CREDS

Macro-economic impacts of green policies in the Economic Recovery Package post-Covid

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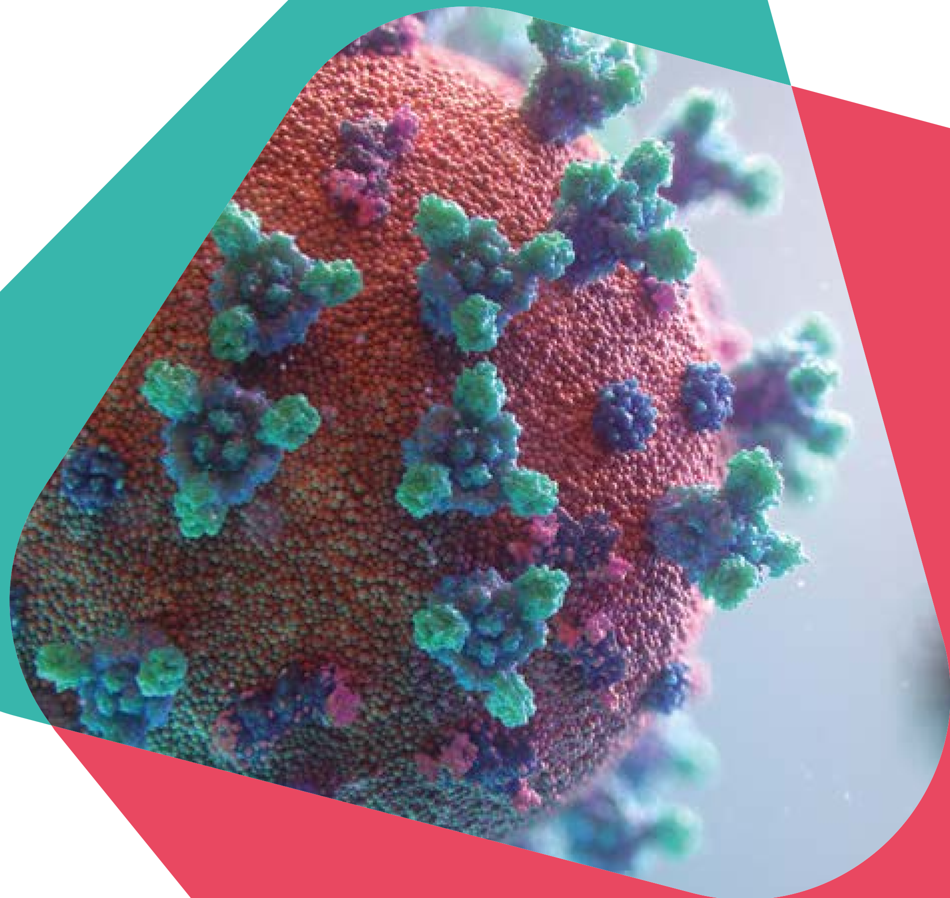

About this report

This study, undertaken by the Centre for Research into Energy Demand Solutions (CREDS), analyses the economic, environmental and welfare impacts of 'green' policies relative to 'brown' policies that could be part of a post-Covid, green, economic recovery. The study uses the Cambridge Econometrics E3ME model to project the macro-economic impacts up to 2050, linked to the Net Zero target on the same timescale and makes recommendations of how energy efficiency policies can support this target.

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Executive summary

During the ongoing Covid-19 pandemic, Government policy has tried to achieve the twin goals of saving lives and maintaining the economy. It is estimated that the full lockdown in spring 2019 resulted in lowering global greenhouse gas emissions by 8%. The UK needs to reduce its emissions by an average of 6% every year to meet the Sixth Carbon Budget goal. Full lockdown is clearly not a viable approach to meeting climate targets. Instead, the increasingly urgent goal of carbon emissions reduction will need to part of the post-Covid recovery economy and this will involve significantly more rapid technical and societal change than has been seen to date.

This report sets out findings from research on the investments and policies that will be required to generate jobs and economic activity and to support the levelling up agenda in the short-term and set us on track to meet the long-term Net Zero target in a socially inclusive and fair way. The study uses the Cambridge Econometrics E3ME model to project the macro-economic impacts of a post-Covid green economic recovery package. E3ME is most often used for scenario analysis, evaluating the impacts of an input shock to a reference/baseline scenario. By comparing outcomes in different scenarios against those in a 'business-as-usual' baseline scenario, it is possible to assess the economic, social and environmental impacts of changes in policies and/or economic assumptions. The baseline forecast in this study is constructed from official published economic and energy-sector projections and adjusted to account for the expected impacts of the Covid-19 pandemic – this is referred to as the 'brown' scenario.

The green scenario analyses the impacts of potential energy efficiency in buildings and industry policy measures that could ensure a green recovery from the Covid-19 pandemic in the UK, such as direct investments in energy efficiency.

Previous work from the Centre for Research in Energy Demand Solutions (CREDS) has shown that significant reductions in energy demand have already been achieved in an economically beneficial way and that further progress with reducing demand will form an essential part of future emissions reduction (The role of energy demand reduction in achieving net-zero in the UK). 'Building Back Better' (Building on our strengths: A market transformation approach to energy retrofit in UK homes) needs to be part of that process and the findings from this report indicate some of the ways that this could be achieved.

CREDS is part of the UK Research and Innovation's Energy Programme and the research focuses on reducing the use of energy, increasing its flexibility and using decarbonised fuels.

Key findings

Investments that have the triple purpose of economic recovery, tackling climate change (both reducing emissions and making the UK more resilient) and creating jobs will be critical to the Covid recovery. The E3ME modelling assessed a range of buildings and industrial policies to determine their potential impact.

The buildings policies include a 0% rate of Stamp Duty granted to those who have increased the energy efficiency rating of their home, a Social Housing Decarbonisation Fund, a large, long-running retrofit programme rollout and a skills and retraining programme for construction workers that could include re-training of gas installers.

The industrial policies include a resource and energy efficiency programme, zero interest loans for energy efficiency investment by SMEs and expansion of the Industrial Strategy Challenge Fund (ISCF), for Industrial Decarbonisation.[1]

The modelling results are separated into economic, social, environmental and distributional welfare impacts.

Economic impacts

Both sets of policies analysed would have positive long-running gross domestic product (GDP) impacts, with the buildings policies having a slightly greater positive impact on GDP. The combined impact of both sets of policies is projected to be around £46bn in 2040 (in 2019 prices), a 1.5% increase relative to baseline GDP. The results indicate that investing in green rather than 'brown' recovery measures would benefit the economy.

Social impacts

The proposed policies would have positive impacts on employment, as the combined policies proposed are projected to add around 215,000 jobs to the UK economy in 2040, a 0.6% increase relative to baseline employment. In the medium-term (by 2030) the largest employment impacts would be seen in the construction sector, and in the long-term (by 2040) the services sector would see the largest employment gains. The model results indicate that investment in green policies is projected to lead to better employment outcomes than investment in 'brown' policies.

Environmental impacts

The positive economic impacts would be accompanied by a significant improvement in environmental performance. Resource and energy efficiency improvements in the industrial and buildings sectors would drive a reduction in UK annual CO_2 emissions of around 20 $MtCO_2$ in the combined scenario in 2040, a 7% reduction relative to baseline emissions. Targeting funds in 'brown' categories of investment would represent a missed opportunity in environmental terms, as economic gains would be made at the expense of a slight increase in carbon emissions relative to the baseline. Though small, these emissions increases would accumulate over the entire forecast period, and eat into the UK's limited carbon budget. In contrast, a green recovery represents an opportunity to drastically improve environmental performance, while also benefiting the economy.

1 The existing challenge fund of £170M from government (also co-funded by industry) supports radical decarbonisation efforts in six key industrial clusters. By expanding the scheme a greater number of locations and sectors could be supported, particularly in some of the most marginalised industrial communities, such as Belfast, West of Scotland, and Tyne and Wear.

Distributional welfare impacts

The distributional impacts of the policy scenarios were analysed in terms of welfare outcomes, defined as the change in income plus the expected energy savings households might experience. The results show that the buildings policy scenario, in particular, would have important distributional impacts, with low-income households seeing greater relative welfare improvements from these policies than high-income households. Conversely, the welfare outcomes from 'brown' investments are more regressive than for the other policies.

In summary, investing in 'green' rather than 'brown' recovery measures would:

- Drastically improve environmental performance (7% reduction in UK annual CO_2 emissions)
- Benefit the economy (1.5% increase in GDP)
- Have better employment outcomes (more jobs), and
- Have important distributional and equity impacts, with low-income households seeing greater relative welfare improvements from these policies.

Implications for policy

Using plausible assumptions about the structure and impacts of the Covid recovery package policies targeted at improving energy efficiency in buildings and industry, the results of this modelling analysis show that such policies can deliver simultaneously on short-term goals related to economic recovery, social improvement on levelling up and medium- and long-term goals to reduce greenhouse gas emissions.

The results of the analysis show that active energy efficiency policy can:

- Increase economic growth;
- Provide short term job opportunities, especially in communities most affected by the economic impacts of the pandemic;
- Improvement welfare for low-income households
- Contribute to the medium- and long-term investments to 'build back better';
- Increase business liquidity and household spending by reducing energy expenditure;
- Add to and stimulate private sector green investment;
- Reduce UK net energy imports; and
- Catalyse innovation in decarbonisation of transport, buildings and manufacturing.

The pandemic has demonstrated how quickly social change can occur. Moving to zero-carbon is a longer-term challenge, requiring very large capital investments for system change, not only behavioural change. But some of the same imperatives apply. Change needs to involve people, not simply be 'done to them' and the role of government in driving this change is critical.

Based on this analysis we conclude that strong Government support for, and investment in, energy efficiency can form a critical part of both the economic recovery and climate policy. We recommend that Government should develop a comprehensive energy efficiency strategy, including:

- Ambitious standards for energy efficiency in buildings, vehicles and products to stimulate private investment.
- A programme for skills and training for the communities most affected by the economic downturn and for retraining workers from fossil fuel sectors.
- A long-term programme of investment in low-carbon building retrofits.
- A waste strategy to promote the move towards a circular economy.
- Support for local government and the private sector to invest in infrastructure to make it easy for people to walk, cycle, and work remotely.
- Funding for innovation in energy demand reduction and decarbonisation.
- Using these commitments to influence international partners to make low-energy, green recovery a key part of international negotiations such as G20 Summits and annual UNFCCC COP events.

1. Introduction

As a result of the Covid-19 lockdown in Spring 2020 it is estimated that globally, greenhouse gas (GHG) emissions might have fallen by 8% or, 2.6 $GtCO_2$ in 2020 (IEA, 2020). Daily emissions in the UK are estimated to have fallen by 31% at the depths of lockdown (CCC progress report 2020). These reductions were driven by changes, such as, more remote working, online shopping and more walking and cycling. To the extent these can be made permanent, some of these changes could increase societal welfare whilst reducing energy demand.

However, full lockdown is clearly not a sustainable approach to meeting climate targets. Instead, the increasingly urgent goal of carbon emissions reduction will need to part of the post-Covid recovery economy. The UK needs to reduce its emissions by an average of 6% each year to meet the Sixth Carbon Budget goal of a 78% reduction from 1990 levels in 2035. This will involve significantly more rapid technical and societal change than has been seen to date.

As the UK moves further into the recovery from the pandemic, there is broad agreement that Government policy needs to move from saving lives to addressing the economic downturn caused by the pandemic, in particular, by creating the conditions for reducing unemployment. CREDS' previous work has shown that significant reductions in energy demand have already been achieved in an economically beneficial way and that further progress with demand reduction will form an essential part of future emissions reduction. 'Building Back Better' needs to be part of that process.

The Centre for Research in Energy Demand Solutions (CREDS) was established as part of the UK Research and Innovation's Energy Programme in April 2018, with funding of £19.5M over 5 years. Its mission is to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable, net-zero society. To do this, the research focuses on reducing the use of energy, increasing its flexibility and using decarbonised fuels. CREDS has a team of over 150 people based at more than 20 UK universities and organisations.

2. Why is energy demand important?

The energy system is at the beginning of a period of massive change. In order to respond to the threat of climate change, we need an energy transition that will eliminate fossil fuels from the UK energy system. The Government has set a target to reach net-zero emissions by 2050 but there is some concern that this timescale is not urgent enough.

It is well-known that the transition will require all energy to come from low carbon sources. However, the transition also has huge implications for the way we use energy. In the current system, most energy is supplied to final users as fossil fuels, e.g. for heating or transport. In a zero carbon system, this will no longer be an option. Instead, all energy will need to be supplied in forms that can utilise zero-carbon supply (e.g. as electricity or hydrogen). It is also clear that this cannot be achieved without reducing energy demand, at least in developed countries, otherwise the amounts of zero-carbon energy required will be too large to allow for a rapid and affordable transition.

Changes to the way that we use energy in buildings, industrial processes and transportation could reduce the world's energy needs globally in 2050 by 40%, even allowing for living standards to rise to meet the Sustainable Development Goals. In developed countries, larger reductions are possible. Improvement in energy efficiency will be at the heart of this – efficiency improvements by a factor of two are achievable and will be assisted by the move to greater use of electricity.

Additional reductions are also possible through social change, for example in how much we travel, and what we eat. Increased resource efficiency, in particular, in the use of energy intensive materials, can also reduce demand for energy in industry by reducing the energy 'embodied' in products.

CREDS insights show that there are multiple ways that we will need to change the way we use energy to enable the energy transition. These may be summarised as:

- **Change** – how we use energy to reduce demand in energy intensive activities, for example through reducing the need to travel by making services more accessible locally or online.
- **Improve** – energy efficiency in buildings, transport and industry, in particular by using more efficient conversion devices such as heat pumps and electric vehicles.
- **Flex** – the timing of energy demand to better match variable renewable supplies, by re-timing when energy is used (e.g. washing clothes) or storing energy locally.
- **Switch** – from fossil fuels to forms of energy that can be produced from zero-carbon sources.

Figure 1 sets out how CREDS sees these issues contributing to energy system transformation.

In making these changes, there will be a number of considerations. The most obvious is cost. Improving energy efficiency and providing the infrastructure for sustainable transport and buildings requires capital expenditure. However, over the long term, this will be offset through the greater efficiency achieved, and therefore lower running costs. In this way, improved efficiency can usually provide energy services at lower cost than supply side investment, leading to the concept, adopted by the IEA and the EU, of energy efficiency as "the first fuel".

Fairness and inclusivity are also important. Change will need to ensure everyone has access to affordable energy services to meet their needs, in particular, as end uses switch to fuels with higher unit costs. In addition, people losing jobs in the 'old energy economy' will need to find new work, much of which can be in delivering demand side investment. Together, these requirements constitute the 'just transition'.

The over-arching goal for long-term changes to energy demand is to enable zero carbon emissions to be achieved with economic benefits. Some other benefits of reducing energy demand, such as comfortable homes, improved air quality and better health, may also help secure support for these aims. None of these justifications disappears in the context of a post-pandemic economic recovery package, but there are other important questions around job creation, economic recovery and addressing inequality.

Using a well-established macroeconomic model, this report describes work that investigates the extent to which policies to improve energy efficiency in buildings and industry can deliver on these goals simultaneously.

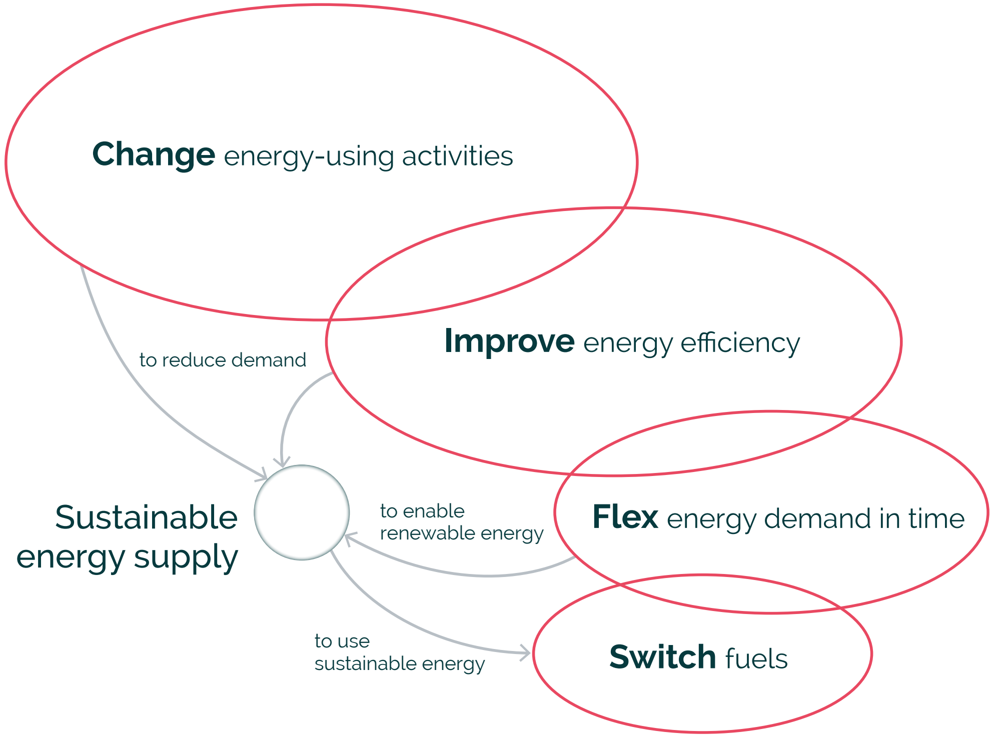

Figure 1: Contributions of the demand side to energy sustainability.

3. Modelling approach

3.1 The E3ME model

E3ME is a global, macro-econometric model of the world's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and is now widely used for policy assessment, forecasting and research purposes across different geographical areas.

As a general model of the economy, E3ME is capable of producing projections for GDP and the aggregate components of GDP (household expenditure, investment, government expenditure and international trade), and other output indicators including employment by sector and GHG emissions.

The structure of E3ME is based on the system of national accounts, with further linkages to energy demand and environmental emissions. The labour market is also covered in detail, including both voluntary and involuntary unemployment. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

E3ME's historical database covers the period 1970-2016 and the model projects forward annually to 2050. The main data sources for European countries (including the UK) are Eurostat and the IEA, supplemented by the OECD's STAN database and other sources where appropriate. For regions outside Europe, additional sources for data include the UN, OECD, World Bank, IMF, ILO and national statistics. Gaps in the data are estimated using customised software algorithms.

The current version of the model has the following dimensions:

- **61 regions** – all major world economies (i.e. G20), the EU28 and candidate countries plus other countries' economies grouped
- **70 industry sectors**, based on standard international classifications
- **43 categories** of household expenditure
- **23 different users** of 12 different fuel types
- **15 users** of 7 raw materials
- **14 types of airborne emissions** (where data are available) including the six greenhouse gases monitored under the Kyoto protocol

For more information on the E3ME model, including the model manual, please visit www.e3me.com.

3.2 Scenario design

E3ME is most often used for scenario analysis, evaluating the impacts of an input shock to a reference scenario. An input shock may be either a change in policy, a change in economic assumptions or another change to a model variable. By comparing outcomes in different scenarios – each representing an alternative future with different policies and/or economic assumptions – against those in a 'business-as-usual' baseline scenario, it is possible to assess the economic and environmental impacts of changes in policies and/or economic assumptions.

Baseline development

The E3ME baseline forecast is constructed from official published economic and energy-sector projections. The baseline forecast includes an adjustment to account for the expected impacts of the Covid-19 pandemic on economic and energy demand growth rates in 2020 and 2021, based on recent projections from official sources including the European Commission, the OECD and the World Bank.

Scenario descriptions

In this report, we analyse the impacts of potential policy measures to ensure a green recovery from the Covid-19 pandemic in the UK. These include direct investments in energy efficiency, alongside other policy measures, targeted at the industrial and residential buildings sectors. We have developed four scenarios to analyse these policies, which are outlined in Table 1. Outcomes in each of these scenarios were compared against the baseline scenario described above.

Table 1: Scenario descriptions

Scenario	Description
Buildings	Includes only measures targeted at the UK housing sector (see details in next section).
Industry	Includes only measures targeted at UK industries (see details in next section).
Combined	Combines all measures included in the industry and buildings scenarios.
Combined brown	Same magnitude of recovery investment as the combined scenario, but focused on non-environmental ('brown') projects

Sensitivities

A 'crowding out' sensitivity[2] was also analysed, which included an assumption that any additional public investment required for the analysed policies would crowd out private investment. This sensitivity is otherwise identical to the 'Combined' scenario, in order to facilitate a direct comparison between the two.

2 Sensitivities are similar to scenarios, but they feature assumptions regarding theoretical mechanisms or future economic developments. Scenarios, on the other hand, focus on policy assumptions. By keeping the two conceptually separate, we can distinguish which impacts are in policymakers' control, and which are not.

Scenario assumptions

The green recovery measures analysed in these scenarios mainly concern public funding for energy efficiency investments in the private and public sectors. Quantitative assumptions were provided by domain experts from the CREDS consortium regarding the size of the public investments that would be associated with each policy, as well as further assumptions regarding the level of private investment leveraged by these policies. The CREDS consortium additionally provided assumptions about the financial savings from energy use that these investments and policies would produce.

These policy inputs and accompanying energy efficiency assumptions are detailed in Table 2. They are organised according to the sector in which the interventions take place –buildings and industry – which correspond to the first two scenarios. These assumptions are all included in the combined scenario.

Distributional assumptions

Some of the buildings policies we analysed would inherently have a distributional dimension, as these policies will tend to benefit or, be targeted at different income groups. For instance, it is reasonable to assume that the Social Housing Decarbonisation Fund would target lower-income groups, while a 0% stamp duty rate would principally benefit higher income homeowners. We made explicit quantitative assumptions regarding the proportion of energy savings associated with each of these polices that would be enjoyed by each income quintile, as summarised in Table 3 below.

Table 2: Scenario policy assumptions

Sector	Policy	Annual public investment assumption	Annual private investment assumption	Annual energy savings assumption	Timescale
Buildings	Stamp duty 0% rate for energy efficiency improvements=[3]	£6bn	£900m	£90m	2021–35
Buildings	Social Housing Decarbonisation Fund	£4bn	£1bn	£750m	2021–23
Buildings	Retrofit programme rollout[4]	£8.5bn	£4.2bn	£12.7bn	2021–38
Buildings	Skills and retraining programme for construction workers	£71.5m	£71.5m	–	2021–27
Industry	Resource and energy efficiency programme[5]	£100m	£400m	£200m	2021–25
Industry	Zero interest loans for energy efficiency investment by SMEs	£30m	£1bn	£400m	2021–25
Industry	Expand ISCF Industrial Decarbonisation challenge[6]	£25m	£38m	–	2023–30

3 The UK Government has extended the temporary removal of Stamp Duty Land Tax until July 2021 (until October 2021 for homes valued at less than £250,000). In order to continue to provide an incentive for energy efficiency improvement, the zero rate should be extended indefinitely for purchasers who make significant improvements within the 12 months following purchase.

4 A comprehensive 'whole house' retrofit programme in England would replace current grant schemes targeting individual measures. It would achieve a transformation of the retrofit sector by working through regional partnerships designed to provide skills, monitoring and learning.

5 This programme would provide support for, and dissemination of, demonstration and best practice in resource and energy efficiency.

6 The existing challenge fund of £170M supports radical decarbonisation efforts in six key clusters. By expanding the scheme a greater number of locations and sectors could be supported, particularly in some of the most marginalised industrial communities, such as Belfast, West of Scotland, and Tyne and Wear.

Table 3: Distribution of energy savings by policy

Policy	1st quintile (lowest income)	2nd quintile	3rd quintile	4th quintile	5th quintile (highest income)
Stamp duty 0% rate for energy efficiency improvements	-	-	-	50%	50%
Social Housing Decarbonisation Fund	50%	50%	-	-	-
Retrofit programme rollout	20%	20%	20%	20%	20%

4. Modelling results

4.1 Economic impacts

Buildings and industry policies

Both sets of policies analysed would have positive long-run gross domestic product (GDP) impacts, with the buildings policies having a slightly greater positive impact on GDP. The combined impact of both sets of policies is projected to be around **£46bn in 2040** (in 2019 prices), a **1.5% increase relative to baseline GDP**.

Most of the initial positive GDP impact from the buildings policies would be driven by the **investment stimulus** associated with them, with large public and private investments required to retrofit residential buildings for energy efficiency improvements. The investment assumed for the industry policies is significantly lower, which explains the initial divergence in outcomes between these scenarios..

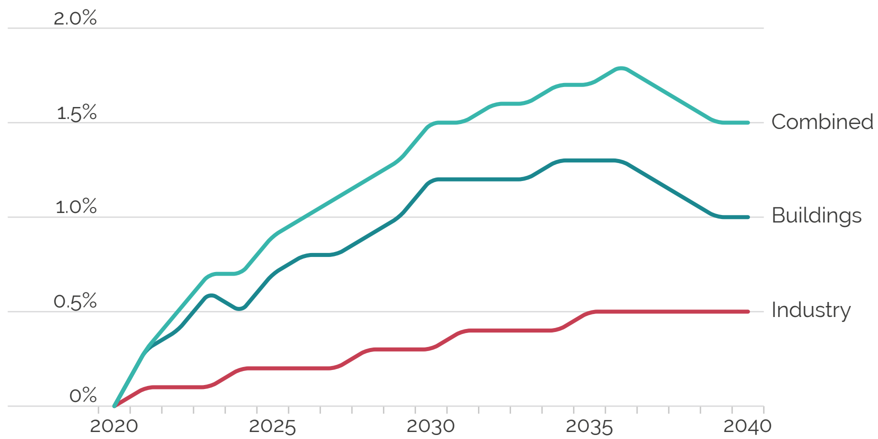

Figure 2: There are positive impacts resulting from both the buildings and industry policies for GDP. The combined impact of both sets of policies leads to a 1.5% increase in GDP in 2040, relative to the baseline.

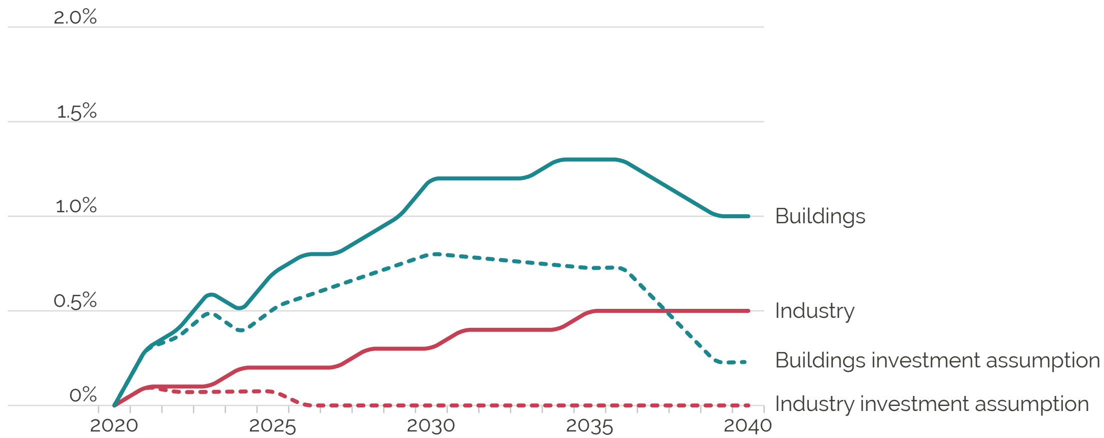

Figure 3: The GDP impacts, relative to the baseline, are driven by investment assumptions associated with the buildings and industry policies. GDP impacts can be seen to be following a similar trend to the investment stimulus associated with the policies.

Further **positive economic impacts from the buildings policies** would be driven by falling residential gas and electricity demand as a result of energy efficiency improvements. Falling electricity demand would in itself lead to further reductions in gas consumption, as gas is the largest energy source in the UK power generation sector. These reductions would lead to an **improvement in the UK trade balance**, as the UK imports less gas to meet domestic demand. Some proportion of the **consumer savings from lower energy consumption** would then be spent on other goods and services, generating further demand in the domestic economy.

A similar dynamic underpins the **positive economic impacts from the industry policies**. Improvements in industrial resource and energy efficiency would lead to decreased intermediate demand for energy and raw materials; this would lead to some import reductions, as well as some reduction in demand for domestic materials industries. However, this would be offset by **cost reductions for industries** that purchase these materials, leading to lower prices for their products, inducing higher consumption levels in the economy. In other words, these cost savings would amount to a positive technological supply shock to the economy, increasing productivity and economic growth.

The gross value added (GVA) results by broad sector show that the **construction sector would see large growth in the medium-term** (by 2030) as a result of the proposed policies. The construction sector would benefit directly from the demand for retrofitting and other energy efficiency measures in buildings and industry, while projects are ongoing.

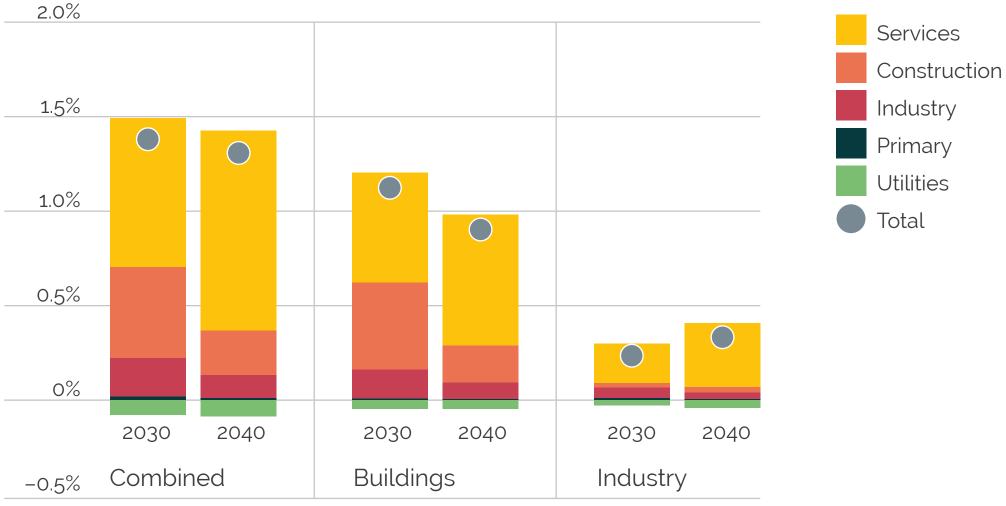

Figure 4: GVA impacts, reported as difference from baseline, are positive as a result of the proposed policies. The construction sector sees large growth in the medium-term, while the services sector has the largest growth in the long term.

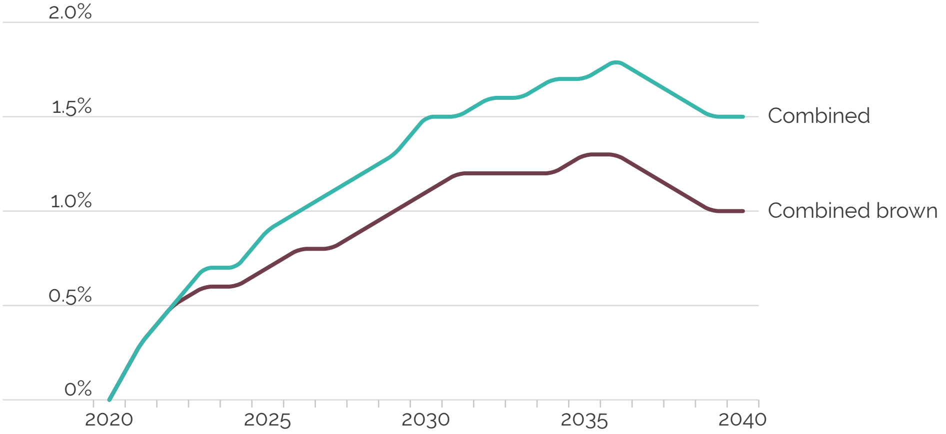

Figure 5: GDP impacts, reported as the difference from baseline, show that the combined 'green' scenario leads to more GDP growth than the combined 'brown' scenario.

The **service sector would see by far the largest gains in the long-term** (by 2040), once the government spending programmes have concluded. This sector would benefit as consumer savings from falling fuel costs would drive demand for retail, professional and hospitality services.

The **utilities sector would decrease in size**, due to falling gas and electricity demand as a result of energy efficiency measures. The UK's oil and gas extractive industry would not be impacted, as the domestic decline in gas demand would lead to lower imports.

Green vs. brown recovery packages

The combined effect of these energy and material efficiency improvements in the industry and buildings sectors can be observed by comparing outcomes between the 'Combined' and 'Combined brown' scenarios. The 'Combined brown' scenario replicates the assumed public and private investment levels in the 'Combined' scenario, but targets this investment towards non-environmental policy objectives.

The clear improvement in economic outcomes produced in the 'Combined' scenario relative to the 'Combined brown' scenario supports the notion that investing in **green rather than 'brown' recovery measures would benefit the economy**.

This outcome can be explained by the impact of energy efficiency improvements and energy savings in the residential sector, and falling material input costs in the industrial sector, as described above.

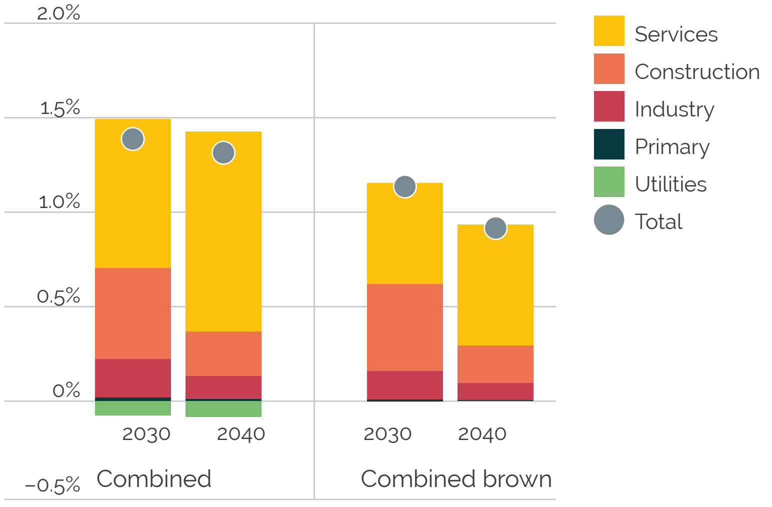

Figure 6: GVA impacts, reported as the difference from baseline, show that the combined 'green' scenario leads to greater GVA outcomes than the combined 'brown' scenario.

4.2 Social impacts

Buildings and industry policies

The proposed policies would have positive impacts on employment, as the combined policies proposed are projected to add around **215,000** jobs to the UK economy in 2040, a **0.6% increase relative to baseline employment**.

The positive employment results are driven by the additional public and private investment associated with the policies analysed in these scenarios. This **investment would mobilise spare labour capacity** in the economy in the wake of the Covid-19 pandemic and recession, creating jobs in the construction sector in particular as the retrofitting of UK buildings gathers pace.

The distribution of employment results largely follows the pattern of GDP results, as the largest impacts are seen when all policies are combined. The buildings policies would be the largest contributors to employment in the short-term, as we have assumed a larger investment is required to achieve these policy goals than for the industrial sector.

As with the GVA results, in the medium-term (by 2030) the **largest employment impacts would be seen in the construction sector**, as public investment in retrofitting and other resource and energy efficiency improvements drives the largest difference in outcomes.

The **services sector would see the largest employment gains in the long-term** (by 2040), after these improvements have been completed. This labour-intensive sector would reap most of the additional consumption generated by residential energy savings and industrial material productivity. Our model projects that employment impacts in other sectors would be much smaller than in construction and services.

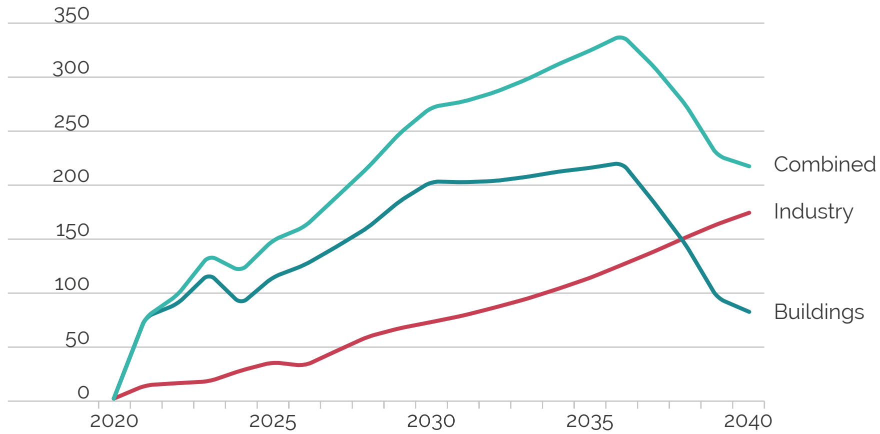

Figure 7: There are positive employment impacts resulting from both the buildings and industry policies. The combined impact of both sets of policies created around 215,000 jobs in 2040, a 0.6% increase in employment relative to the baseline.

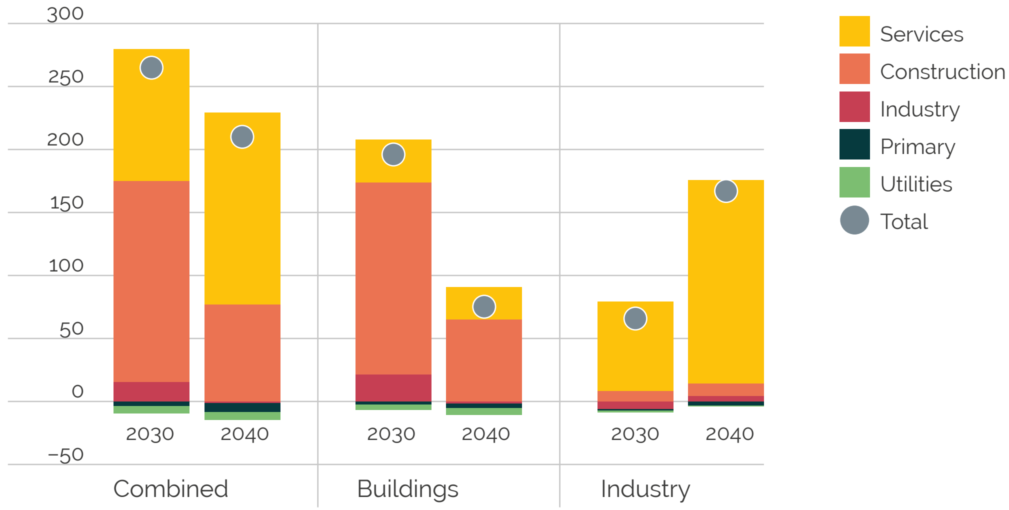

Figure 8: The largest employment impacts (reported as absolute difference from baseline) are seen in the construction sector in the medium-term, and in the services sector in the long term.

Green vs. brown recovery packages

The model results indicate that **investment in green policies is projected to lead to better employment outcomes than investment in 'brown' policies**. Much of this impact can be attributed to the effects discussed above, namely energy savings in the residential sector and material productivity improvements in the industrial sector. These efficiency savings would improve the trade balance by reducing the need for gas imports, and would instead be spent mainly on domestically produced services, which would give an important boost to service-sector employment.

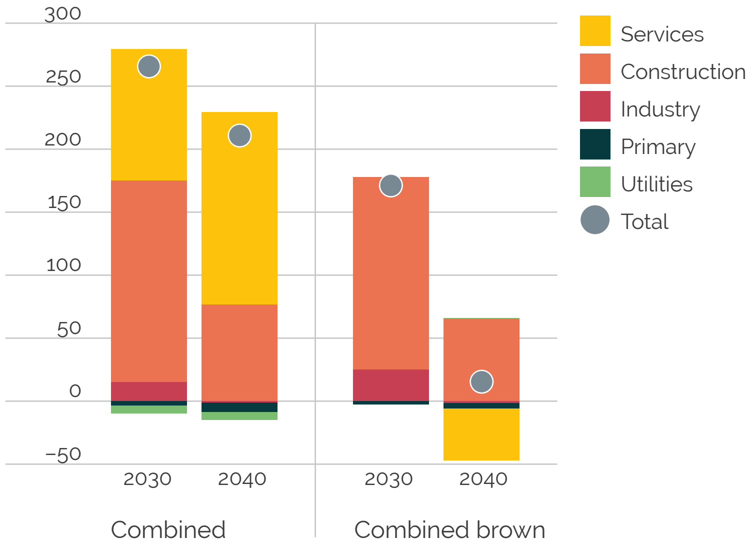

Figure 9: The impact on employment, reported as the difference from baseline, show that the combined 'green' scenario leads to greater job creation overall than the combined 'brown' scenario, with much of the gains seen in the services sector.

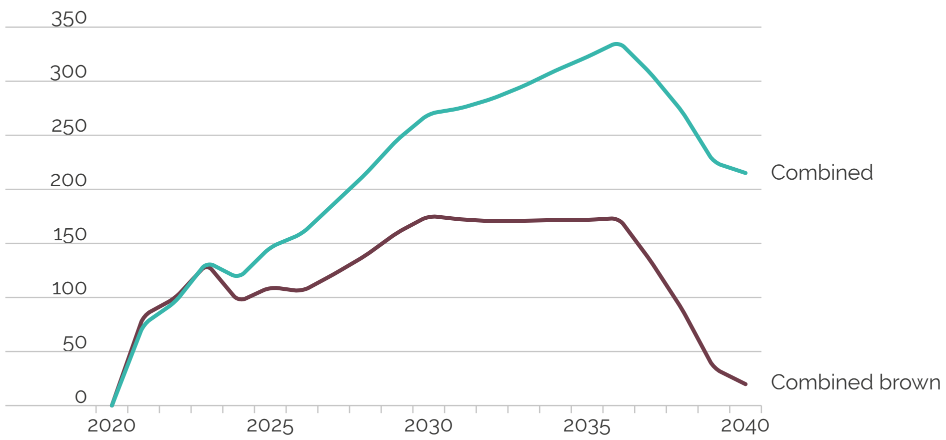

Figure 10: The impact on total employment, reported as the difference from baseline, show that the combined 'green' scenario leads to greater job creation than the combined 'brown' scenario.

4.3 Environmental impacts

Buildings and industry policies

The positive economic impacts would be accompanied by a significant improvement in environmental performance. Resource and energy efficiency improvements in the industrial and buildings sectors would drive a **reduction in UK annual CO_2 emissions of around 20 $MtCO_2$** in the combined scenario in 2040, a **7% reduction** relative to baseline emissions.

The reductions in CO_2 emissions from the proposed policies would mostly be seen in the **power generation and residential sectors,** as energy efficiency measures would lead to significant **declines in gas consumption and fossil fuel-based electricity generation**.

A smaller contribution would be made from policies to improve energy and material efficiency in the industrial sector.

Green vs. brown recovery packages

Targeting funds in 'brown' categories of investment would represent a missed opportunity in environmental terms, as economic gains would be made at the expense of a slight increase in carbon emissions relative to the baseline. Though small, these emissions increases would accumulate over the entire forecast period, and eat into the UK's limited carbon budget. In contrast, **a green recovery represents an opportunity to drastically improve environmental performance, while also benefiting the economy**.

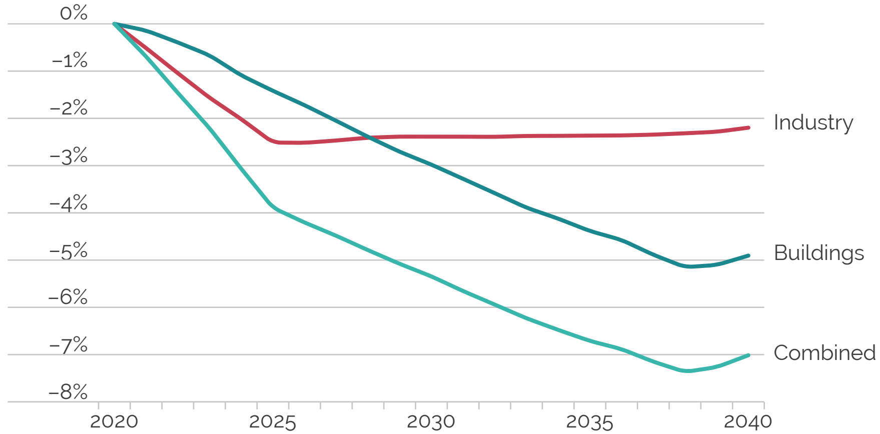

Figure 11: The industry and buildings policies lead to reductions in annual CO_2 emissions of around 20 $MtCO_2$ in the combined scenario in 2040, a 7% reduction relative to baseline emissions.

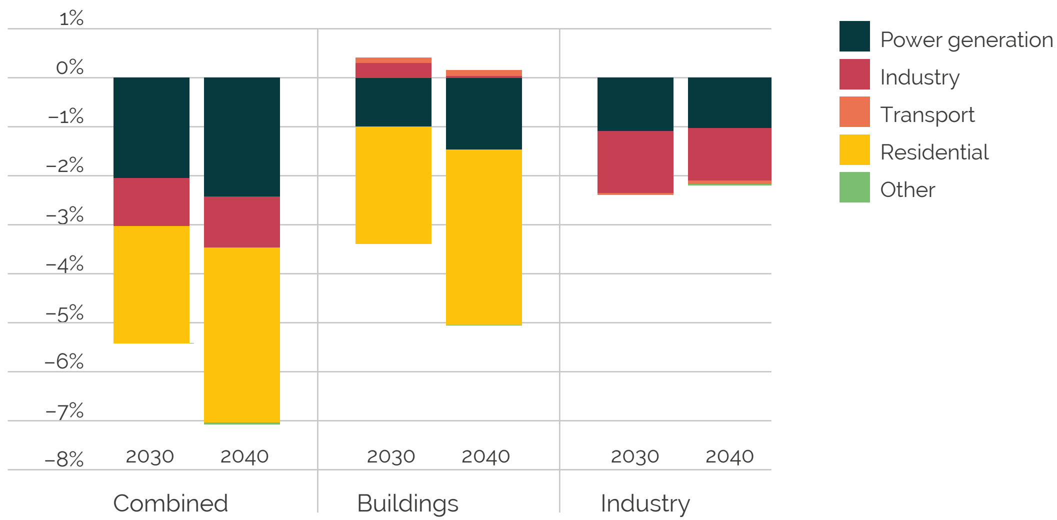

Figure 12: The CO_2 emissions results by broad sector show that the greatest emission reductions occur in the power generation and residential sectors.

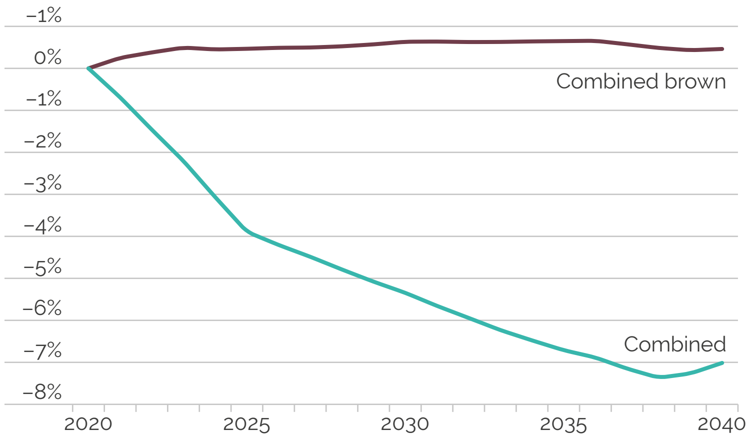

Figure 13: Comparing CO_2 emissions in the combined 'brown' scenario and the combined 'green' scenario shows that the 'brown' scenario leads to a slight increase in emissions in 2040, while the 'green' scenario leads to a substantial reduction in emissions (7% compared to baseline).

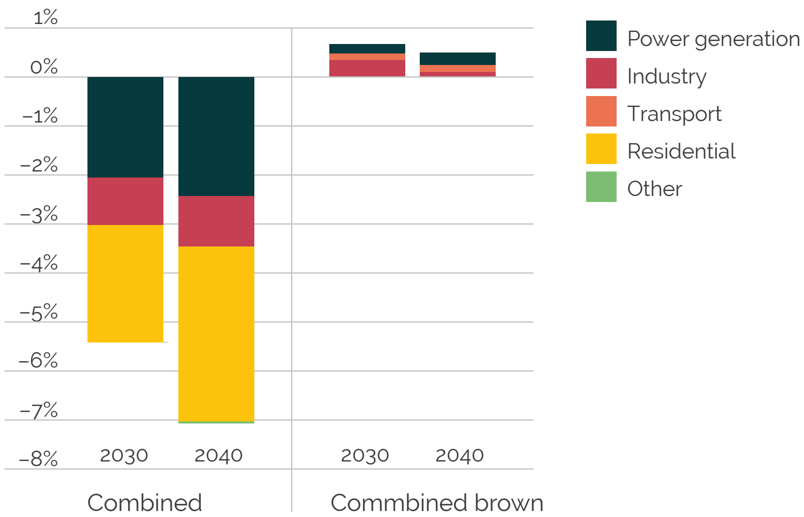

Figure 14: There are substantial reductions in the power generation, transport and residential sector in the combined 'green' scenario, while in the combined 'brown' scenario, there are small increases in emissions in these same sectors.

Rebound effects

Although increases in energy efficiency will nominally reduce energy consumption, the money saved from lower energy bills may be used to fund other activities, which can create a rebound in energy demand. The **possibility of rebound effects is important for policymakers**, as it suggests that efforts to reduce energy consumption through efficiency improvements may be an uphill struggle.

The rebound effect can occur through direct and indirect channels. A **direct rebound effect** occurs when money saved on energy bills from a given technology is spent on more of the same technology. For example, an energy efficiency improvement would make heating more affordable, and may induce a household to increase its heating demand, and thereby negate any reduction in energy demand. Equally, an **indirect rebound effect** may be observed: the household may prefer to spend its savings from energy bills on other consumption items, such as leisure activities or retail, which would increase economic and energy demand elsewhere in the economy.

Increases in material efficiency in industry may create a **technological rebound effect**. If an intermediate product can be produced more efficiently and cheaply by one industry, other industries further down the supply chain may be able to increase their production, increasing demand for the original material input.

As an E3 model, E3ME can capture these feedbacks between the economy and energy demand. As a result, it is possible to **calculate the rebound effect in each scenario** as the difference between the scenario input assumptions regarding energy efficiency savings, and the scenario outcomes in final energy demand.

Our results suggest that there would be a moderate rebound in final energy demand that would be produced by the policies analysed. The combined scenario produced a 5.1% reduction in energy demand, compared to an assumption of energy efficiency savings of 5.7% – this represents a **rebound effect of 11%**. **Overall, this rebound is small enough to suggest that policies promoting energy efficiency would not be counterproductive**.

Much of this rebound would be driven by policies promoting energy efficiency in the buildings sector (the rebound effect in the Buildings scenario is calculated at around 12%), while the rebound from policies in the industrial sector would be more limited (at around 7%). This suggests that the **rebound from energy efficiency in consumption would be greater than the technological rebound effect in production**.

4.4 Distributional impacts

The distributional impacts are analysed in terms of welfare outcomes by income quintile. We define welfare as distinct from income in these results. The measures to improve residential energy efficiency analysed in our scenarios would, all else being equal, lead to reduced energy spending, with the accrued savings possibly spent on other items. **Income changes do not fully capture welfare improvements** in this type of scenario, as they would not account for increasing consumer surplus as households can afford the same benefits of energy spending (e.g. a warm house) at a lower cost, while potentially maintaining overall spending at the same level as before. We **define welfare impacts instead as the change in incomes *added* to the energy savings assumptions**.

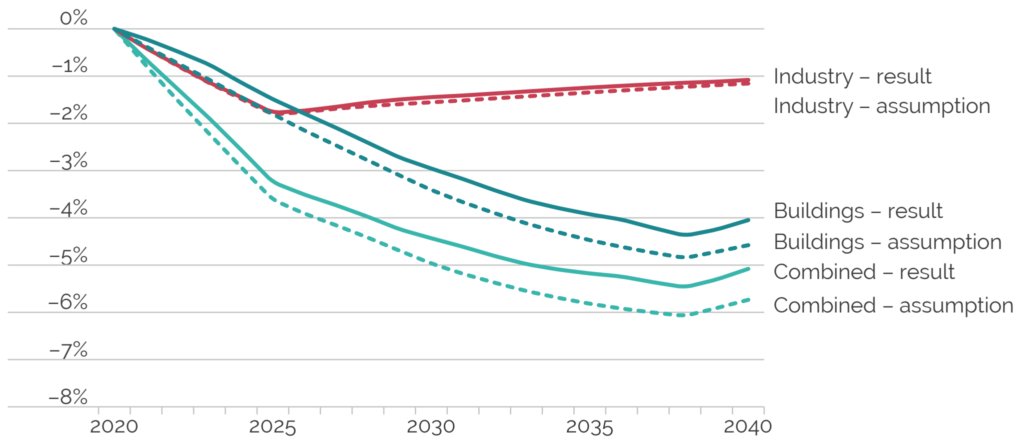

Figure 15: Final energy demand, reported as % difference from baseline, shows that there would be a moderate rebound in energy demand as a result of the policies analysed.

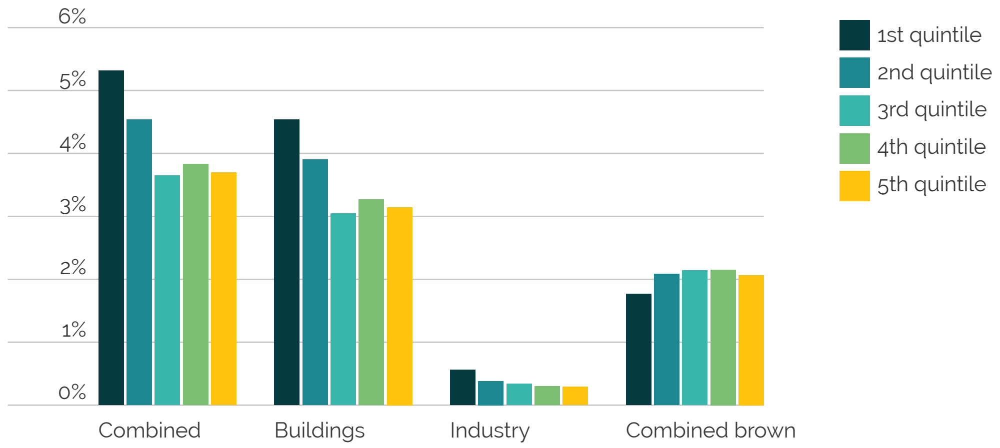

Figure 16: The distributional effects, reported as the relative difference in welfare by quintile, show that low-income households see greater welfare improvements from the policies compared to high-income households.

We made specific quantitative assumptions about how energy savings from various retrofitting policies would be distributed among income groups. These assumptions are summarised in Table 3 above (see Section 1.2).

The welfare results by quintile show that the progressive targeting of **policies in the buildings sector would have important distributional impact**, with low-income households seeing greater relative welfare improvements from these policies than high-income households.

This progressive distribution of the welfare impacts of the buildings policies can in part be attributed to the targeting of some of these policies towards low-income households, such as the Social Housing Decarbonisation Fund. But equally, this pattern can be explained by the fact that **energy consumption forms a larger share of spending in lower-income households, and so a given percentage reduction in energy consumption has a greater proportional impact on welfare**. Given that lower-income households tend to have a high marginal propensity to consume, these welfare improvements are likely to be a significant driver of the rebound effects discussed in section 2.3.

The industrial sector policies would have smaller welfare impacts overall, but these impacts would also be distributed progressively, with poorer households seeing marginally higher relative welfare improvements than high-income households.

Middle-income households would benefit the least from the buildings policies analysed, as targeted policies such as the Social Housing Decarbonisation Fund would benefit low-income households more, while we have assumed that other non-targeted policies such as the 0% stamp duty rate for energy efficiency improvements would primarily benefit higher-income households.

The welfare outcomes from 'brown' investments are more regressive than for the other policies. This is partly because we have not assumed any targeting of investment towards lower-income households, and furthermore these households would not benefit from energy savings, which can be expected to have a progressive impact as described above.

4.5 'Crowding out' sensitivity analysis

Our analysis so far has assumed that a government investment stimulus would lead to a rise in aggregate investment. In other words, we have assumed that government deficits do not 'crowd out' private investment.

Some economists would dispute this account, citing the neoclassical 'crowding out' hypothesis most often associated with Milton Friedman. The simplest version of this theory states that government spending must be funded by taxes or by borrowing, and either of these would lead to an equal reduction in private spending, either by reducing consumption in the first case, or by increasing interest rates and reducing investment in the second case.[7]

To account for this alternative hypothesis, we have developed an alternative 'crowding out' sensitivity against which to compare our 'Combined' scenario.[8] This sensitivity assumes that all public investment crowds out an equivalent quantity of private investment, leaving overall investment levels unchanged.

7 See a more in-depth discussion of the 'crowding out' hypothesis.

8 We have analysed the crowding out hypothesis as a sensitivity rather than a scenario as it reflects a modelling assumption rather than a policy assumption. It is therefore appropriate to present this analysis separately from the earlier analysis of policy scenarios, to distinguish clearly which effects can be influenced by the actions of policymakers.

However, the crowding out sensitivity retains the same material and energy efficiency improvements as are assumed in the 'Combined' scenario. In practice, this sensitivity allows us to isolate the impact of the material and energy efficiency improvements in the 'Combined' scenario, independently of the investment assumptions that were associated with these.

The results suggest that the GDP and employment impacts of the full policy package would remain positive, though somewhat diminished, under a crowding out assumption.

The reduction in CO_2 emissions resulting from these policies would be slightly larger under a crowding out assumption. This tallies with the smaller GDP and employment impacts, and can be explained by the smaller rebound effects of energy consumption as the investment stimulus is offset by reduced private investment.

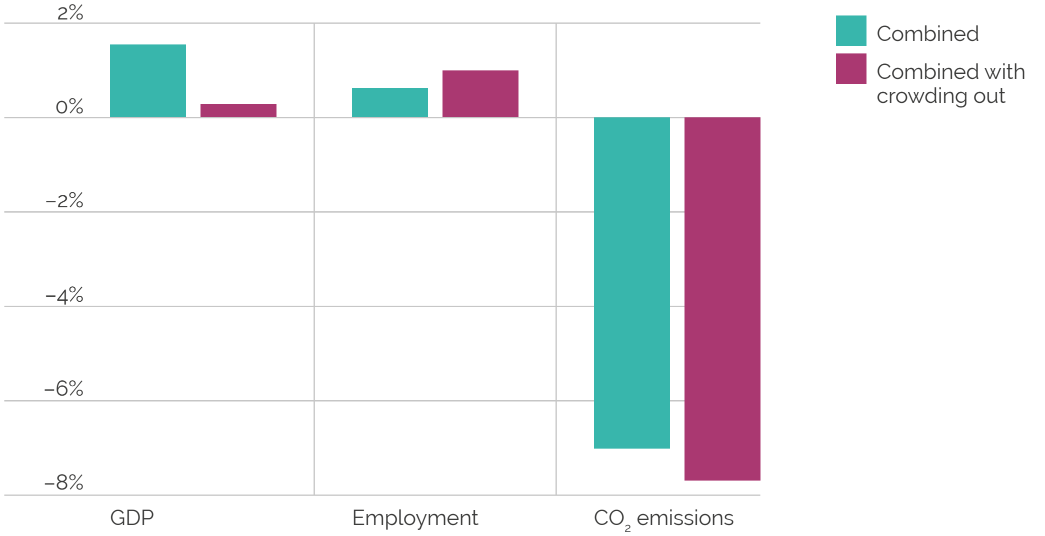

Figure 17: The crowding out sensitivity results show that the GDP and employment impacts would remain positive, though smaller, if crowding out is assumed.

5. Conclusions

Investments that have the triple purpose of economic recovery, tackling climate change (both reducing emissions and making the UK more resilient) and creating jobs will be critical to the Covid recovery. The E3ME modelling described in this report has assessed a range of buildings and industrial policies to determine their potential impact.

The buildings policies include a 0% rate of Stamp Duty granted to those who have increased the energy efficiency rating of their home, a Social Housing Decarbonisation Fund, a large and long-running retrofit programme rollout and a skills and retraining programme for construction workers and gas installers.

The industrial policies include a resource and energy efficiency programme, zero interest loans for energy efficiency investment by SMEs and expansion of the Industrial Strategy Challenge Fund (ISCF), for Industrial Decarbonisation.

The modelling results are separated into economic, social, environmental and distributional welfare impacts, with assessment of rebound effects and crowding out of investment.

Economic impacts

Both sets of policies analysed would have positive long-running gross domestic product (GDP) impacts, with the buildings policies having a slightly greater positive impact on GDP. The combined impact of both sets of policies is projected to be around £46bn in 2040 (in 2019 prices), a 1.5% increase relative to baseline GDP. The results indicate that investing in green rather than 'brown' recovery measures would benefit the economy.

Social impacts

The proposed policies would have positive impacts on employment, as the combined policies proposed are projected to add around 215,000 jobs to the UK economy in 2040, a 0.6% increase relative to baseline employment. In the medium-term (by 2030) the largest employment impacts would be seen in the construction sector, and in the long-term (by 2040) the services sector would see the largest employment gains. The model results indicate that investment in green policies is projected to lead to better employment outcomes than investment in 'brown' policies.

Environmental impacts

The positive economic impacts would be accompanied by a significant improvement in environmental performance. Resource and energy efficiency improvements in the industrial and buildings sectors would drive a reduction in UK annual CO_2 emissions of around 20 $MtCO_2$ in the combined scenario in 2040, a 7% reduction relative to baseline emissions. Targeting funds in 'brown' categories of investment would represent a missed opportunity in environmental terms, as economic gains would be made at the expense of a slight increase in carbon emissions relative to the baseline. Though small, these emissions increases would accumulate over the entire forecast period, and eat into the UK's limited carbon budget. In contrast, a green recovery represents an opportunity to drastically improve environmental performance, while also benefiting the economy.

Distributional welfare impacts

The distributional impacts of the policy scenarios were analysed in terms of welfare outcomes, defined as the change in income plus the value of energy savings to households. The results show that the buildings policy scenario, in particular, would have important distributional impacts, with low-income households seeing greater relative welfare improvements from these policies than high-income households. Conversely, the welfare outcomes from 'brown' investments are more regressive than for the other policies.

Rebound effects

Although increases in energy efficiency directly reduce energy consumption, the money saved from lower energy bills may be used to fund other energy using activities, which can create a 'rebound' in energy demand.

The possibility of rebound effects is important for policymakers. Our results suggest that there would be a moderate rebound in final energy demand that would be produced by the policies analysed. The combined scenario produced a 5.1% reduction in energy demand, compared to an assumption of energy efficiency savings of 5.7% – this represents a rebound effect of 11%. Overall, this rebound is small enough to suggest that policies promoting energy efficiency would not be environmentally counterproductive. Much of this rebound would be driven by policies promoting energy efficiency in the buildings sector (the rebound effect in the Buildings scenario is calculated at around 12%), while the rebound from policies in the industrial sector would be more limited (at around 7%). This suggests that the rebound from energy efficiency in consumption would be greater than the technological rebound effect in production.

Crowding out sensitivity analysis

The analysis assumed that a government investment stimulus would lead to a rise in aggregate investment. In other words, we have assumed that government deficits do not 'crowd out' private investment. However, there is an alternative hypothesis, that suggests that private investment diminishes with government spending and this theory has been tested in an alternative 'crowding out' sensitivity compared to the 'Combined' scenario. The results suggest that the GDP and employment impacts of the full policy package would remain positive, though somewhat diminished, under a crowding out assumption.

The reduction in CO_2 emissions resulting from these policies would be slightly larger under a crowding out assumption.

Implications for policy

Using plausible assumptions about the structure and impacts of Covid-recovery package policies targeted at improving energy efficiency in buildings and industry, the results of this modelling analysis show that such policies can deliver simultaneously on short-term goals related to economic recovery, social improvement on levelling up and medium- and long-term goals to reduce greenhouse gas emissions.

The results of the analysis show that active energy efficiency policy can:

- Increase economic growth;
- Provide short term job opportunities, especially in communities most affected by the economic impacts of the pandemic;
- Improvement welfare for low-income households
- Contribute to the medium- and long-term investments to 'build back better';
- Increase business liquidity and household spending by reducing energy expenditure;
- Add to and stimulate private sector green investment;
- Reduce UK net energy imports; and
- Catalyse innovation in decarbonisation of transport, buildings and manufacturing.

The pandemic has demonstrated how quickly social change can occur. Moving to zero-carbon is a longer-term challenge, requiring very large capital investments for system change, not only behavioural change.

But some of the same imperatives apply. Change needs to involve people, not simply be 'done to them' and the role of government in driving this change is critical.

Based on this analysis we conclude that strong Government support for, and investment in, energy efficiency can form a critical part of both the economic recovery and climate policy. We recommend that Government should develop a comprehensive energy efficiency strategy, including:

- Ambitious standards for energy efficiency in buildings, vehicles and products to stimulate private investment.
- A programme for skills and training for the communities most affected by the economic downturn and for retraining workers from fossil fuel sectors.
- A long-term programme of investment in low-carbon building retrofits.
- A waste strategy to promote the move towards a circular economy.
- Support for local government and the private sector to invest in infrastructure to make it easy for people to walk, cycle, and work remotely.
- Funding for innovation in energy demand reduction and decarbonisation.
- Using these commitments to influence international partners to make low-energy, green recovery a key part of international negotiations such as G20 Summits and annual UNFCCC COP events.

C R E D S

This report

This study, undertaken by the Centre for Research into Energy Demand Solutions (CREDS), analyses the economic, environmental and welfare impacts of 'green' policies relative to 'brown' policies that could be part of a post-Covid, green, economic recovery. The study uses the Cambridge Econometrics E3ME model to project the macro-economic impacts up to 2050, linked to the Net Zero target on the same timescale and makes recommendations of how energy efficiency policies can support this target.

About CREDS

The Centre for Research into Energy Demand Solutions (CREDS) was established as part of the UK Research and Innovation's Energy Programme in April 2018, with funding of £19.5M over 5 years. Its mission is to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable, net-zero society. CREDS has a team of over 150 people based at more than 20 UK universities..

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