The economic impact of decarbonising household heating in the UK

Final Report

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Introduction & the rationale for this study

Emissions from residential buildings, primarily from the use of fossil fuel for heating, are a major source of the UK's CO_2 emissions. As a result, and as part of its 10 Point Plan to build back better and support the UK's transition to Net Zero, the UK Government have set an ambition to deploy electric heating in residential buildings, by delivering 600,000 heat pumps installations per year by 2028. However, the Climate Change Committee's 2021 Progress Report to Parliament states that this target is insufficient and should be upscaled to 900,000 installations per year by 2028, if the path to Net Zero is to be successful (Climate Change Committee, 2021).

An ambitious deployment of low-carbon heating technologies, together with the implementation of energy efficiency measures in residential buildings, has the potential to improve the efficiency, and reduce the environmental impact, of the UK's housing stock, while at the same time creating jobs and economic activity and addressing issues of inequality and social inclusion.

This report provides a robust analysis of the potential macroeconomic impacts of deploying energy efficiency measures and low-carbon heating technologies in the UK's residential buildings. The analysis is intended to highlight the potential return on action to increase take-up of such technologies and inform the debate on the policy needed to put the UK's household heating stock on the right trajectory for net zero.

What scenarios were modelled?

In this analysis, three scenarios were modelled:

- a 'central' scenario (reflecting the CCC's Balanced Net Zero Pathway ambition for heating technologies and energy efficiency). In this scenario average heat pump installation costs are assumed to start at £11,855 in 2021 and decrease over time in line with the CCC's assumptions.
- a '10-Point Plan deployment' scenario (reflecting the UK Government's lower ambition for the deployment of low-carbon heating technologies). The cost trajectory for heat pump installations is assumed to be the same as in the Central scenario.
- a 'low technology cost' scenario (reflecting a significant decrease in the average costs of heat pumps including installation, from the current assumption of £11,855 to £5,500 in 2022, as some industry players anticipate, and to further decrease over time, albeit at a slower rate than in the Central scenario).

Impacts of the scenarios are compared to a 'no action' counterfactual, drawn from the CCC's Sixth Carbon Budget baseline.

Key macroeconomic impacts

The table below shows the economic impacts of shifting to low-carbon heating and implementing energy efficiency measures. The economic impacts shown in the following table include direct, indirect, and induced effects.

	GDP £bn / % change		Employment FTEs	
	2025	2030	2025	2030
Central scenario	2.4 0.11%	4.8 0.22%	44,700	84,700
10-Point Plan deployment	2.4 0.11%	3.9 0.18%	44,000	71,500
Low technology cost	2.4 0.11%	5.0 0.23%	44,400	83,400

The headline messages from these results are:

- There are positive impacts on GDP across the three modelled scenarios. Increased ambition in terms of the number of heat pumps deployed, or the substantial lowering of costs associated with heat pump installation, would lead to greater economic benefits for the UK economy by 2030, as demonstrated by the results of the 'Central' scenario and 'Low Technology Cost' scenario respectively.
- There is substantial job creation associated with all three scenarios, with around 44,000 net jobs created in 2025 in all scenarios (taking account of potential job losses associated with the shift away from fossil fuels). By 2030, the largest employment impacts are associated with the Central scenario, again demonstrating the additional economic benefits that can be attained by greater deployments of heating.
- The deployment of low-carbon technologies results in a large number of manufacturing jobs being created in the production of low-carbon equipment (i.e. heat pumps). Similarly, enhanced energy efficiency in residential buildings results in more jobs being created in construction, and a smaller number in manufacturing. Supply chain effects and increased consumer spending because of greater employment leads to further jobs being created, primarily in services sectors.

How do the economic impacts vary when we consider 'who pays'?

In this modelling analysis, assumptions were developed to outline the amount of public and private investment required to finance decarbonisation measures in residential buildings; essentially, how much is paid for by Government, and how much by private homeowners. The table below shows the economic impacts under alternative sensitivities where the Government either funds all, or none, of the additional capital expenditure required in the Central scenario.

	GDP £bn / % change		Employment FTEs	
	2025	2030	2025	2030
Central case	2.4 0.11%	4.8 0.22%	44,700	84,700
Government paying for all CAPEX	5.0 0.23%	9.8 0.45%	72,100	138,600
Households paying for all	0. 0 0.00%	0.2 0.01%	19,000	34,700

- The results of our analysis suggest that the economic impacts of decarbonisation measures are maximised when public spending covers all capital investments associated with heat pump installation and energy efficiency.
- Nevertheless, it is important to note that positive impacts are expected even when consumers pay the cost of all capital investments in decarbonisation measures.

There are further socioeconomic benefits too…

The benefits of decarbonising heating in, and improving the energy efficiency of, residential buildings are not just limited to environmental and economic effects. Decarbonised heating can also cultivate positive social effects, alongside reductions in emissions, gains in employment and the creation of economic output. Further benefits identified in this report include:

- Reduced vulnerability to fuel poverty
- Improved health and wellbeing
- Greater educational attainment and employment opportunities
- Financial benefits of occupiers and property-owners
- Improved local air quality

Key takeaways for policymakers

The findings of this analysis demonstrate that alongside the environmental gains, the decarbonisation of residential heating combined with energy efficiency improvements would also be beneficial for the UK economy, with an overall net positive impact on jobs and GDP.

They show the additional economic gains that could be realised from achieving the more ambitious target proposed by the CCC, compared to the Government's deployment target set out in the 10-Point Plan. As specified in the CCC's most recent Progress Report to Parliament, the Government is currently falling short of the ambition required to reach the Sixth Carbon Budget, including its targets for heat pump deployment, and this shortfall should be addressed.

Similarly, lower costs have the potential to increase the potential economic benefits through increased take-up of heat pump installations (although such impacts are not evaluated in this analysis). To encourage the reduction in the cost of heat pump technologies, Government should enact consistent and committed heating decarbonisation policy, to provide industry with the right signals that a market for heat pumps will exist and reduce the element of risk which may be hindering investment in heat pump technologies.

The economic impacts of heating decarbonisation are maximised when public spending covers all capital investments associated with heat pump installation and energy efficiency. This finding suggests that Government should develop a heat pump and energy efficiency deployment programme in which households are provided with financial support to carry out the necessary investments.

It is important also that the supply side of the household heating decarbonisation industry is supported in its expansion. To avoid bottlenecks occurring within the construction and manufacturing sectors, and to maximise the potential economic benefits of an ambitious deployment programme, Government should ensure that UK workers are equipped with the right mix of skills and qualifications to carry out new and changing jobs linked to heat pump production and installation.

To help realise the additional social co-benefits listed above, it is important to clearly identify the groups in society who are most vulnerable to fuel poverty and target and/or prioritise Government funding for heating decarbonisation accordingly.

1 Introduction

1.1 Policy context and project background

Emissions from residential buildings, primarily from the use of fossil fuel for heating, are a major source of the UK's CO_2 emissions. As a result, and as part of its *10 Point Plan* to build back better and support the UK's transition to Net Zero, the UK Government have set an ambition to deploy electric heating in residential buildings, by delivering 600,000 heat pumps installations per year by 2028. However, the Climate Change Committee's 2021 Progress Report to Parliament states that this target is insufficient and should be upscaled to 900,000 installations per year by 2028, if the path to Net Zero is to be successful (Climate Change Committee, 2021).

An ambitious deployment of low-carbon heating technologies, together with the implementation of energy efficiency measures in residential buildings, has the potential to improve the efficiency and reduce the environmental impact of the UK's housing stock, while at the same time creating jobs and economic activity and addressing issues of inequality and social inclusion. However, the UK Government needs to play a role in driving forward this change, and that is likely to require moving beyond simply setting targets for deployment. Effective policy also needs to be developed with more urgency, starting with the publication of the Heat and Buildings Strategy.

1.2 Objectives

This report provides a robust analysis of the potential macroeconomic impacts of deploying energy efficiency measures and low-carbon heating technologies in the UK's residential buildings. The analysis is intended to highlight the potential return on action to increase take-up of such technologies and inform the debate on the policy needed to make the Net Zero transition happen.

1.3 Key terms

Various key terms are used throughout this report, which are defined in Table 1.1.

Table 1.1 Key terms

	Abbreviation	Definition
Economic terminology		
Gross domestic product	GDP	A monetary measure of the market value of all final goods and services in the national economy.
Gross value added	GVA	Gross value added is the value of output less the value of intermediate inputs (i.e. the 'value added' at each stage of production). It is a measure of the contribution to GDP made by an individual producer, industry or sector.
Full time equivalent	FTE	An FTE represents one person's work for one year at regulated norms (e.g. 35 hours a week for 52 weeks a year, excluding holidays).
Direct impacts		Impacts that result from the change in the demand for goods and services directly related to the shift to low-carbon heating and energy efficiency in buildings (i.e. construction linked to building renovation, the manufacture and installation of heat pumps, the supply of electricity)
Indirect impacts		Impacts resulting from the change in the demand for goods and services produced by sectors that supply those directly involved in the transition to low-carbon heating (e.g. fuel extraction, manufacturing of materials and components that form part of heat pumps and renovation measures)
Induced impacts		Impacts resulting from households re-spending the additional income generated by the investment (i.e., new workers' wages spent on goods and services in the economy).
Other acronyms		
Air source heat pump	ASHP	Air source heat pumps absorb heat from the outside air and transfer the heat to water, which it then distributed around a building via radiators and underfloor heating systems.
Ground source heat pump	GSHP	Ground source heat pumps use pipes that are buried in the ground to extract heat. This heat is transferred to a fluid which is distributed around radiators and underfloor heating systems.
Input-Output table	IO table	An input-output table is a table which describes historical linkages between different actors in the economy; it captures purchases between industries, and how final demand for each industry is built up. In addition, it breaks down the components of output from the production side, including the proportion that is paid out in wages to employees.

2 Methodology and scenarios

This chapter outlines the methodological approach adopted in this analysis to estimate the economic benefits of heating decarbonisation. The three scenarios designed for this analysis are described in detail in the following sections, together with the main underpinning assumptions. The chapter also provides an overview of the major limitations to this approach and how these are tackled in the analysis.

2.1 Methodological approach

The quantification of impacts

The wider economic impacts of heat decarbonisation in the UK are estimated in this report using Input-Output (IO) analysis to estimate potential impacts in terms of GDP and employment. To do this, data from Climate Change Committee (CCC)'s Sixth Carbon Budget Balanced Net Zero Pathway is used to provide the investments required, and resultant changes in consumer demand, over the period to 2030 (Climate Change Committee, 2020a). Specifically, we used changes in demand and investments for the following products:

Energy Efficiency	High-carbon heating	Low-carbon heating	High-carbon fuels	Low-carbon fuels
• Loft insulation • Wall insulation • Floor insulation	• Gas boilers • Oil boilers	• Heat pumps • Electric resistive heating • Electric storage	• Gas • Petroleum • Solid fuel	• Electricity • Bioenergy • Hydrogen

The changes in consumer demand and related investments are then used as inputs for the IO analysis, which traces how changes in final demand for these products alter demand for intermediate inputs and leads to changes in both employment and Gross Domestic Product (GDP). The mapping of overall investments to economic sectors is based upon expert judgement, and reflects inputs used in previous similar modelling exercises (Forthcoming & Scottish Government, n.d.). Another key input into this analysis is the UK Input-Output table, the most recent of which is published based upon data for 2017, which shows interlinkages between sectors, and how these combine to meet final demand for industrial output (Office for National Statistics, 2021).

This approach relies upon the use of Type I and Type II multipliers from the UK Input-Output (IO) tables. The Type I multipliers capture both the direct and indirect impacts of shifting from fossil fuel heating to electric heating. For example, increased demand for electricity would be expected to lead to lower employment in the gas supply sector (this is known as the direct effect), but also in sectors which provide inputs to that sector, such as the extraction of natural gas (known as the indirect effect). Type II multipliers capture the follow-on impacts of changes in consumer spending through the economy, known as the induced impacts. This reflects changes in employment, and therefore in total wages across the economy, that occur through both the direct and indirect economic impacts (e.g., job losses at natural gas suppliers, or increased employment at electricity suppliers, leading to lower and higher aggregate wages in each respective sector), and the impacts of these additional wages being spent in the economy (and leading to increased demand for consumer goods and services, as well as further indirect and induced effects).

Utilising IO tables within economic research and for analysis such as the estimation of economic impacts of policy is common practice, and is recognised as valuable and insightful by Government, governing bodies such as the European Commission (European Commission, 2021) and the OECD (OECD, 2021).

Limitation of the approach

The input-output (IO) analysis approach relies upon a static input-output table. This implies that the economic structure of the economy (i.e., the inter-sectoral supply chain linkages) does not change over time. However, in most sectors this does not represent a major restriction in this analysis as the modelling is carried out for the short- and medium-term, over which period supply chains would not be expected to radically change.

Furthermore, coefficients capturing the interlinkages across economic sectors are only available in historical data. Therefore, the modelling approach does not capture changes in interlinkages across sectors over time. For instance, suppose that because of technological change, the electrical equipment sector relies less on mining sectors and more on service sectors in future years. This would mean that, if the electronics sector is shocked in 2025, the approach would over-estimate the knock-on impacts on the mining sector and under-estimate the knock-on impacts on services sectors. However, changes in interlinkages across sectors are not a major limitation for this analysis as the forecast period does not extend very far into the future.

Similarly, the approach implies that the electricity system does not change over time. As a result, the supply chain linkages to the electricity sector in 2030 will resemble those of 2017, i.e. a substantial dependence on gas, and will still include some role for coal, even though coal will be regulated out of use by 2025. The analysis will therefore underestimate the potential impact that heat electrification will have on the demand for renewable electricity generation in the UK, and the resultant economic impacts through supply chains.

In this analysis, direct employment impacts draw on estimates of the labour intensity of the opportunities. However, the analysis assumes that labour intensity (and hence labour productivity) is constant over time. This is a simplifying assumption. In practice, labour productivity is likely to increase over time and therefore the employment impacts could be lower (all other things equal) in the future.

Finally, the analysis shows impacts on the domestic natural gas extraction industry, as a reduction in demand for natural gas for heating leads to reduced demand for the extraction of this (as a portion of domestic demand is met from UK sources). However, there is substantial uncertainty around this impact; it is likely that, in the absence of domestic demand, the gas would still be extracted, and sold into export markets, assuming that there remained substantial demand in other overseas markets. As a result, the analysis may be over-stating the jobs lost in gas extraction and refining.

2.2 Scenarios modelled

The three modelled scenarios cover a central scenario (reflecting the CCC's Balanced Net Zero Pathway for heating technologies and energy efficiency), a 10-Point Plan deployment scenario (reflecting the UK Government ambition on the deployment of low-carbon heating technologies) and a Low technology cost scenario (reflecting a significant decrease in the costs of heat pumps as some industry players anticipate). Impacts of the scenarios are compared to a 'no action' counterfactual, drawn from the CCC's Sixth Carbon Budget baseline.

Central scenario

The Central scenario is based on the Balanced Net Zero Pathway from the CCC's Sixth Carbon Budget (Climate Change Committee, 2020a). This scenario includes a pathway for the UK to reduce emissions from buildings to zero by 2050. This is achieved through upgrading all buildings to EPC C standards within the next 10-15 years and delivering all new buildings with high levels of energy efficiency and low carbon heating from 2025. In this scenario the uptake of energy efficiency measures delivers a 14% reduction in household electricity demand by 2030, even though the sales of heat pumps reach just over one million per year by the same year. The average cost of installing a heat pump falls over time, from £11,855 in 2021, in line with the CCC's assumptions in the Balanced Net Zero Pathway.

10-Point Plan deployment scenario

The 10-Point Plan deployment scenario is also based on the Balanced Net Zero Pathway from the CCC's Sixth Carbon Budget, but with the introduction of one variation. The deployment of heat pumps in this scenario is adjusted to be in line with the UK Government target. According to the Government's Ten Point Plan, the number of heat pumps installed each year in the UK reaches 600,000 by 2028 (Climate Change Committee, 2021). We assume that annual heat pump deployments increase linearly between 2022 and 2028 to reach this target, and the number of heat pumps installed is then assumed to remain constant between 2028 and 2030. This results in lower capital investments in heating technologies, and reduced demand for low-carbon fuels, compared to the Central scenario. The cost trajectory for heat pump installations is assumed to be the same as in the Central scenario.

Low technology cost

The Low Technology Cost scenario is also based on the Balanced Net Zero Pathway from the CCC's Sixth Carbon Budget, but with the introduction of a different variation. In this scenario, there is a rapid reduction in the average cost of installed heat pumps, from the current assumption of £11,855 to £5,500 in 2022, and continues to fall afterwards, albeit at a slower rate than in the Central scenario. This results in an overall reduction in capital investment in low-carbon heating technologies compared with the Central scenario. To allow ready comparison with the central scenario, it is assumed that the number of heat pumps deployed is not affected by this reduced cost (and is therefore in line with the Balanced Net Zero Pathway from the CCC). However, it is important to highlight that if costs were to fall in such a way, the take-up of heat pumps would be very likely to increase, as households respond to lower total costs, ultimately increasing demand for low-carbon heating technologies.

2.3 Financing options

For the modelling, assumptions were developed to outline the amount of public and private investment required to finance decarbonisation measures in residential buildings; essentially, how much is paid for by Government, and how much by private homeowners. A central case is developed and adopted for the three scenarios previously outlined in this chapter (see 2.1 Scenarios modelled). In addition, a sensitivity is carried out on the Central scenario, to explore the impact of different financing options.

Central case

In the Central scenario, it is assumed that the UK Government offers a grant scheme to support the installation of heat pumps. The grant scheme is assumed to be fixed at £4,000 for every heat pump installed for the first three years from its introduction in 2022; then the grant is assumed to reduce in value but hold constant as a percentage of the difference in costs between a heat pump and a gas boiler. This is done to follow the pathway established by the Plug-In Grant, which has declined in value as the price gap between battery electric and combustion engine vehicles has narrowed; it allows the value of the grant to decrease in line with the reduction in the cost of heat pumps over the period to 2030. In addition, it is assumed that Government finances 45% of the additional investment required for the implementation of building energy efficiency measures. This is in line with previous analysis carried out by EEIG (EEIG, 2021). Crucially, in this analysis Government spending is not 'balanced', which is to say that it is not offset by an increase in tax rates (and therefore revenues) across the economy.

The remaining costs are assumed to be paid by households. This includes the remaining capital investments in energy efficiency measures and heat pump installation, capital expenditure for less efficient electric heating technologies (e.g. electric resistive heating), and the operational costs associated with running the heating system. Consumer spending on these is balanced out by reduced consumption of other goods and services; for the sake of simplicity, it is assumed that (at the aggregate whole economy level) capital costs are balanced by reduced expenditure *in the year in which the investment is made*. In fact, many investments in new heating technologies and energy efficiency measures may be loan financed, which would serve to push repayment into later years. As such, our analysis may overestimate this "drag" on economic activity, more of which may in fact take place after 2030.

This financing option is modelled for all the three scenarios.

Government pays for all CAPEX

The first sensitivity foresees the UK Government financing all additional capital expenditure required to install heat pumps and implement energy efficiency measures across the UK housing stock in the period to 2030. The difference between this and the central scenario shows the direction of travel for an increase in Government financing, such as if the Government chose to offer to cover all costs for low-income households in addition to a subsidy for other households. In this analysis Government spending is not financed by an increase in tax rates & revenues or by decreased spending elsewhere in the economy.

The different operational costs are still assumed to be paid by households. Any differences in energy bills resulting from the use of low-carbon heating technologies are balanced out by changed expenditure elsewhere in the economy. Where energy bills are lower, more is spent on other goods and services, and where energy bills are higher, spending in other areas is reduced.

Households pays for all

In the second sensitivity, households are required to pay for 100% of the additional investment (in both heating technologies and energy efficiency measures, in addition to all operating costs. This increased investment from the private sector is balanced out by reduced consumer expenditure on other goods and services in the economy.

3 The economic impacts of decarbonising household heating

This chapter sets out the analysis carried out on potential transitions in the UK building heating sector over the period to 2030. The economic modelling is carried out for three scenarios: a Central decarbonisation scenario, a 10-Point Plan deployment of heating technologies and a variant of the Central scenario based upon lower technology costs. In addition, two sensitivity analyses are also applied to the Central scenario, to account for differences in the way in which such transitions are financed.

3.1 Key results

Table 3.1 below shows the economic impacts of shifting to low-carbon heating and implementing energy efficiency measures. The economic impacts shown in the following table include direct, indirect, and induced effects.

The analysis found that there are positive impacts on GDP across the three modelled scenarios. All scenarios are expected to increase GDP by around 0.11% by 2025, whereas the Central scenario and the Low technology cost scenario show the larger impacts by 2030, with an increase in GDP of 0.22-0.23%. Similarly, there is substantial job creation associated with all three scenarios, of around 44,000 jobs in 2025 in all scenarios. By 2030, the highest employment impacts are associated with the Central scenario, where 84,700 full-time jobs are created due to the additional investment in heating technologies and energy efficiency.

Although the modelling suggests positive economic impacts across the three scenarios, the smallest effects are associated with the 10-Point Plan deployment scenario, where the deployment of heat pump is lowest, suggesting that the deployment of additional heat pumps sales could bring larger economic impacts to the whole economy.

Table 3.1 The net economic impacts of the three modelled scenarios in 2025 and 2030

	GDP £bn / % change)		Employment FTEs	
	2025	2030	2025	2030
Central scenario	2.4 0.11%	4.8 0.22%	44,700	84,700
10-Point Plan deployment	2.4 0.11%	3.9 0.18%	44,000	71,500
Low technology cost	2.4 0.11%	5.0 0.23%	44,400	83,400

3.2 Detailed employment impacts

The analysis that follows decomposes the employment impacts of the transition to low-carbon heating and energy efficiency into five distinct effects:

- The deployment of additional energy efficiency measures in residential buildings
- Reduced demand for high-carbon heating technologies
- Increased demand for low-carbon heating technologies
- Lower demand for high-carbon fuels
- Higher demand for low-carbon fuels

Table 3.2 below considers each of these impacts in turn in the three modelled scenarios. Enhanced energy efficiency in buildings results in the creation of 62,200 full-time jobs in 2025 and 87,900 full-time jobs in 2030. This change in employment is consistent across the three scenarios. The modelling suggests that, in net terms the potential job gains from a shift to low-carbon heating technologies will create more jobs than are lost; in part, this is because the low-carbon technologies are more expensive than the low-carbon technologies that they are replacing.

Conversely, more jobs are lost from reduced demand for high-carbon fuels than are gained from increased demand for low-carbon fuels, which reflects the fact that total energy demand is falling (as a result of the energy efficiency measures), and the fact that heat pumps are more efficient than gas boilers in terms of input energy required to meet a fixed heat demand. Even without the switch to heat pumps, the investment in energy efficiency measures would lead to fewer jobs in the high-carbon energy sectors, although this is more than balanced out by the jobs created in the manufacture and construction of the energy efficiency measures. This narrative is consistent across the three modelled scenarios.

The modelling also shows a negative impact from the balancing of household spending. This is because, when faced with higher capital costs for heating technologies and energy efficiency measures, consumers are assumed to balance out their spending by reducing consumption for other goods and services. Ultimately, this will result in job losses in sectors where consumer spending is lowered.

Table 3.2 Employment changes by spending component (FTEs)

	Central scenario		10-Point Plan deployment		Low technology cost	
	2025	2030	2025	2030	2025	2030
Enhanced energy efficiency	62,200	87,900	62,200	87,900	62,200	87,900
Switch away from high-carbon heating technologies	-21,500	-56,400	-19,900	-37,700	-21,500	-56,400
Switch towards low-carbon heating technologies	30,400	102,000	28,400	68,200	23,000	69,600
Change in demand for high-carbon fuels	-3,500	-17,300	-3,500	-14,200	-3,500	-17,300
Change in demand for low-carbon fuels	1,100	5,700	1,100	4,500	1,100	5,700
Impact of spending reallocation	-24,000	-37,200	-24,400	-37,300	-16,900	-6,100

The sectoral breakdown of employment

Looking at the sectoral distribution of the jobs being created, the switch to low-carbon technologies results in a large number of jobs being created in the production of low-carbon equipment (i.e., heat pumps), most notably in the manufacturing sector. Similarly, enhanced energy efficiency in residential buildings results in more jobs being created in construction (as a direct impact of building renovation activity) and in services (through supply chain and induced effects). The shift away from high carbon fuels results in a small number of jobs losses linked to the extraction of oil and natural gas, in the mining and utilities sectors. There are net job losses in utilities, despite the higher domestic content of electricity as compared to natural gas, as a result of high labour productivity in this sector and the increased efficiency of the housing stock meaning that the increase in demand for electricity is smaller than the fall in demand for natural gas. A small number of jobs is also lost in agriculture, due to the shift away from bioenergy for household heating towards electricity. There are similar narratives across all scenarios, as showed in Table 3.3. The largest changes in employment are seen in the Central scenario, followed by the Low technology cost, with the smallest impacts (both positive and negative) in the 10-Point Plan scenario.

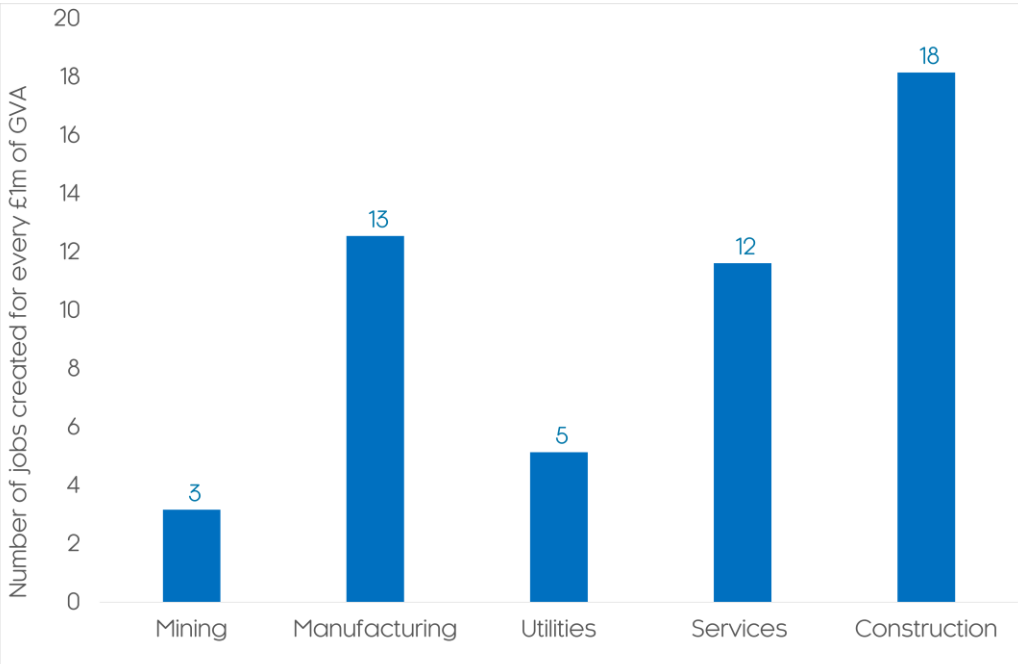
Table 3.3 Employment changes by major economic sector (FTEs)

	Central scenario		10-Point Plan scenario		Low technology cost scenario	
	2025	2030	2025	2030	2025	2030
Agriculture	-140	53	-154	-110	-47	460
Mining	-91	-412	-84	-264	-101	-457
Manufacturing	3,600	10,200	3,600	8,600	2,500	5,200
Utilities	-671	-2,400	-635	-2,100	-971	-3,700
Services	3,500	18,600	2,900	9,700	5,100	25,600
Construction	38,600	58,700	38,400	55,700	38,000	56,300
Total	**44,700**	**84,700**	**44,000**	**71,500**	**44,400**	**83,400**

The employment impacts reflect the trends in investment and consumer spending, as outlined above – however they are also substantially influenced by the relative labour intensity of the different sectors of the UK economy.

Figure 3.1 shows the number of jobs created for every £1 million of Gross Value Added (GVA) in different sectors of the UK economy in 2017. The construction, services and manufacturing sectors are characterised by high numbers of job created per £1 million, meaning that these sectors are more labour intensive and shifting expenditure from sectors with low labour intensity (such as mining and utilities) and towards these is likely to have the effect of net job creation in the economy (before jobs in the supply chain and through induced effects are taken into account). The fact that a sizeable proportion of the natural gas used for household heating in the UK is imported also means that supply chain employment effects are likely to be larger for alternative spending categories than for gas, as spending is shifted away from the latter.

Figure 3.1 Labour intensity by major economic sector



Source: Cambridge Econometrics calculations based on (Office for National Statistics, 2021)

3.3 Alternative financing options

This analysis also includes an evaluation of how the economic impacts of investing in efficient heating change under different options for financing heat pumps installations. Table 3.4 shows the economic impacts under alternative sensitivities where the Government either funds all, or none, of the additional capital expenditure required in the Central scenario.

The economic impacts are maximised when public spending covers all capital investments associated with heat pump installation and energy efficiency. In this case, GDP is expected to increase by 0.23% and 0.45% in 2025 and 2030 respectively, while the number of full-time jobs created is estimated to be 72,100 in 2025 and 138,600 in 2030. The employment impacts are found to be approximately 38% lower for the central case, and approximately 74% lower for the sensitivity where households are expected to pay the entire cost of installing heat pumps.

It is a significant finding that positive impacts are expected even when consumers pay the cost of all capital investments. In this scenario, all additional costs are funded through the reallocation of household consumption away from high-carbon technologies (and some other goods and services) and towards more efficient heating systems, with no funding coming from Government. Although GDP impacts are essentially zero, jobs are created as a result of shifting spending towards construction activities. This is due to the high labour intensity of the construction and manufacturing sectors; shifting economic activity from other sectors of the economy and towards these two sectors will net create jobs.

Table 3.4 Net economic impacts in the Central scenario for different financing option

	GDP £bn (% change)		Employment FTEs	
	2025	2030	2025	2030
Central case	2.4 0.11%	4.8 0.22%	44,700	84,700
Government paying for all CAPEX	5.0 0.23%	9.8 0.45%	72,100	138,600
Households paying for all	0.0 0.00%	0.2 0.01%	19,000	34,700

3.4 Key takeaways

The analysis demonstrates that there are positive economic impacts from the transition to low-carbon heating and energy efficiency measures. The modelling suggests that investing in heat pumps and energy efficiency will lead to the creation of around 84,600 jobs in 2030 in the Central scenario, after accounting for jobs lost due to the shift away from high-carbon heating and fuels. Large positive impacts on employment and GDP are found for the three modelled scenarios, even when no public money is committed to aiding the transition. However, economic impacts are maximised when a higher number of heat pumps are deployed, and Government funding is used to help households absorb the higher capital costs required in the transition.

4 Further socioeconomic benefits

4.1 Introduction

The benefits of decarbonising heating in and improving the energy efficiency of residential buildings are not just limited to environmental and economic effects. Decarbonised heating can also cultivate positive social effects, alongside reductions in emissions, gains in employment and creation of economic output. Improvements to the energy efficiency and heating system of a home allow for warmer, more comfortable homes at a more affordable running cost. The knock-on impacts of warmth and more affordable heat include reduced fuel poverty, improved health and wellbeing, and greater educational attainment possibilities. Policies to address energy efficiency and the decarbonisation of heat thus have the chance to address issues of inequality simultaneously, which is essential for the transition to net zero to be considered fair and inclusive.

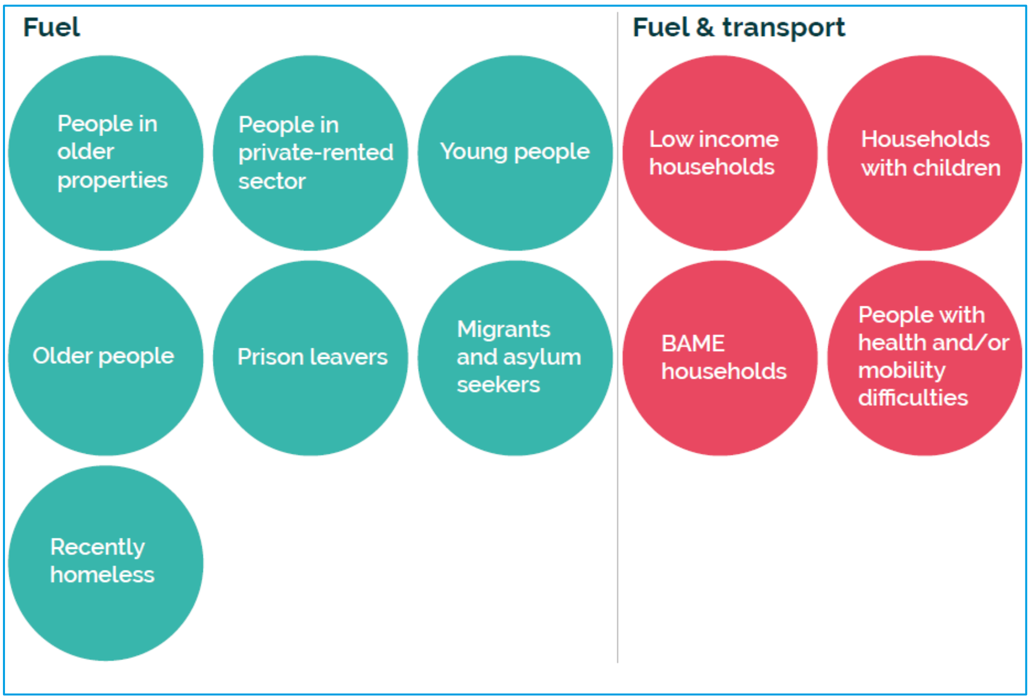
4.2 Reducing vulnerability to fuel poverty

Increased energy efficiency that results from measures such as improved insulation or double-glazed windows reduces the energy required to achieve a certain level of comfort, and households can enjoy lower energy bills as a result. Following savings on their energy bills, households may choose to increase the level of comfort in their home (i.e. increase their demand for energy and spend some of the money initially saved on more heating) or spend their increased discretionary income on other goods and services.

The first of these two options is particularly important when considering aspects of inequality. There are various groups in societies identified as being more vulnerable to fuel poverty, broadly defined in academic research as 'the inability to attain sufficient levels of domestic energy services' (Bouzarovski & Petrova, 2015). Focusing specifically on heating, fuel poverty occurs when a household cannot sufficiently heat their home to a comfortable level. A lack of comfortable heating can lead to a series of detrimental impacts on individuals, including reduced mental and physical health, reduced educational attainment and reduced employment opportunities.

There are many factors which can make a household vulnerable to fuel poverty; low household income (which can be a particularly prominent factor for single parents, elderly people and people with health conditions or disabilities), poor energy efficiency of the home and/ or heating system (a prominent factor for those living in older properties and people living in privately-rented homes) and high energy prices (Boardman, 2013; Simcock et al., 2020). A recent review of academic research on the issue of fuel and transport poverty identifies the key groups in society who may be more likely to experience these factors, and therefore experience fuel poverty (Simcock et al., 2020) (see Figure 4.1).

Figure 4.1 The groups of people vulnerable to fuel or fuel and transport poverty



Source: Simcock et al., 2020

Impact of COVID-19

The COVID-19 pandemic has in many cases exacerbated fuel poverty and associated inequality issues. For example, households on low incomes, or households with children are facing rising energy bills (therefore spending an even higher proportion of their income on heating) because of spending more time in the home. During periods of school closures, children living in fuel poverty may not have experienced the same level of environmental comfort at home as they would be in school, which could lead to disparities in educational attainment. Being advised to work from home may be particularly costly for young people or people living in the private-rented sector who are either spending a disproportionate amount of their income on heating or are living in inefficient homes.

4.3 Improved health and wellbeing

Retrofitting and improving the energy efficiency of homes can alleviate some of the associated mental health impacts, such as stress, anxiety and depression, which can be associated with thermal discomfort (IEA, 2019b). Similarly, an improvement in the thermal comfort of the home is associated with improved physical health, since colder houses place greater physical stress particularly on the elderly, infants and the sick. Exposure to cold has been associated with increased risk of respiratory problems linked to damp (Clark et al., 2004) and circulatory conditions, cardiovascular problems, and arthritic and rheumatic illnesses besides exacerbating existing health conditions, including common flu and cold, and allergies. According to a report published by the CCC, 'the health cost to the NHS of conditions exacerbated by poor housing is currently estimated to be £1.4-2bn per year in England' (Climate Change Committee, 2019) Other studies suggest a similar annual cost. Across the entire UK population, and including estimates for the cost of GP consultations, associated treatments, days in hospital and referrals caused by housing-related factors, the cost to the NHS of cold homes is estimated to be up to £1.4bn a year according to (Nicol S. & Roys M., 2010). While the aforementioned studies focused on a wide definition of poor housing conditions, which included dangers such as unsafe stairs, fire hazards and poor sanitation, the hazards of excess cold and falls on stairs were considered to be the most impactful on health. Fixing the problem of excess cold offered by far the most savings to the NHS, some £848m per year compared to £207m of savings to be made from improving stairs. While it is difficult to separate and quantify the health benefits of more affordable warmth, (Liddell, 2008) estimated that the avoided health costs for the NHS amounted to 42p for every £1 spent on reducing cold through the Warm Home Scheme. Clearly, improved energy efficiency and warmth of homes can lead to substantial social benefits in terms of improved health and wellbeing.

Furthermore, from a government revenue perspective, evidence suggests public funding of energy efficiency pays off, when all benefits are considered. A study conducted in New Zealand found the combined energy and health benefits associated with improving the energy efficiency of homes outweighs the costs of energy efficiency programmes (Grimes et al., 2012), therefore creating a compelling case for investment in such programmes. While the schemes investigated in this study contained many components aimed at improving the energy efficiency of homes, the study finds that 'the dominant benefits (gross and net) of the programme are attributable to the insulation component of the scheme'.

4.4 Greater educational attainment and employment opportunities

Indoor temperature is linked to productivity (IEA, 2019b), and can therefore impact upon the ability of school-age children to carry out homework or study for exams at home, which can have a knock-on effect on their educational attainment, and ultimately their employment opportunities. In some cases, the link between warmth and productivity is further exacerbated by the fact that a household may prioritise heating only some rooms in a home, reducing the possibility that there is a quiet place to study, away from other household activities. Improved energy efficiency or lower heating costs allows families the ability to affordably heat a larger area of the home, effectively increasing the space available to a family, reducing tensions arising from space restrictions, and providing more private and comfortable spaces for activities like homework and studying.

There is evidence that other links between educational attainment and warm homes exist. For example, according to the Energy Saving Trust (Payne et al., 2015), avoidance of physical (particularly respiratory health in children) and mental stresses through warmer and more comfortable homes has been linked to decreased absenteeism from school by children and from work by adults; with potential impacts on academic performance, labour productivity and earning power.

Living in an energy inefficient home is costly, and the poorest housing is often occupied by the most vulnerable people, and households experiencing fuel poverty face difficult decisions about how much to spend on heating and how much to spend on food (End Hunger UK, 2018). A more energy-efficient home could therefore lead to better nutrition for people vulnerable to fuel poverty - by making fuel bills more affordable a 'heat or eat' situation can be avoided. Improved nutrition could subsequently lead to improved concentration and improved chances of educational attainment for school-age children, and better performance (and therefore future employment opportunities) for adults.

4.5 Financial benefits to occupiers and property-owners

Air source and ground source heat pumps offer low-carbon and low-maintenance ways to heat a home, allowing homeowners to generate heat from electricity and save money on their annual heating costs, when compared to using a conventional gas boiler heating system. Furthermore, increasing the energy performance of a UK property (specifically moving from an EPC rating of G to B), through energy-saving methods such as installing low-carbon heating technologies, better insulation or double-glazing, typically increases its value by 14%[1](Department of Energy & Climate Change, 2013). Other international studies also suggest that improving the energy efficiency of a property may increase its value, for example (Jensen et al., 2016) concludes that the energy performance ratings of buildings have an impact on property sales prices in Denmark and that this positive market response provides an incentive to perform energy upgrades to a home. Similarly, evidence from Ireland suggests energy efficiency has a significant, positive effect on property values (Hyland et al., 2013).

In the case of rental properties, although the 'split incentive' exists, whereby a landlord may be reluctant to invest in a low-carbon heating technology or energy efficiency measure as they pay the up-front costs and do not benefit from the lower energy bills, they may benefit financially in other ways. First, individuals may be more willing to pay a higher rent for property with improved energy performance (Eichholtz et al., 2011). Second, improved energy efficiency has the potential to increase the satisfaction of the renter with the property, thereby reducing vacancy periods and tenant turnover (Department for Business, 2021; IEA, 2019a).

4.6 Improved local air quality

Improved energy efficiency has the potential to reduce outdoor concentrations of air pollutants, and the subsequent improvement in air quality generates positive health impacts. Increased energy efficiency reduces the demand from gas boilers, which is directly beneficial for local air quality. Replacing gas boilers with low-carbon alternatives such as heat pumps would provide further scope for improved outdoor air quality (Department for Environment, 2020).

[1] For an average home in the UK, improving its EPC rating from band G to B.

5 Recommendations

The deployment of low-carbon heating technologies, together with the implementation of energy efficiency measures in residential buildings, has the potential to substantially reduce the environmental impact of the UK's housing stock. The findings of this analysis clearly demonstrate that alongside the environmental gains, the decarbonisation of residential heating combined with energy efficiency improvements would also be beneficial for the UK economy, with an overall net positive impact on jobs and GDP.

In this analysis alternative targets for the future deployment of heat pumps were assessed, with the results clearly demonstrating the additional economic gains to be made from the more ambitious target proposed by the CCC, as compared to the Government's deployment target set out in the 10-Point Plan. As specified in its most recent Progress Report to Parliament, the Government is currently falling short of the ambition required to reach the Sixth Carbon Budget, including its targets for heat pump deployment, and this shortfall should be addressed.

Similarly, the analysis explored the economic impacts associated with lower costs of heat pump technologies. Lower costs have the potential to increase the potential economic benefits through increased take-up of heat pump installations, although this is not modelled in our analysis. Consistent and committed policy related to the decarbonisation of residential heating would provide industry with the right signals that a market for heat pumps will exist and reduce the element of risk which may be hindering investment in heat pump technologies.

This analysis also includes an evaluation of how the economic impacts of investing in heat pumps and energy efficiency measures change under different options for financing heat pumps installations, i.e. whether financed publicly or privately. The economic impacts are maximised when public spending covers all capital investments associated with heat pump installation and energy efficiency. This finding supports the view that Government should develop a heat pump and energy efficiency deployment programme in which households are provided with financial support to carry out the necessary investments.

A large proportion of jobs created are highly likely to remain local, given that installations of technology or energy efficiency measures are likely to be carried out by local tradespeople. However, to avoid bottlenecks occurring within the construction and manufacturing sectors, and to maximise the potential economic benefits of an ambitious deployment programme, Government should ensure that UK workers are equipped with the right mix of skills and qualifications to carry out new and changing jobs linked to heat pump production and installation.

This report sets out numerous social co-benefits which may be brought about by Government investment in the decarbonisation of domestic heating. To help realise the additional social co-benefits described, it is important to clearly identify the groups in society who are most vulnerable to fuel poverty and target and/or prioritise Government funding for heating decarbonisation accordingly. Thus, the decarbonisation of social housing and older properties should be prioritised, and measures to improve standards or provide incentives for landlords to improve efficiency of homes for tenants could be considered.

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