered to be too low to reflect the net-zero target.

67. **Finance rate:** As these proposed regulations do not stipulate how measures will be funded, we do not include finance costs in our central estimates. To demonstrate the potential impact of different financing cost assumptions we conduct sensitivity analysis using 3.5% (the social rate of return), 8.5% and a high of 10%.

68. **Compliance:** The central scenarios assume perfect compliance with a (linear) natural replacement cycle. A delayed deployment profile has been used in a sensitivity scenario to understand the impact of non/late compliance.

69. **Load factor:** Load factors are a parameter that define the heating hours of a building using a specified heating system. In the central scenarios the heating system load factor in each non-domestic building is assumed not to change as the system switches to low carbon alternatives. There is uncertainty surrounding how the load factor changes, although it has the potential to increase significantly compared to the existing fossil fuelled heated system. A higher load factor of 15% for all heat pumps is used in a sensitivity scenario to understand the impact of this. Previously it would remain at ~6%. The 15% represents a significant increase in heating hours and better reflects evidence from the RHI that heat pumps have an estimated load factor of ~18%[37]. This assumption is still highly uncertain as we do not have sufficient evidence to determine how the load factors of heating systems in individual buildings can change as they switch to low carbon alternatives.

70. During the first ten years half of the off-gas grid non-domestic buildings would have transitioned voluntarily, with 5% of boilers being replaced each year by heat pumps or low carbon alternatives, instead of the ~7% that should require replacing (as assumed in the central run). This results in 50% deployment after ten years. With the possible end date (~early 2040s) approaching, this will increase steeply in the final five years to

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[36] Green Book supplementary guidance: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

[37] Table 3 in: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938142/RHI-ND-Quarterly-Forecast_October_2020.xlsx

reach 100% deployment. We assumed this would happen as follows: 7.5% of deployment in the eleventh and twelfth year, 10% in the thirteenth and fourteenth, then 15% in the final year.

71. This rate of deployment has been chosen only to see the general effects of backloaded deployment, as we do not know the specific compliance rates of businesses on environmental based policy. As a guide we have used evidence (from Business in the Community) that around half of all businesses have set objectives, targets and key performance indicators to monitor and evaluate their carbon reduction strategy[38] (signalling some commitment to climate action) to assume that at the lowest, only just over half of businesses could abide by this policy intended to reduce carbon emissions.

72. **Description of sensitivity tests**

The calculated NPVs are sensitive to changes in the underlying assumptions. The full list of assumptions is listed in annex III. Variations are made from the central assessment one at a time. Sensitivity analysis conducted on option 2 is presented below and the full list of results are in the annex IV.

S1 - Technology mix:

- Allow only low temperature (LT) heat pumps
- Turn off energy efficiency

S2 – Fuel prices and carbon values:

- Central carbon value
- Low energy prices
- High energy prices
- Low electricity price, high oil price and high LPG price

S3 – Finance rate:

- 3.5% (social rate of return)
- 8%
- 10%

S4 – Late compliance:

- Deployment starts small and ramps up in later years

S5 – Load factor:

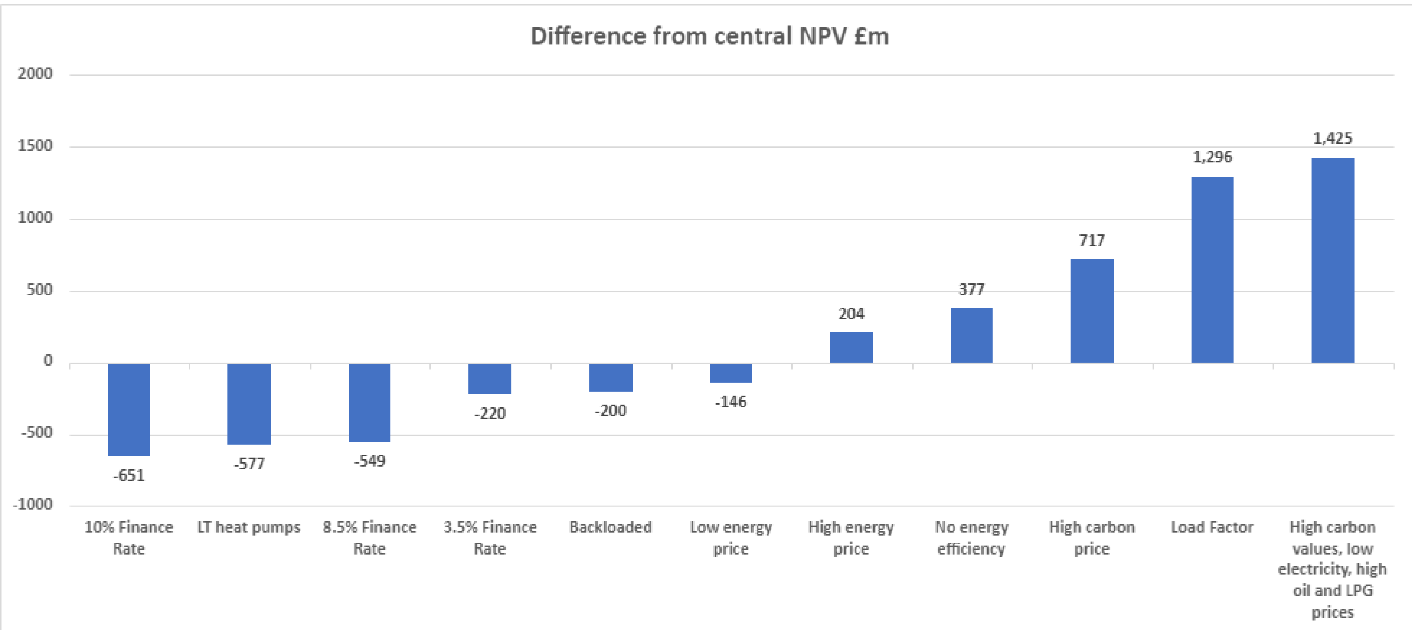
- Increase to 15% to reflect a change in heating hours.

[38] https://www.bitc.org.uk/news/most-businesses-are-not-prioritising-climate-action-or-protecting-nature-says-uks-largest-measure-of-responsible-business/

Table 6 - Sensitivity results

Sensitivity test		NPV £m	NPV variation from central estimate	
			%	£m
Central		**£100**	**0%**	**£0.0**
S1: Technology Mix	LT heat pumps only	-£477	-578%	-£577
S1: Technology Mix	No energy efficiency	£477	378%	£377
S2: Carbon value/Energy price	High carbon value	£817	719%	£717
S2: Carbon value/Energy price	Low energy price	-£46	146%	£146
S2: Carbon value/Energy price	High energy price	£304	205%	£204
S2: Carbon value/Energy price	Low electricity, high oil and high LPG prices	£1,525	1429%	£1,425
S3: Finance rate	3.5%	-£120	-220%	-£220
S3: Finance rate	8.5%	-£449	-551%	-£549
S3: Finance rate	10%	-£551	-653%	-£651
S4: Deployment	Backloaded	-£100	-201%	-£200
S5: Load Factor	15%	£1,395	1299%	£1,296

Figure 3 - Sensitivity impacts on central NPV £m



73. The largest positive impact on NPV is if we set heat pumps with a fixed load factor of 15% or if we have high carbon and fossil fuel prices and low electricity prices. This increases the NPV to £1,395m-£1,525m. The

heating hours of installing a heat pump is a sensitive assumption that will be investigated for the final stage IA.

74. The "no energy efficiency" sensitivity gives a positive increase to the NPV. This is due to using the high carbon value to monetise non-traded emission benefits. It places a greater value on carbon savings and as energy efficiency measures have not been deployed there is a significant increase to abatement potential.

75. Finance assumptions also have a significant impact on NPV. It is important to understand the extra burden these costs can have, and the Government acknowledges the need to take a fair and proportionate approach to supporting businesses on their path to net zero.

76. Carbon savings during CB5 generally stay constant throughout except for the no energy efficiency and backloaded deployment run. Constant carbon savings across other runs are due to the linear rollout profile being consistent on each run.

Table 7 - Carbon savings for the central, no energy efficiency and backloaded deployment runs.

	Total lifetime carbon savings, MtCO2e	CB5 non-traded savings MtCO2e	CB5 traded carbon increase MtCO2e
Central	8.5	1.0	0.2
No energy efficiency	16.5	1.9	0.3
Backloaded deployment	6.8	0.4	0.1

77. The no energy efficiency run was baselined against a no energy efficiency counterfactual. As a result, there are greater carbon savings available to this policy. While this is an extreme case of installing no energy efficiency measures, it highlights the range of benefits and costs if the energy efficiency policy is not realised.

78. It is important to note that in this scenario, to reach the target of zero non-traded emissions we see an increase in traded emissions as electricity consumption is significantly higher than the central scenario.

79. Back loading deployment unsurprisingly results in less CB5 savings and lower lifetime savings as the policy benefits are delayed. Costs are similar as the cost benefit ratio is similar to the original scenario.

Distributional analysis

80. This section describes the impact of additional cost on different segments of the non-domestic stock. It will look at building size, energy use and number of buildings in each category.

81. The diversity of non-domestic buildings makes modelling the likely costs of installing a low carbon heating system instead of a like-for-like fossil fuel replacement particularly challenging. Based on the cost of heat pumps today, our indicative analysis suggests the typical additional upfront cost for businesses will be 1.5 to 4 times higher than a reinstalling a fossil fuel system. The precise nature of these costs is dependent on the size of the building and its energy use, for example we expect small buildings with low energy use to see additional costs ranging from around £3,000 – £4,000, which would represent a 1.5 to 2.5 times increase.

Table 8 - Additional cost to non-domestic buildings for transitioning to low carbon heat.

Floor area (m2)	***Energy use[39]***	***Median additional cost per building (range shown in brackets)***	***Typical relative increase compared to like-for-like replacement of heating system***
>1000	High	£75k (58k – 80k)	3 - 4 times
150-1000	High	£12k (11k – 20k)	2 – 3.5 times

[39] Low: <15MWh; medium: 15-35MWh; high: 35+MWh.

Floor area (m2)	*Energy use*[39]	*Median additional cost per building (range shown in brackets)*	*Typical relative increase compared to like-for-like replacement of heating system*
	Medium	£9k (8k – 10k)	1.75 – 2.5 times
	Low	£7k (6k – 9k)	1.5 – 2 times
<150	Low	£4k (3k – 5k)	1.5 – 2.5 times

The median additional costs for transitioning to clean heat[40]

82. The additional costs include items such as the new heating system, removing the redundant one, pipework, replacing heating emitters, testing and design fees. We recognise there will be outliers which see costs above or below what we have provided, and this reflects the varied nature of non-domestic buildings. This cost analysis is based on a relatively small sample size for off-gas grid buildings and scaled up to a national level.

Equivalent Annualised Net Direct Cost to Business (EANDCB)

83. This section considers the direct costs to assess the net regulatory impact to businesses. For the analysis we have only considered direct costs to private businesses. The direct costs and benefits to businesses that are being monetised for the EANDCB analysis are:

- Capital and installation costs – detail in annex III.
- Operating costs – Excluding fuel.
- Finance costs.
- Direct benefits through bill savings.

84. As businesses transition over to mainly heat pumps as their low carbon heating option, there are benefits made through bill savings. Table 9 below shows how businesses (excluding public) can recoup the extra capital cost spent through these savings. Using the central scenario, sensitivities were conducted on the finance rate and energy prices to draw out a range capital costs that are covered through potential bill savings:

Table 9 - Percentage of upfront costs covered by bill savings over lifetime of new heating system.

Sensitivity	**% of additional capital and operating costs that are covered by bill savings**[41]**.**		
	Total - All buildings	**Large - > 1000 m2**	**Small/Medium - < 1000 m2**
Central	8%	9%	6%
High energy price	18%	21%	14%
Low energy price	0%	0%	1%

85. Under the central scenario, bill saving will benefit larger buildings more than smaller buildings. However, the amount of capital costs covered by bill savings are relatively small for all building sizes.

40 These are illustrative and does not assume energy efficiency has been installed.

41 Derived by taking the total undiscounted bill savings over the lifetime of the policy and total discounted cost to business (capital, operating and finance costs). Therefore the % given is the average annual % of costs covered by bill savings.

86. Bill savings only start to contribute towards covering significant amounts of business costs when we use high energy prices from the green book[42]. Worst case shows businesses would on average be paying the same in energy bills.

87. Table 10 shows the EANDBC results for both policies.

Table 10 - EANDBC results.

	Option 1	Option 2 – Preferred
EANDCB - Discounted EANDCB 2019 RPC Discount Base Year 2020	£79m	£83m
BIT score (EANDBC x 5)[43]	395m	416m

Small and Micro Business Assessment (SaMBA)

88. Table 11[44] shows the impact on small and micro businesses by floor area. Note this shows the impact on businesses for which we have both floor area and building size data only. We see the impact on micro businesses in large buildings is relatively small. We expect to see a larger impact on small and micro businesses in the second phase of regulations from the central scenario. As mentioned above SMEs occupy around 80% of the buildings in scope. The distributional analysis shows that these businesses will pay significantly less compared to the larger buildings with higher consumption. We also know from the building stock that small buildings account for <5% of emissions so the majority of the cost will fall on larger buildings that are not occupied by SMEs.

Table 11 Breakdown of business sizes in scope by floor area.

Floor area	Micro (1-9 employees)	Small (10-49 employees)	Medium (50-249 employees)	Large (250+ employees)	Total
<100 m2	31%	4%	1%	3%	39%
100-999 m2	26%	12%	3%	11%	52%
>1000 m2	1%	3%	2%	3%	9%
Total	59%	18%	6%	17%	100%

89. The Government is committed to reducing emissions at the lowest possible cost to business but recognises that everyone needs to play their part in tackling climate change. This means businesses must start to consider the cost of transitioning to low carbon heating in the coming years as part of their long-term decarbonisation plans. The Government acknowledges, however, the need to take a fair and proportionate approach to supporting businesses on their path to net zero.

Direct costs to installers

90. Across the UK there are currently around 8,000 oil boiler installers, 130,000 natural gas boiler installers and as estimated by the Heat Pump Association, 1,800 heat pump installers[45]. Even though quoted figures are for UK this is indicative of how skills will differ within England. Under the proposal a significant number of oil and gas installers would have to be retrained to meet the new demand for the installation of low carbon technologies. Installers will also face one off familiarisation costs to understand the regulation. These costs have not been quantified at this stage, and we seek to understand the direct costs to installers through the consultation.

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42 Green Book supplementary guidance: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

43 BIT score calculated as EANDBC multiplied by five as advised by the RPC in their informal opinion.

44 Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED. Table 7, where missing values were omitted.

45

Monitoring and Evaluation

91. We plan to implement robust monitoring and evaluation which will demonstrate the impact and outcomes of the proposed regulations. 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 by the sector?
    - What is the quality of installations?

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

Annex

Annex – Full list of modelling assumptions and risks, non-domestic

Assumptions:

Capital costs include:

Table 12 - Capital costs in scope.

Preparatory works include	Installation includes	Completion includes	Sundries include
"Modifications and preparatory work"	Main plant (parts and labour)	Servicing and updating Building Management System	Testing and commissioning
"Strip out existing redundant heating system"	Other plant room components:	Servicing zone controls	BWIC ("builder's works in connection)
	connection to existing / upgraded pipework	Finishing works	M&E Preliminaries
	connection to mains power		Design fees
	buffer tanks		Contingency
	pumps		
	Replacement of heat emitters		

Risks and modelling limitation:

94. **Statistical uncertainty:** As the exact end-use of oil, LPG and coal in the non-domestic sector is uncertain we have used ND-NEED[46] to estimate oil, LPG and coal consumption by buildings. Although ND-NEED does not have data on the consumption of these fuels, we can estimate non-electric fuel consumption in off-gas grid buildings by comparing the intensity of energy consumption levels in natural gas heated buildings with off-gas grid properties. We essentially estimate off-gas grid non-electric consumption by the gap it leaves behind in the ND-NEED data. There is some uncertainty in this estimated consumption, as we are estimating consumption indirectly. The key risk comes from a consumption cut-off point set whilst determining if an off-gas grid building uses electricity or oil, LPG or coal for heating. Other risks come from removing outliers, scaling a sample of the stock to the whole of ND-NEED and from assuming that the energy consumption profiles are similar between on gas grid and off-gas grid buildings. However, flexing these assumptions does not substantially alter the level of consumption. There is still considerable uncertainty across different statistical publications in how commercial oil consumption is attributed to different end-uses or sectors, specifically, whether it is used for buildings (mostly space heating) versus mobile machinery in agriculture and industry.

95. **Finance rate:** Our core scenarios assume no additional cost of capital. At this stage it is unclear what additional financing costs will be faced by building owners as it depends on policy design and the circumstances of individual firms. Sensitivity analysis was conducted using 3.5% (the social rate of return), 8.5% and a high of 10% to test the relative impact on NPV.

96. **Appraisal period:** Is set to 2024-2050.

    Our modelling assumes measures are re-installed at the point of expiry. This continues until the end of the appraisal window, at which point most measures would be part-way through their operational lifetime. Hence, to ensure we do not overestimate social costs by failing to include the full lifetime of benefits, the

[46] ND NEED: Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED.

capital is prorated by lifetime assuming a linear amortisation and rebated in the cost-benefit analysis. In short, if a measure is only 60% through its lifetime in 2038, then 40% of the capital value is rebated.

97. **Technology mix:** There is a high degree of uncertainty around the types of technologies that are likely to be taken up given the heterogeneity of the non-domestic building's population and the choice of measures available. A sensitivity was completed on the technology mix to understand the impact of only having low temperature heat pumps available.

98. **Energy efficiency in counterfactuals:** The analysis assumes energy efficiency has happened in the counterfactual. In addition, businesses as usual (BAU) heating systems are re-installed (at a higher efficiency). This is to account for non-domestic energy efficiency policies so not to double count benefits. Below gives the counterfactual energy demand reduction for both options:

Table 13 - Energy reduction in counterfactual for both options

	Energy demand reduction		
Counterfactuals	**2030**	**2035**	**2040**
Option 1	12%	24%	35%
Option 2 - Central	15%	27%	35%

99. There is a risk that this level of energy efficiency does not happen. A sensitivity run was used to test no energy efficiency measures to understand the additional cost required to install low carbon alternatives. This was based on the central scenario (option 2). The counterfactual also removed energy efficiency measures but still installed BAU heating systems. These still gave energy reductions as newer boilers had higher efficiencies:

Table 14 - Energy reduction in no energy efficiency counterfactual.

	Energy demand reduction		
Counterfactuals	**2030**	**2035**	**2040**
Option 2 - No energy efficiency	2%	4%	6%

100. **EANDBC:** Off-gas grid includes private and public businesses. To assess the impact to business, we removed public buildings from the EANDBC calculations.

101. **Hassle costs:** We have not monetised hassle costs. We do not have the evidence base to do this. However, we have addressed these challenges qualitatively.

102. **Familiarisation costs:** The analysis assumes an energy manager will take 2 hours to familiarise the company with the new equipment. 2 hours is highly uncertain and not based on robust evidence. These costs attribute extremely little to the overall cost and so have minimal impact. The cost of the energy manager is taken from: https://www.prospects.ac.uk/job-profiles/energy-manager.

103. **Cost assumptions:** Evidence[47] suggests that due to competition and technological improvements, the real cost of heat pumps could reduce by 20% in a mass market scenario. For the purposes of this IA, it is assumed that this reduction takes place by 2030. This decrease is assumed to start after the introduction of this policy. The utilisation of heating systems in non-domestic buildings are relatively small and are assumed not to change when the low carbon measure is installed. These assumptions determine significant capital costs and

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

will be investigated further for the final stage impact assessment. To illustrate the impact of this assumption, sensitivity analysis is used to compare a run where the utilisation of low carbon system increases upon installation. Further detail can be found in the sensitivity analysis section.

104. **Building stock:** Based off the BEES report. The model underpinning this IA uses BEES sample of ~3700 buildings, which provides evidence on building characteristics and potential for non-domestic properties, a subset of ~155 samples are scaled up to England and Wales (https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees)

105. **England and Wales:** The Government will legislate to introduce this policy and we are considering different options for doing so. This includes the use of performance standards in the Building Regulations, which are devolved. This Impact Assessment is therefore for England only. To understand the impact of this we have identified the number of off-gas grid buildings in the England and those in Wales. We determined which non-domestic buildings are off the gas grid by matching the postcodes of non-domestic buildings from ND-NEED[48] with a list of postcodes which lie entirely off the gas grid (using data from the centre for sustainable energy[49]). We again matched this set by postcode to the NSPL[50], which specifies the country, further splitting the stock between England and Wales. We found that Wales accounts for only 8% of the combined English and Welsh non-domestic off-gas grid stock.

106. **Biomass air quality assumptions:** Biomass air quality emissions factors are based on MEP/EEA air pollutant emission inventory guidebook[51]. Current policy on the RHI imposes a limit on oxides of nitrogen (NOx) and particulate matter (PM) emitted by biomass products. Applicants are required to provide a valid emissions certificate to show their boiler does not exceed these limits. The Ofgem website provides further information on RHI limits and emissions certificates.[52] The regulations will impose the same emissions limits and certificate requirements. Biomass air quality damage costs are based on Defra's 2020 air quality appraisal guidance[53].

	PM2.5 domestic	NOx domestic
Emission factors (kg/kWh)	0.000216	0.000288
Damage costs (£/kg) 2017 prices	89.46	12.45

Annex IV – Full results of non-domestic sensitivities

Technology mix:

Table 15 - Technology mix sensitivity full results

(£m 2020 discounted to 2021)	Central Scenario	LT heat pumps	No energy efficiency
NPVs	**£100**	**-£477**	**£477**
Benefits	**£2,074**	**£2,145**	**£4,056**
Carbon savings	**£1,434**	**£1,442**	**£2,784**
Energy savings	**£124**	**£183**	**£245**

48 Based on analysis from ND NEED: Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020: ND NEED. This does not include buildings that are on the gas grid but choose not to be connected.
49 The list of Off-gas grid postcodes from the Centre for Sustainable Energy: https://www.cse.org.uk/news/view/2441
50 NSPL: National Statistics Postcode Lookup August 2020 as published by the Office for National Statistics.
51 http://efdb.apps.eea.europa.eu/?source=%7B%22query%22%3A%7B%22match_all%22%3A%7B%7D%7D%2C%22display_type%22%3A%22tabular%22%7D
52 Emission Certificate (RHI): https://www.ofgem.gov.uk/key-term-explained/emission-certificate-rhi
53 https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance.

(£m 2020 discounted to 2021)	Central Scenario	LT heat pumps	No energy efficiency
AQ benefits	£516	£520	£1,026
Costs	£1,974	£2,622	£3,579
Capital costs	£1,967	£2,614	£3,564
Running costs	£5	£4	£12
Lifetime non-traded carbon savings, MtCO2e	8.93	8.93	17.34
Non-traded cost effectiveness £/ton	£145.89	£205.30	£130.96

Fuel and carbon values:

Table 16 - Fuel prices and carbon value sensitivity full results

(£m 2020 discounted to 2021)	Central Scenario	High carbon value	Low energy price	High energy price	Low electricity, high Oil, LPG and carbon prices
NPVs	£100	£817	-£46	£304	£1,525
Benefits	£2,074	£2,791	£1,928	£2,278	£3,499
Carbon savings	£1,434	£2,151	£1,434	£1,434	£2,151
Energy savings	£124	£124	-£22	£328	£832
AQ benefits	£516	£516	£516	£516	£516
Costs	£1,974	£1,974	£1,974	£1,974	£1,974
Capital costs	£1,967	£1,967	£1,967	£1,967	£1,967
Running costs	£5	£5	£5	£5	£5
Lifetime non-traded carbon savings, MtCO2e	8.93	8.93	8.93	8.93	8.93
Non-traded cost effectiveness £/ton	£145.89	£150.12	£160.94	£124.83	£77.14

Finance rate:

Table 17 - Finance rate sensitivity full results.

(£m 2020 discounted to 2021)	Central Scenario	3.5% Finance Rate	8.5% Finance Rate	10% Finance Rate
NPVs	£100	-£120	-£449	-£551
Benefits	£2,074	£2,074	£2,074	£2,074
Carbon savings	£1,434	£1,434	£1,434	£1,434
Energy savings	£124	£124	£124	£124
AQ benefits	£516	£516	£516	£516
Costs	£1,974	£2,194	£2,523	£2,625

(£m 2020 discounted to 2021)	Central Scenario	3.5% Finance Rate	8.5% Finance Rate	10% Finance Rate
Capital costs	**£1,967**	**£1,967**	**£1,967**	**£1,967**
Running costs	**£5**	**£5**	**£5**	**£5**
Finance costs		**£220**	**£549**	**£651**
Lifetime non-traded carbon savings, MtCO2e	**8.93**	**8.93**	**8.93**	**8.93**
Non-traded cost effectiveness £/ton	**£145.89**	**£168.54**	**£202.45**	**£212.96**

Late compliance:

Table 18 - Late compliance sensitivity full results.

(£m 2020 discounted to 2021)	Central Scenario	Backloaded
NPVs	**£100**	**-£100**
Benefits	**£2,074**	**£1,469**
Carbon savings	**£1,434**	**£1,097**
Energy savings	**£124**	**-£25**
AQ benefits	**£516**	**£397**
Costs	**£1,974**	**£1,569**
Capital costs	**£1,967**	**£1,569**
Running costs	**£5**	**-£2**
Lifetime non-traded carbon savings, MtCO2e	**8.93**	**7.16**
Non-traded cost effectiveness £/ton	**£145.89**	**£163.30**

Load factor:

Table 19 – Load factor sensitivity full results.

(£m 2020 discounted to 2021)	Central Scenario	Load Factor
NPVs	**£100**	**£1,395**
Benefits	**£2,074**	**£1,997**
Carbon savings	**£1,434**	**£1,426**
Energy savings	**£124**	**£55**
AQ benefits	**£516**	**£516**
Costs	**£1,974**	**£601**
Capital costs	**£1,967**	**£672**

(£m 2020 discounted to 2021)	Central Scenario	Load Factor
Running costs	**£5**	**-£73**
Lifetime non-traded carbon savings, MtCO2e	**8.93**	**8.93**
Non-traded cost effectiveness £/ton	**£145.89**	**£12.44**