Department for Environment, Food and Rural Affairs (Defra)

Economic analysis of policy pathways for increasing resource productivity

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clarity from complexity

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Introduction & the rationale for this study

The use of natural resources is an intrinsic part of economic development and wealth creation, but over time our use of resources has become unsustainable. Overexploitation of natural resources contributes to climate change, biodiversity loss and threatens the health of ecosystems and the health and well-being of people[1].

The benefits of resource productivity

Resource productivity (also known as resource efficiency) can be defined as *'using…limited resources in a sustainable manner while minimising impacts on the environment. It allows us to create more with less and to deliver greater value with less input'*[2].

Improving resource productivity reduces the strain placed on the natural environment by the economy. If through better product design, production processes, and waste reduction less resources can be used to produce the same amount of output, the detrimental impacts on the environment of further economic growth can be reduced.

Benefits for the economy and businesses

In the long-run, resource productivity improvements will be essential for economic growth to continue in the face of depleting natural resources. As well as the continuation of economic development, greater resource productivity may also benefit the economy and businesses by reducing production costs and improving competitiveness, creating jobs, stimulating innovation, creating new low-carbon industries associated with recycling and repair and reducing risk associated with supply chains and the imports of materials.

Benefits for people and society

The detrimental effects of unsustainable resource use on the natural environment have direct consequences for human health and well-being. Toxic substances and emissions released into the environment from resource extraction and production processes pose health risks to people, wildlife and plants, and the degradation of the natural environment reduces the amount of green space that is accessible to people. Reducing resource use and its associated environmental impacts can therefore increase the quality of life of people and societies, through living in a healthier environment and by having greater access to nature.

Existing policy landscape

To be able to implement the measures set out within the Government's Waste and Resources Strategy[3], the Environment Bill was established, becoming known as the Environment Act in November 2021 when it received Royal Assent. The Environment Act intends to safeguard the natural environment for future generations by introducing legally bindings targets, plans and policies related to biodiversity, resource efficiency and waste reduction, air quality and water. The Office for Environmental Protection, whose responsibility it will be

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[1] We're gobbling up the Earth's resources at an unsustainable rate (unep.org), The Sustainable Use of Natural Resources: The Governance Challenge | International Institute for Sustainable Development (iisd.org)

[2] Resource Efficiency - Environment - European Commission (europa.eu)

[3] Resources and waste strategy for England - GOV.UK (www.gov.uk)

to improve the natural environment, has also been established through The Environment Act.

Alongside policy intended to improve air quality, nature and biodiversity and water, through The Environment Act the Government will be able to implement policies which aim to reduce waste and improve resource productivity such as extended producer responsibility, deposit return schemes and greater resource productivity information standards (e.g. through product labelling).

The purpose of this study

As part of ongoing work associated with The Environment Act, within the area of resource efficiency and waste reduction, targets are being explored to drive improvements in material resource productivity. There are various pathways through which these targets could be achieved. These pathways could consist of changes in consumer behaviour, production processes and business models which could be encouraged through Government policy - for example through regulation or fiscal measures. Different policy pathways used to achieve waste reduction and resource productivity will each lead to different economic outcomes. This report provides a robust analysis of the potential macroeconomic impacts of a set of possible resource productivity pathways developed by the Department for Environment, Food and Rural Affairs (Defra), in association with the University of Leeds. The interventions outlined below are not Government policies, instead this work provides exploratory analyses which could later be used to inform potential Government policies.

Exploring alternative pathways

An Excel-based tool has been produced in additional to this report. The tool allows users to adjust the assumptions used in some of the resource productivity pathways and select which pathways to include in a single, combined policy scenario. Users can then view the macroeconomic impacts of up to two alternate scenarios.

What policies were modelled within the pathways?

In this analysis, a number of policies were modelled individually, to estimate the macroeconomic impacts of each policy, while a ‘combined scenario’ modelled the aggregate impacts of all policies:

Regulatory policies

Regulatory policies included:

- **Policies to reduce food and drink waste:** policies to encourage behaviour change in consumers’ purchasing decisions, and regulatory policies to improve resource productivity in the food and drink manufacturing sector.
- **Policies to increase resource productivity in the Construction sector:** embodied carbon standards and targets aimed at encouraging the adoption of new materials, techniques and supply chain structures.
- **Policies to increase resource productivity in the Vehicles sector:** policies to improve resource productivity such as car-sharing initiatives, consumer information campaigns and extended producer responsibility.
- **Policies to increase resource productivity in the Electricals sector:** policies aimed at improving resource productivity in the electrical sector including eco-design standards for electricals to increase product lifetimes, extended producer responsibility, kerbside collections and consumer information campaigns.

- **Policies to increase resource productivity in the Furniture sector:** extended producer responsibility within the furniture sector.

Fiscal policies

Fiscal policies include:

- A **reduced VAT rate for repaired, refurbished or second-hand goods** in the furniture, electricals and construction sectors in particular.
- Policy which **increases the prices of aggregate materials and metallic ores**.
- Policy to **increase the price of disposing of all material types via landfill**.
- For the latter two policies the impacts of **simultaneous government investment in initiatives to further encourage the creation of a circular economy**, such as industrial symbiosis schemes, whereby waste or by-products of one industry are used as inputs to another industry, local circular economy hubs and direct financial support to recommerce businesses are also examined.

Key findings/ macroeconomic impacts

The table below shows the key findings of this analysis in 2035:

Policy	Macroeconomic impacts in 2035 (% difference from baseline)		
	GDP	Employment	Consumer prices
All policies combined, with revenue recycling	0.84	-0.50	-0.60
Policies to reduce food & drink waste	0.10	0.00	-0.38
Regulatory policies aimed at Construction sector	0.31	-0.61	-0.40
Regulatory policies aimed at Vehicles sector	0.18	0.01	-0.01
Regulatory policies aimed at Electricals sector	0.03	0.00	0.10
Regulatory policies aimed at furniture sector	0.13	0.10	0.05
Fiscal policy to increase prices of virgin materials, with revenue recycling	0.05	-0.01	0.04
Fiscal policy to increase prices of waste disposal, with revenue recycling	0.05	0.00	0.04
Reduced VAT rate for repaired, refurbished or	0.02	0.00	-0.50

second-hand goods

The headline messages from these results are:

- All the resource productivity and waste measures together result in a 0.9% increase in GDP by 2035. When revenues from fiscal policies are recycled, each of the resource productivity and waste measures individually contribute positively to GDP.
- The effect of the combined resource productivity and waste measures on employment are negative by 2035. This is because lower use of resources leads to lower gross output across the targeted sectors, which reduces demand for labour. The employment effects are mainly driven by measures affecting the construction sector, in which large scale reductions in material consumption (and therefore demand for intermediary products) occur. Although lower costs in the construction sector feed through into lower prices for consumers and therefore increased spending and consumption, this consumption effects employment in other, less labour-intensive sectors (construction is a labour-intensive sector), so the overall impact is a reduction in net employment.
- When all resource productivity and waste measures are combined, the effect on consumer prices is negative by 2035 (Figure 3.5); economy-wide average prices are pushed down by 0.6% compared to the baseline. Most of these effects come from the measures in the construction sector. The costs faced by the construction industry fall due to the substantial decrease in material consumption, which feeds through to industries which use construction services and ultimately consumers.
- Of all the individual policies, the policies aimed at improving resource productivity in the construction and vehicles sectors see the largest economic gains in terms of GVA and GDP. Within the construction sector, these gains are driven by the large efficiency gains and cost reductions that result from reduced material consumption. In the vehicles sector, the economic gains are driven by the reduction in imports of vehicles and metals, and more efficient manufacturing processes.
- The macroeconomic impacts of the fiscal policies are small and, in the case of measures aimed at increasing the price of virgin materials and waste disposal, are driven by the recycling of government revenues, which provides a small boost to GDP. In the case of reduced VAT for repaired, refurbished or second-hand goods, the VAT rate results in a decrease in real consumer prices, leading to higher demand and a small increase in economic activity.

Key takeaways for policymakers

- Improved resource productivity places less pressure on the natural environment, reduces biodiversity loss and can contribute to the pathway to net zero through reduced emissions from both industry and waste disposal. **This analysis has demonstrated that at the same time, policy pathways for increasing resource productivity can also lead to economic gains.**

- There is no silver bullet solution for increasing resource productivity across the economy, as different industrial sectors and economic agents will require different incentives to reduce material consumption or to consider reusing, repairing or recycling products before buying new. In this analysis a variety of both regulatory and fiscal policies, aimed at increasing resource productivity across a range of sectors, were modelled. The findings show that **the magnitude of the economic gains varies depending on the specific policy pathway applied, with the regulation-based pathways leading to greater gains in GDP compared to the fiscal policies**.
- Investment associated with improving resource productivity is a key driver of economic gains. In the case of regulatory policies, the **private investment required to move towards more efficient production processes has a large part to play in the economic gains**. Without this necessary investment, resource productivity and resulting lower material consumption would lead to declines in the output of sectors that make up the supply chains of targeted sectors, and the overall economic impact of the resource productivity policies could be negative. Similarly, in the case of fiscal policies, policymakers will want to ensure that the environmental gains from resource productivity policy pathways do not come at a cost to the economy, through reduced consumption. This analysis shows that **revenue recycling in the form of public investment in circular economy initiatives has important implications for the magnitude (and direction) of the GDP effects of these policies**.
- How revenue is recycled is an important consideration for policymakers when implementing fiscal policies, in terms of ensuring material consumption does not in fact increase in line with additional government investment. Ringfencing the revenues to specifically invest in circular economy-related initiatives ensures that increased public spending does not simply result in greater material consumption (for example if revenues were used to fund road infrastructure). **The results of this analysis clearly demonstrate that using government revenues to invest in carefully targeted initiatives leads to reduced material consumption overall, at the same time as achieving economic growth.**
- Each measure analysed in this report has a positive impact on the environment through reduced material consumption and the economy, and a combination of these policies should form the basis for an overall strategy to improve resource productivity across all sectors. **A policy strategy should be carefully designed to mitigate any adverse effects**, such as reduced employment resulting from reduced output in supply chains, as well as through investment to stimulate and support developing green industries and jobs within a circular economy. Successful implementation of the policies will depend on consultation and collaboration with both the industries affected and consumers.
- Furthermore, **stability in the policy strategy to increase resource productivity creates certainty and boosts the confidence of investors** to invest in both new production techniques and materials and the reuse, remanufacturing and recycling sectors.

1 Introduction

1.1 Resource productivity and sustainability

Our use of resources has become unsustainable

The use of natural resources is an intrinsic part of economic development and wealth creation, but over time our use of resources has become unsustainable. Overexploitation of natural resources contributes to climate change, biodiversity loss and threatens the health of ecosystems and the health and well-being of people[4].

The benefits of resource productivity

Resource productivity (also known as resource efficiency) can be defined as *'using…limited resources in a sustainable manner while minimising impacts on the environment. It allows us to create more with less and to deliver greater value with less input'*[5]. At the macro-level, resource productivity can be measured by comparing the total volume of materials used in an economy to GDP, or similarly at a sectoral or firm level resource productivity can be measured by the total volume of materials used by a sector or firm compared to its output.

There are many benefits associated with greater resource productivity, not only associated with the improvement of the natural environment, but also for the economy and businesses, and for people and society too.

Benefits for the natural environment

Detrimental impacts of unsustainable resource use include:

- Greenhouse gas emissions, particularly from energy-intensive resource extraction
- Loss of biodiversity and ecosystem imbalances
- Air and water pollution
- Degraded habitats which would otherwise act as natural carbon sinks (e.g. forests and peatlands
- Degradation and depletion of resources such as fish stocks or soil nutrients (caused by unsustainable management practices)[6]

Improving resource productivity reduces the strain placed on the natural environment by the economy. If through better product design, production processes, and waste reduction less resources can be used to produce the same amount of output, the aforementioned detrimental impacts on the environment of further economic growth can be reduced.

Resource productivity and its contribution to net zero

Resource productivity can also make a substantial contribution to reducing emissions, both domestically (in cases where products are manufactured in the UK) and across global supply chains (in cases where products are imported into the UK), since the embodied emissions in products can be reduced by improving the way they are manufactured or resources consumed. The contribution of resource productivity, and therefore reduced embodied

[4] We're gobbling up the Earth's resources at an unsustainable rate (unep.org), The Sustainable Use of Natural Resources: The Governance Challenge | International Institute for Sustainable Development (iisd.org)

[5] Resource Efficiency - Environment - European Commission (europa.eu)

[6] Material Resources, Productivity and the Environment | READ online (oecd-ilibrary.org)

emissions, associated with products manufactured in the UK can help to meet the UK's net zero target by 2050. Research from the Centre for Industrial Energy, Materials and Products (CIEMAP) reveals that improving material consumption in the construction, vehicles, food and drink, electronics & appliances, and clothing & textiles sectors could reduce emissions by nearly 200 MtCO2e by 2032, potentially making a valuable contribution to meeting the fifth carbon budget[7]. The research highlights that *'the potential carbon savings from resource efficiency measures are greater than those already achieved by many of the government's other climate policies, including the Renewable Heat Incentive, the Renewable Transport Fuel Obligation, the Carbon Reduction Commitment energy efficiency scheme and the smart meter rollout'*. This research is also supported by the Committee on Climate Change's 'Balanced Pathway' to net zero scenario, which implies that resource efficiency improvements and material substitution within the manufacturing and construction sectors could reduce emissions by 8MtCO2e and 1 MtCO2e per year respectively by 2035[8].

Benefits for the economy and businesses

In the long-run, resource productivity improvements will be essential for economic growth to continue in the face of depleting natural resources. As well as the continuation of economic development, greater resource productivity may also benefit the economy and businesses by reducing production costs and improving competitiveness, creating jobs, stimulating innovation, creating new low-carbon industries associated with recycling and repair and reducing risk associated with supply chains and the imports of materials.

Benefits for people and society

The detrimental effects of unsustainable resource use on the natural environment have direct consequences for human health and well-being. Toxic substances and emissions released into the environment from resource extraction and production processes pose health risks to people, wildlife and plants, and the degradation of the natural environment reduces the amount of green space that is accessible to people. Reducing resource use and its associated environmental impacts can therefore increase the quality of life for people and societies, through living in a healthier environment and by having greater access to nature.

Furthermore, research by Green Alliance suggests that there is substantial public support for improving resource efficiency, with 90% of people surveyed strongly believing that society should be more resource efficient[9]. The research reveals which approaches to resource productivity are popular, providing insight into the benefits of resource productivity that matter to people and society. For example:

- Resource productivity measures, such as standards and regulation to improve the design and durability of products, are deemed valuable to consumers since purchased goods would be expected to be of better quality and have a longer lifespan.
- Improved and more accessible repair services can reduce inconvenience and costs for consumers.

[7] Less_in_more_out.pdf (green-alliance.org.uk)

[8] The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf (page 126)

[9] By_popular_demand.pdf (green-alliance.org.uk)

- Encouraging a sharing economy, whereby communities share products such as tools, can increase social interaction and community spirit, reducing loneliness and isolation.

In addition, in its final report the Climate Assembly UK, a group of 108 UK citizens selected to represent UK society strongly supported '*a future in which businesses make products using less energy and materials, and low(er) carbon energy and materials, as well as the idea of individuals repairing and sharing more'*[10]. The Climate Assembly UK also supported greater information being provided to consumers, such as better product labelling, to improve sustainable purchasing decisions and recycling.

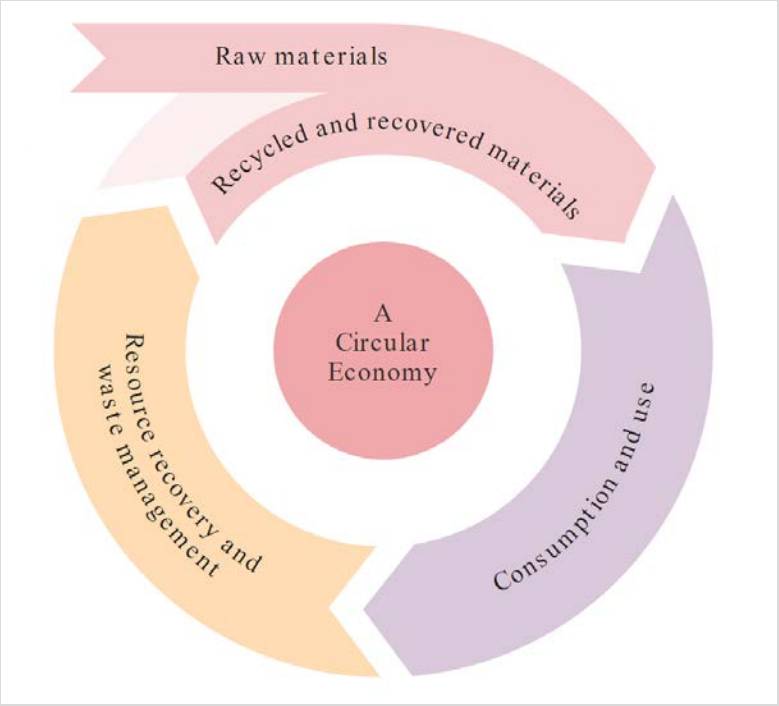
1.2 Existing policy landscape

The Government's 25 Year Environment Plan (hereafter referred to as 'the Plan') recognises that in the last century we have experienced unprecedented expansion in population, consumption, energy use, waste and pollution, and the conversion of land to agriculture, leading to harmful effects on wildlife and habitats[11]. The Plan pledged to leave the natural environment in better condition for the next generation and includes goals such as using resources more sustainably and efficiently, and minimising waste.

Resources and Waste Strategy

The Resources and Waste Strategy was developed to meet the commitments related to resource productivity and waste reduction set out in the Plan. The strategy outlines how England will move towards a circular economy in which waste is minimised and resources are recycled, recovered and kept in use as long as possible, and away from a linear economy where resources are extracted, used and thrown away.

Figure 1.1 A circular economy



Source: Resources and waste strategy: at a glance - GOV.UK (www.gov.uk)

[10] Report - Climate Assembly UK

[11] 25-year-environment-plan.pdf (publishing.service.gov.uk)

The key elements of the Strategy include:

- Introduction of extended producer responsibility whereby producers pay the costs of dealing with the packaging waste they produce, therefore encouraging recycling, and better-designed products and packaging
- Increasing the rate of household waste recycling through consistent collections, and implementing separate food waste collections
- Measures aimed at tackling the environmental impacts of food and plastic waste[12]

The Waste Prevention Programme seeks to build upon the aims of the Resources and Waste Strategy, focusing on the top of the waste hierarchy, the prevention of unnecessary production.

The Environment Act 2021

To be able to implement the measures set out within the Strategy, the Environment Bill was established and in November 2021 it received Royal Assent and is now known as the Environment Act 2021. The Environment Act intends to safeguard the natural environment for future generations by introducing legally bindings targets, plans and policies related to biodiversity, resource efficiency and waste reduction, air quality and water. The Office for Environmental Protection, whose responsibility it will be to improve the natural environment, has also been established through The Environment Act.

Waste reduction and resource productivity

Alongside policy intended to improve air quality, nature and biodiversity and water, through The Environment Act, the Government will be able to implement policy which reduces waste and improves resource productivity. Specifically:

- Extend producer responsibility to make producers pay for 100% of the costs of disposal of products, starting with plastic packaging
- A deposit return scheme for single use drinks containers
- Charges for single use plastics
- Greater consistency in recycling collections in England
- Electronic waste tracking to monitor waste movements and tackle fly-tipping
- Measures to tackle waste crime
- Powers to introduce new resource productivity information (labelling on the recyclability and durability of products)
- Regulate shipment of hazardous waste
- Bans or restrictions on the export of waste to non-OECD countries[13].

1.3 The purpose of this study

As part of ongoing work associated with The Environment Act, within the area of waste reduction and resource productivity, targets are being explored to drive improvements in material resource productivity. There are various policy pathways through which these targets could be achieved. These policy

[12] Resources and Waste Strategy for England | WRAP

[13] World-leading Environment Act becomes law - GOV.UK (www.gov.uk)

pathways could consist of changes in consumer behaviour, production processes and business models, which could be encouraged through Government policy - for example through regulation or fiscal measures. The specific policy pathways used to achieve waste reduction and resource productivity will each lead to different economic outcomes. This report estimates the economic impacts of a set of possible resource productivity pathways being explored by the Department for Environment, Food and Rural Affairs (Defra), in association with the University of Leeds, as described in Section 1.4. The interventions analysed in this study are not Government policies, instead this work provides exploratory analyses which could later be used to inform potential Government policies.

1.4 Prior research

Baseline development

In 2021, the University of Leeds and WRAP developed a range of scenarios for raw material consumption (RMC) across 13 material groups and resource productivity (measured as GDP/RMC) in England to 2050. Two workshops were held to elicit expert opinion on how the drivers of final demand volume and structure on one hand, and material intensity on the other, might develop to 2050. Levels of potential change in these parameters were incorporated into a modelling framework to quantify reference scenarios for RMC across the 13 material groups and resource productivity to 2050.

A key purpose of this prior research was to produce reference scenarios against which policy scenarios could be compared. The policy scenarios can then introduce possible interventions to improve resource productivity.

Resource productivity pathways

Hypothetical pathways for economy-wide and sector-specific interventions which could be introduced in the period to 2035 were subsequently developed by Defra to explore the routes or scenarios by which improvements in national resource productivity might be realised in England.

The analysis presented in this report utilises the outputs of the pathways of interventions, to estimate the macroeconomic impacts of these. A more detailed description of the modelling approach is described in Chapter 2.

1.5 The structure of this report

The remainder of this report is structured as follows:

- In Chapter 2 we provide an introduction to the E3ME model used in this analysis, the modelling approach applied and describe the scenarios modelled.
- In Chapter 3 we present the results of the modelling analysis, through tables, charts and written interpretation.
- In Chapter 4 we consider what the results of this analysis imply for policymakers.
- In Appendix A we detail the quality assurance procedures and checks carried out throughout the analysis.

2 Modelling approach

This chapter outlines the methodological approach adopted in this analysis to estimate the macroeconomic impacts of policy pathways for increasing resource productivity. The scenarios explored in this analysis are described in detail, together with the main underpinning assumptions. The chapter also provides an overview of the major limitations to the modelling approach and how these are tackled in the analysis.

2.1 Introduction to the E3ME model and the modelling approach

The macroeconomic modelling described in this report was carried out using the E3ME model, developed and maintained by Cambridge Econometrics. E3ME is a computer-based model of the world's economic and energy systems, and linked environment impacts. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe and beyond for policy assessment, forecasting and research purposes.

E3ME is commonly used for evaluating the impacts of an input shock through a scenario-based analysis. The shock may be either a change in policy, a change in economic assumptions or another change to a model variable. The scenarios represent alternative versions of the future based on a different set of inputs. By comparing the outcomes to the baseline (usually in percentage terms), the effects of the change in inputs can be determined.

In the E3ME baseline, unemployment can exist and it is therefore possible that well-designed policy can draw on spare capacity in the economy to create a stimulus effect, with net gains to GDP and employment. Demand for goods/services by consumers, industries and government is the key determinant of domestic output, and prices are modelled using an empirical approach. The econometric approach also means that E3ME can capture short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g. up to 2030) and rebound effects, which are included as standard in the model's results. For further reference, please see the E3ME technical manual[14]:

The modelling was carried out for different resource productivity scenarios. The key scenario inputs that have changed between scenarios are material taxes, waste taxes and the demand for raw materials.

Waste modelling

Taxes on waste are treated as a cost that industry and households must pay on each unit of waste produced. This feeds through the economic system and ultimately some of these costs are passed on to final consumers.[15] There may also be a loss of international competitiveness due to the higher costs faced by firms.

[14] Cambridge Econometrics (2019) E3ME Model Manual v6.1. Available online at: https://www.e3me.com/wp-content/uploads/2019/09/E3ME-Technical-Manual-v6.1-onlineSML.pdf

[15] Cost pass-through rates are empirically estimated at an industry sector level, and dependent on the market structure and competitiveness of each industry.

The waste generation routine formulates the relationship between waste generation and economic output. The projected generation of each of the ten waste types by waste generator is calculated using a constant coefficient derived from waste generation and economic output in 2018 (the final year of historical waste data in E3ME).[16]

A logarithmic relationship between waste tax rates and waste generation is assumed with an elasticity of -0.08, implying that a 1% increase in costs leads to a 0.08% reduction in waste generation.[17] A simple treatment is used to capture landfilled waste substitution effects: half of the reduction in landfilled waste goes to a combination of incineration and recovery.[18]

The waste disposal routine links together waste type and disposal method. Specifically, this calculates projections of waste disposal method shares for each of the ten waste types. Again, this uses a constant coefficient which is derived from the relationship between total generation of a given waste type and method of disposal of a given waste type in the last year of historical waste data in E3ME. Note that in each year, total generation is adjusted to be consistent with the reduction in waste disposals.

More detail on the waste modelling approach within the E3ME model can be found in Cambridge Econometrics (2013).[19]

Material submodule modelling

Few macroeconomic models currently include physical measures of material consumption, although environmentally extended input-output analysis is much more common. The advantage that E3ME offers over other input-output approaches is its dynamic nature, with rates of material intensity allowed to change in response to price (including materials tax rates) and other economic factors; rather than following a fixed input-output structure. This means that E3ME can be used to test scenarios including policies aimed at reducing material consumption.

E3ME models material consumption for each region within the model. The following material types are modelled:

- Food
- Feed
- Forestry
- Construction minerals

[16] The coefficient of waste generation to industry output is based on the last year of data (rather than a period average, for example), to best reflect current industry attuites and behaviour with respect to waste, capturing the effect of recent waste-related policies and improved information.

[17] This value is based on findings from a literature review and is broadly consistent with the elasticities presented in: OECD (2004) 'Addressing the Economics of Waste', OECD, Paris.

[18] There is limited data available on the substitution effect between waste types and, in practice, it is dependent on local policies. For this reason, a high-level approximation about landfill waste substitution is made. Whilst this assumption is important for the model results on physical waste it has very limited impact on the economic results.

[19] Cambridge Econometrics (2013), 'Modelling Milestones for Achieving Resource Efficiency: Economic Analysis of Waste Taxes'. Available online at: https://ec.europa.eu/environment/enveco/resource_efficiency/pdf/Task%203-waste.pdf

- Industrial mineral
- Ferrous ores
- Non-ferrous ores

Data for material consumption are typically not disaggregated by sector. However, in E3ME consumption is split into a set of material users, so sectoral consumption must be estimated. This is done largely by combining two different data sets: material flows data, which is disaggregated by country and material; and the information from individual country supply and use tables. Some additional assumptions are made where data is missing, for example that only the agriculture sector consumes animal feed. Time series are constructed on this basis and used to estimate the model parameters.

Material consumption is modelled as a function of economic activity, material prices (including materials tax) and measures of technology. There is also a term in the equation to account for the changing share of imports in consumption, due to the relatively different weights of imports and domestic extraction. It is assumed that all material consumption meets intermediate demands (i.e. materials are used as part of the production process and not bought by households directly). A relatively small number of sectors produce the materials: agriculture and fishing produce food and feed; the forestry sector produces forestry; and other mining produces all mineral categories. The feedback from the material submodule to economy is through adjustments to economic input-output coefficients.

2.2 Scenarios explored in this analysis

We model 10 resource productivity and waste policies in this project, of which five are regulatory policies and five are fiscal policies. The summary table of the policy assumptions can be found in Appendix B.

Regulatory scenarios assumptions

The regulatory policies are:

- Policies to reduce Food and drink waste
- Policies to increase resource productivity in the Construction sector
- Policies to increase resource productivity in the Vehicles sector
- Policies to increase resource productivity in the Electricals sector
- Policies to increase resource productivity in the Furniture sector

The post-Keynesian modelling approach within E3ME allows for capturing the multiplier effects of these changes. We assume that additional investments are required to adapt manufacturing processes in order to reduce materials use, and there are multiplier effects from this investment stimulus. In the regulatory scenarios, the material efficiency in different economic sectors drives cost savings, some of which are passed onto consumers (via sector-specific econometrically-estimated cost pass through rates), and this drives an increase in real incomes and consumption.

The policies to reduce food and drink waste incorporate consumer behaviour change, improved demand forecasting and ordering, as well as regulatory changes. This result in a 1% reduction in the food sector's use of all products, a 7% reduction in the hotels and catering sector's use of all products and a 7%

reduction in household spending on food and drink from 2023. We also model the investment needed to implement these changes in the sector – the broad assumption taken is that the capital expenditure (i.e. investment) required to achieve these changes is equivalent to the cumulative operational expenditure savings accrued over three years.

The policies to increase resource productivity in the construction sector incorporate embodied carbon targets for public procurement of infrastructure and embodied carbon standards. This results in a 50% reduction in construction sector's use of all products from 2023. We also model investments needed to implement these changes in the sector – the broad assumption taken is that the capital expenditure (i.e. investment) required to achieve these changes is equivalent to the cumulative operational expenditure savings accrued over a single year. [20]

The policies to increase resource productivity in the vehicles sector incorporate accessible consumer information for vehicles, car-sharing initiatives and extended producer responsibility (EPR) for vehicles and investment in electric arc furnaces. This results in a 63% reduction in motor vehicle's purchases of other metals, a 13% reduction in all sectors' purchases of motor vehicles and a 15% reduction in household purchases of vehicles from 2023. We also model investments needed to implement these changes in the sector – the broad assumption taken is that the capital expenditure (i.e. investment) required to achieve these changes is equivalent to the cumulative operational expenditure savings accrued over three years.

The policies to increase resource productivity in the electricals sector incorporate eco-design standard for electricals to increase product lifetimes, and a package of electrical policies which include EPR, kerbside collections, and consumer information. This results in a 9.5% reduction in all sectors' purchases of electrical products and a 9.5% reduction in household purchases of electrical products from 2023. We also model investments needed to implement these changes in the sector – the broad assumption taken is that the capital expenditure (i.e. investment) required to achieve these changes is equivalent to the cumulative operational expenditure savings accrued over three years.

The policies to increase resource productivity in the furniture sector incorporate EPR for the furniture sector to include environmental costs. This results in a 40.5% reduction in all sector's purchase of furniture products, as well as the same percentage reduction in household purchase of furniture products from 2023. We also model investments needed to implement these changes in the sector – the broad assumption taken is that the capital

[20] A consultation with experts was used to inform our assumption about the required level of investment to bring about the scale of material efficiency improvements modelled in these scenarios. The feedback from the expert consultation suggested that in the Construction sector, many of the material efficiency improvements could be brought about at no or minimal cost, which is why a short (1-year) pay-back period on investments is assumed in that case. For the other industries modelled, the investment costs to transform industrial processes and bring about material efficiency improvements are expected to be relatively higher, In these cases we assume a level of investment consistent with a 3-year payback period, which is more in-line with the returns required from a typical investment project.

expenditure (i.e. investment) required to achieve these changes is equivalent to the cumulative operational expenditure savings accrued over three years.

Fiscal scenarios assumptions

Across the five fiscal policies, we present the results of three scenarios, because we aggregate the virgin material and waste taxes' impacts. The reason for this is that they have similar and small macroeconomic effects, which are better shown as aggregated scenarios.

In the fiscal scenarios, the standard assumption is that the additional waste and materials taxes fund additional government investments. In these revenue neutral scenarios, it is assumed that multiplier effects are associated only with the investment stimulus.

The fiscal policies are:

- Policies to increase prices of virgin materials
- Policies to increase prices of waste disposal
- Reduced VAT for repaired, refurbished or second-hand goods

The policies to increase the prices of virgin materials incorporate virgin material taxes. This results in a 10% increase in the cost of metallic ores from 2023, and the continued increase of the aggregates levy for construction and industrial minerals, at a rate of 2 percentage points (pp) per year. Additional materials taxes raised are used to fund public sector investment, which reduces material consumption.

The policies to increase prices of waste disposal incorporate landfill taxes on all materials. This results in a 2 pp annual real (i.e. growth over inflation) increase in landfill taxes on inert waste from 2026 (which covers minerals and construction minerals), and an 8 pp annual real increase on landfill taxes on all other materials from 2023. Additional waste taxes raised are used to fund public sector investment, which reduces material consumption as outlined in the paragraphs below.

The policies to reduce VAT for repaired, refurbished or second-hand goods incorporate a lower VAT rate of 5% for certain products in the furniture, electronics, construction and repair sectors.

In the default fiscal scenarios, we assume that the extra government revenues from increased virgin materials tax and waste taxes are recycled to fund additional government investment in circular economy initiatives. We have also modelled two additional sensitivity scenarios, where we explore the effect of not recycling these additional tax revenues.

These sensitivities cover:

- Policies to increase prices of virgin materials without revenue recycling
- Policies to increase prices of waste disposal without revenue recycling

2.3 Any limitations described

The modelling approach outlined above has some limitations. The first is that, through the linkages in the model, which are based on historical data, it is assumed that as sectoral output falls, so too does employment. In reality, specific policies may lead to structural changes within a sector which alter the labour intensity of sectoral processes, and it may be the case that the historical relationship between output and employment changes such that a decline in output does not necessarily mean a reduction in employment. The second is that the modelling is carried out in E3ME at the UK level, since England is not included in the model as a distinct region. To address this, we use information from Cambridge Econometrics' UK MDM sectoral model, which models the four nations of the UK. England's shares of the UK output by sector from this model is applied to the UK level results from E3ME across the projection period to estimate England-level impacts.

Another limitation is that within the E3ME model it is not possible to explicitly model the specific ways in which resource productivity policies are funded. It is assumed that any additional government revenues generated through these policies are used to fund additional government investment. We use this category (government investment) as a proxy for investment in circular economy measures within government - which generates additional economic activity but does not create additional demand for materials.

Finally, the investment requirements in the regulatory scenarios might be underestimated due to lack of data. The capital expenditure (i.e. investment) required to implement resource productivity improvements in these scenarios is assumed to be equivalent to the cumulative operational expenditure savings accrued over a single year, in the case of the construction sector, and over the course of three years for all other sectors. These assumptions could also explain why the employment effects are small or negative.

3 The impacts of resource productivity policy

3.1 Introduction

This chapter presents results from the analysis undertaken. It presents, for each resource productivity pathway/ scenario, the impact on key economic indicators up to 2035, as well as the combined impacts of all interventions.

Key terms

Various key terms are used throughout this Chapter, which are defined in the table below.

	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.
Prices	Prices	Changes in prices are measured in terms of an Industry Price Index, which tracks the change in final prices of industry output, taking into account costs of inputs including raw materials, products from other parts of the economy, labour costs and producer margins.
Employment	Employment	Employment is measured as domestic jobs in each sector of the economy. This is a jobs-based measure, meaning that an individual holding two jobs would be counted twice under such a measure, although such impacts are small at the macro level.

Exploring alternative pathways

An Excel-based tool has been produced in additional to this report. The tool allows users to adjust the assumptions of some of the resource productivity pathways and select which pathways to include in a single, combined intervention scenario. Users can then view the macroeconomic impacts of up to two alternate scenarios.

3.2 Combined scenario

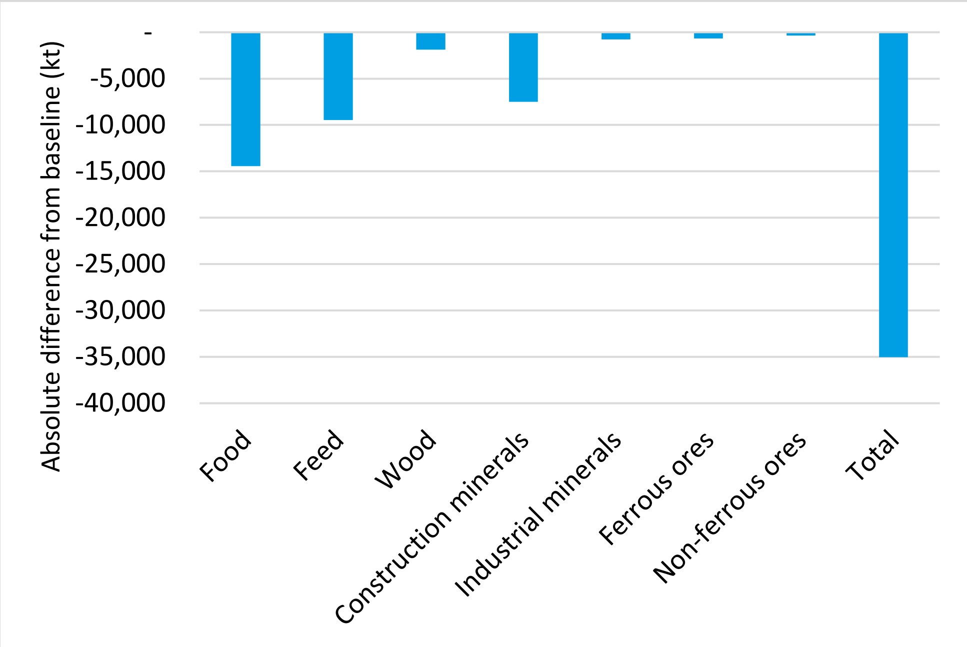
Introduction

Each set of policy measures (which are separated into individual scenarios in the forthcoming sections) are combined to form a single estimate of impacts when all policies are introduced together. Below we present two sets of results; one with additional tax revenues recycled into additional government investment, and another without any recycling of these revenues (e.g. they are used to pay down debt, with no macroeconomic impacts).

Material consumption

Overall, economy-wide material consumption is 35 000 kt lower compared to the baseline by 2035 (Figure 3.1), when all resource productivity and waste policies are combined. The largest reductions are in food, feed and construction minerals. These decreases are driven by the policies included in the food and construction regulatory scenarios. As revenues are recycled into additional government investment, with no rebound in material consumption, the material consumption impact is the same with or without the revenue recycling.

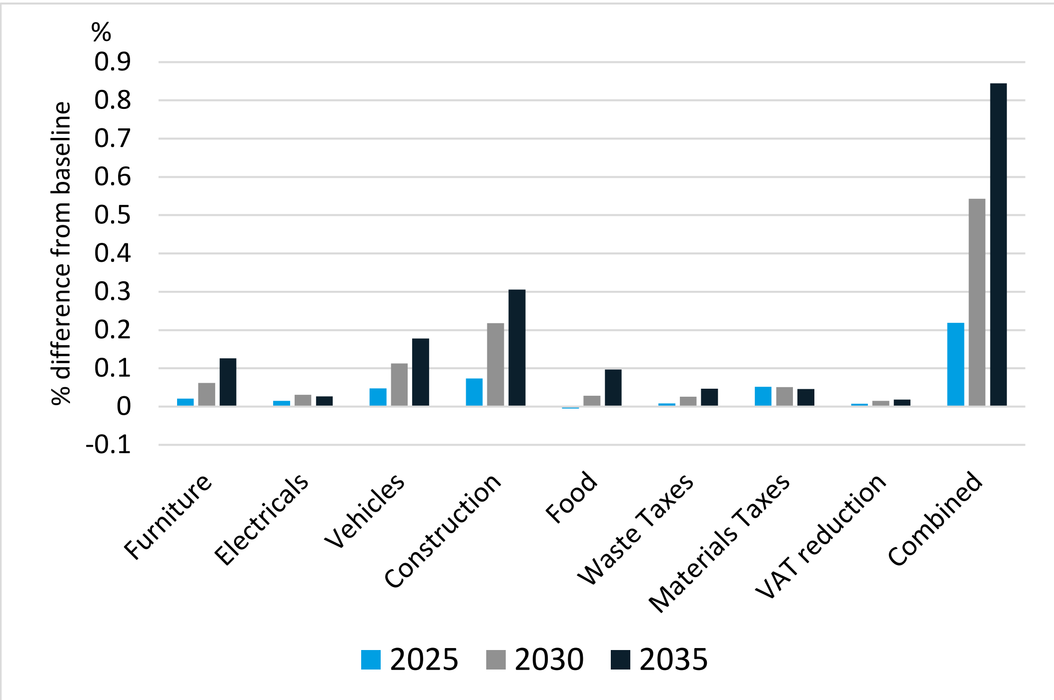
Figure 3.1 Material consumption impacts by material type, 2035, Combined scenario



Economic impacts

All the resource productivity and waste measures together result in close to a 0.9% increase in GDP by 2035 (see Figure 3.2). With revenues recycled, all the resource productivity and waste measures contribute some positive GDP effect to the total. The largest effect come from the policies in the construction and vehicles sectors. The main reason for these positive impacts is the reduction in costs in the affected industries, which increases demand. There is also a shift in consumer spending away from goods with a high import content,

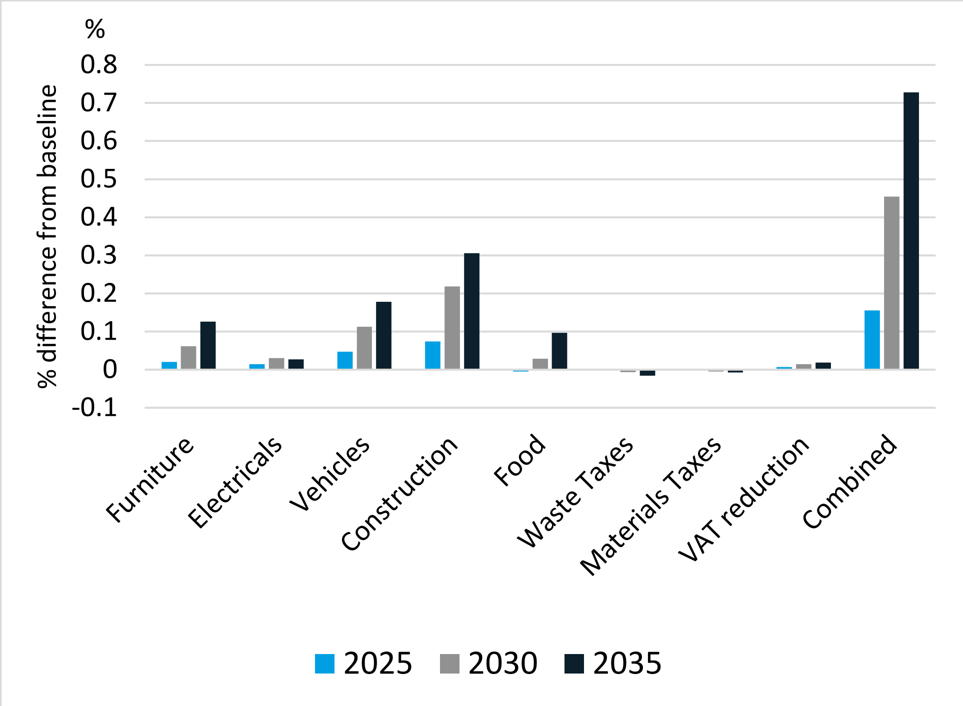
Figure 3.2 GDP impacts with revenue recycling by policy group



and towards those with a lower import content, which improves the balance of trade and therefore GDP.

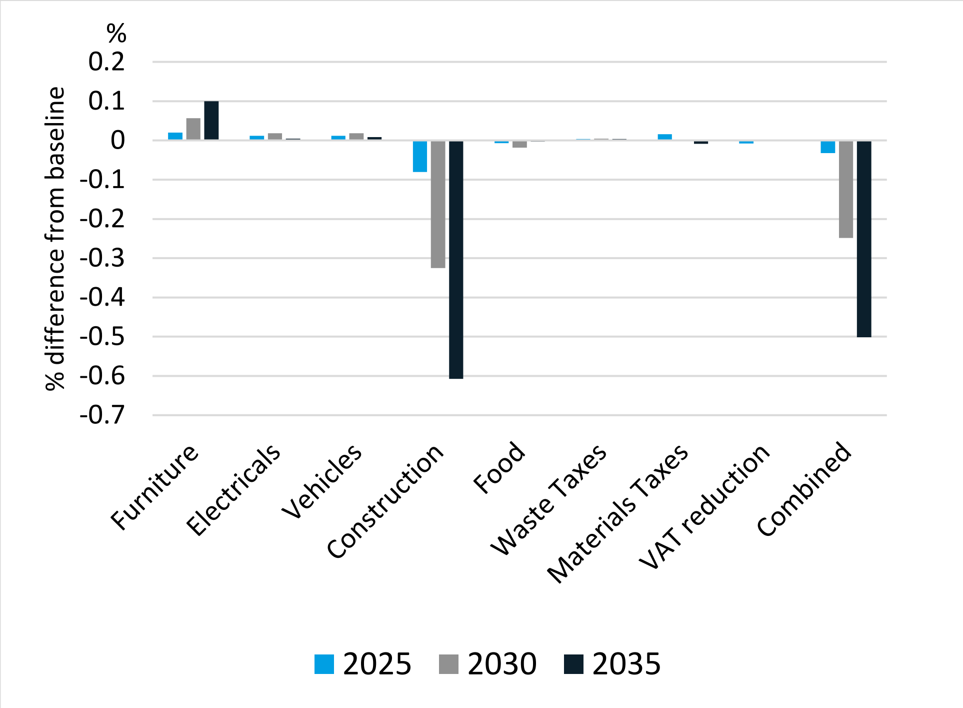
If the impacts of revenue recycling are removed, the GDP effects linked to the waste and materials tax measures become slightly negative (see Figure 3.3). As a result, the total GDP effect decreases to a 0.7% increase above baseline in 2035.

Figure 3.3 GDP impacts without revenue recycling by policy group



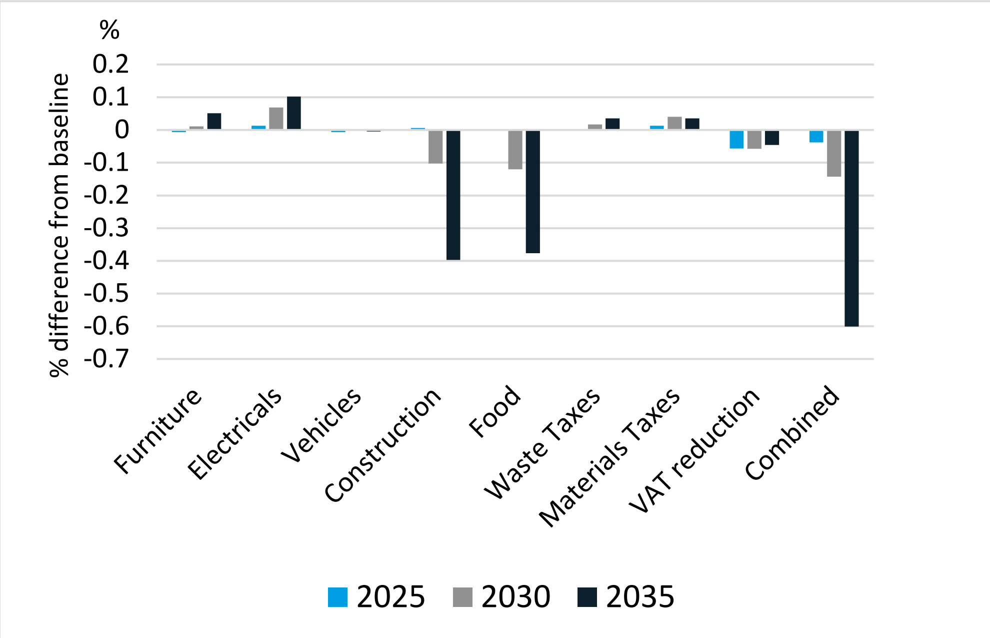
The effect of the combined resource productivity and waste measures on employment are negative by 2035 (see Figure 3.4). This is because lower use of resources leads to lower gross output across the targeted sectors, which reduces demand for labour. The measures affecting the construction sector have the largest negative impact on employment, linked to the scale of the change introduced by the measures. In the construction resource productivity scenario, there is a 50% reduction in the construction sector's use of all products as a result of the introduction of embodied carbon standards. This leads to a substantial negative employment impact in the construction sector's supply chain. If we take out the revenue recycling from the waste and materials taxes, it does not change the overall employment impacts. This is due to the relatively small volume of revenues raised, which do not notably change the macroeconomic results when redistributed.

Figure 3.4 Employment impacts with revenue recycling by policy group



The effect of all the resource productivity and waste measures on consumer prices is negative by 2035 (see Figure 3.5); economy-wide average prices are pushed down by 0.6% compared to the baseline. Most of these effects come from the measures in the construction sector – the costs faced by the construction industry fall due to the substantial reduction in material consumption. Some of these cost savings are passed on in final product prices and so the impact feeds through to industries which use construction services and ultimately consumers. Revenue recycling has a minimal impact on price levels.

Figure 3.5 Consumer price impacts with revenue recycling by policies



Differences from previous analyses

There are a number of previous studies that have assessed the socioeconomic impacts of improved resource productivity, including those that have applied E3ME. Cambridge Econometrics carried out resource productivity scenario analysis in 2014 and 2018 for the European Commission[21]. In those analyses, meeting resource productivity targets increased overall employment, as compared to the negative employment results in the current analysis, when all scenarios are combined.

These different outcomes principally rest on different scenario assumptions. In the current analysis, a decreased demand for virgin materials is assumed, while in the 2014 and 2018 studies, there is also an increased demand for recycled products, which creates extra positive macroeconomic and employment effects. In addition, in the scenarios modelled for this study, the scale of material efficiency improvements in some sectors (in particular, the construction sector) was much larger, leading to larger reductions in demand (and thus, output and employment) in the associated supply chain. Finally, the method of recycling of additional tax revenues was also different. In the 2014 study, additional tax revenues were offset by reductions in labour taxes, which lead to higher overall employment (through increasing labour market participation, reducing industry labour costs and boosting household consumption) in a more direct way than in the current analysis, where it is assumed that additional revenues are used to fund additional government investments.

3.3 Policies to reduce food and drink waste

Food and drink wastage

Around 20% of total UK GHG emissions are associated with the production[22] and consumption of food and drink, but a proportion of these emissions could be avoided if edible food did not go to waste. WRAP estimate that around 9.5 million tonnes of food and drink wastage was generated in the UK in 2018[23], and annually 70% of food and drink wastage arises from households, 16% comes from the food and drink manufacturing sector, 12% is produced by the hospitality sector while the remaining 3% comes from the retail sector[24]. Of the food and drink purchased by households, 20-25% of food is wasted, most of which is avoidable[25] and this costs the average household around £700 a year[26]. Introducing resource productivity measures which address food and drink waste could have a major impact on both the total material consumption of the UK, and total GHG emissions. Green Alliance estimates that policies to address resource productivity in food and drink could reduce carbon emissions by a total of 24 MtCO2e between 2023 and 2032, reducing the

[21] Cambridge Econometrics - BIO Intelligence Service (2014) 'Study on modelling of the economic and environmental impacts of raw material consumption'. Available at: https://ec.europa.eu/environment/enveco/resource_efficiency/pdf/RMC.pdf

Cambridge Econometrics et al. (2018) 'Impacts of Circular Economy Policies on the Labour Market'. Available at: Circular-Economy-DG-Env-final-report.pdf (camecon.com)

[22] I.e. agriculture and manufacturing

[23] UK progress against Courtauld 2025 targets and UN Sustainable Development Goal 12.3 | WRAP

[24] food- surplus-and- waste-in-the- uk-key-facts-oct-21.pdf (wrap.org.uk)

[25] As opposed to unavoidable food waste, for example fruit peel or eggshells.

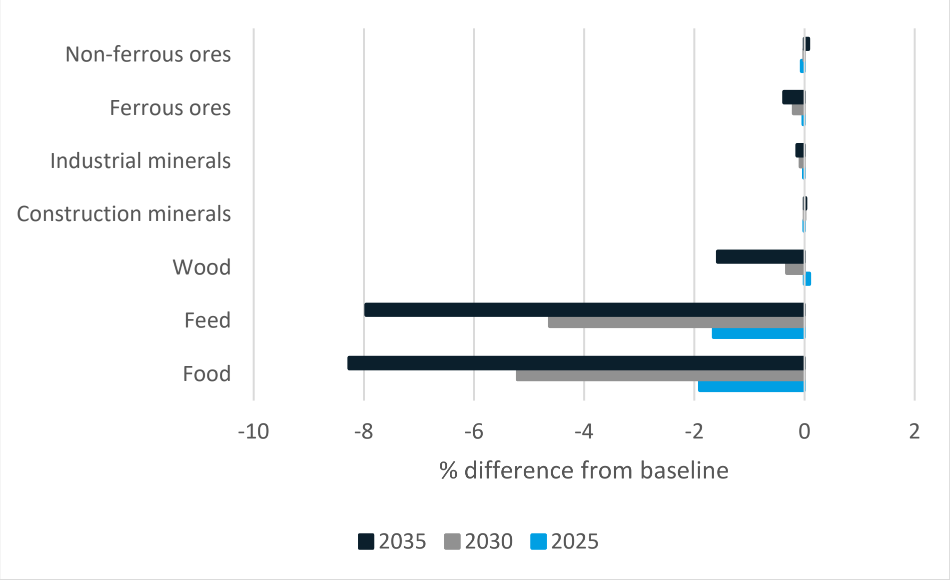
[26] Household food waste in the UK, 2015 | WRAP

emissions overshoot by 16% in the fourth carbon budget and more than 12% in the fifth[27]. Most of this reduction could be achieved through policies to address food wastage, in particular from households. With the help of government intervention, some progress has been made in reducing food waste across both households and businesses in recent years; between 2007 and 2018 food and drink waste fell by 15%. However, the volume of food and drink wasted remains a considerable problem and the current Government has pledged to reduce wastage further[28]. In this analysis we have examined the effects of policies to encourage behaviour change in consumers' purchasing decisions, and regulatory policies to improve resource productivity in the food and drink manufacturing sector.

Material consumption

This scenario comprises a reduction in the demand for food and feed products, resulting from consumer behaviour change, improved demand forecasting and ordering and regulatory measures. Demand is assumed to decrease by over 8% compared to the baseline by 2035 (see Figure 3.6).

Figure 3.6 Material consumption impacts by material type, Policies in food and drink sector



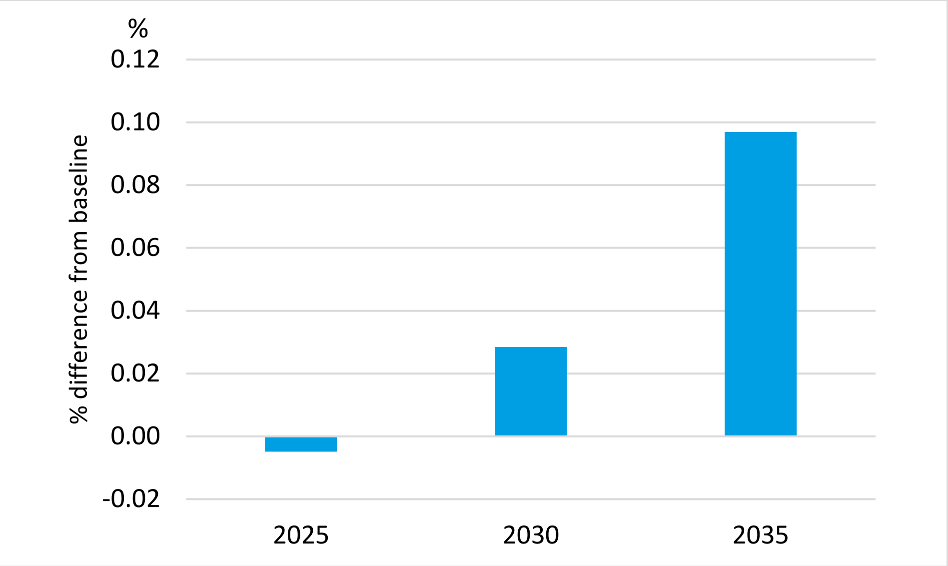
Economic impacts

In this scenario, there is a small positive GDP impact of 0.1% above baseline by 2035 (see Figure 3.7). The improved resource productivity reduces industry costs, due to better stock control. This reduces costs faced by households, and ultimately increases their spending power, which drives the small increase in GDP.

[27] Less_in_more_out.pdf (green-alliance.org.uk)

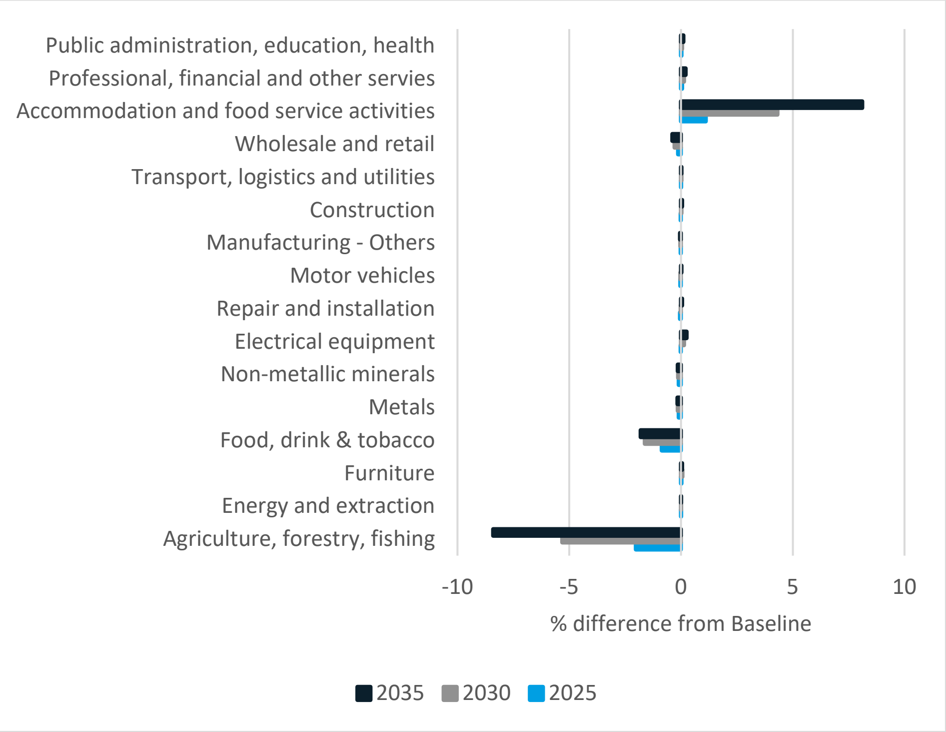
[28] Resources and waste strategy: at a glance - GOV.UK (www.gov.uk)

Figure 3.7 GDP impacts, Policies in food and drink sector



The largest increase in value added is in the accommodation and food services sector (see Figure 3.8), which accounts for 1.7% of the total GVA in 2020. This is because there is a substantial reduction in the intermediate purchases of the industry, reflecting the improved stock control, which decreases its costs without impacting on output. As a consequence of the reduction in spending on food and feed materials, and efficiency improvements in food and drink manufacturing processes, the value added of the Agriculture, forestry and fishing sector falls by over 8% compared to baseline by 2035. The sector accounts for 0.7% of total GVA in 2020, so changes in output in this sector do not shift total economy-wide output substantially.

Figure 3.8 Value added impacts by sectors, Policies in food and drink sector



3.4 Policies to increase resource productivity in the Construction sector

Resource productivity in construction

The construction sector is the largest single consumer of material resources[29] and generates by far the largest share of all waste in the UK. In 2018, 62% of all of the UK's waste could be attributed to the construction, demolition and excavation sector[30]. While there are high rates of recycling within some construction materials - for example the recovery rate for non-hazardous construction and demolition waste was around 92% in 2018 - much of this is 'downcycling', for instance, when waste is used to fill holes on building sites which is inefficient in terms of the energy originally used to create the materials[31]. A huge amount of embodied carbon exists in any construction project since many of the materials used in construction are energy-intensive to manufacture, for example cement or steel. Research published by Green Alliance estimates that by addressing resource productivity in construction, through measures to encourage design optimalisation, the reuse of materials and substituting high-carbon materials with low-carbon materials, the UK could reduce its carbon emissions by 79 MtCO2e between 2023 and 2032, reducing the emissions overshoot by more than 50% in the fourth carbon budget period and by 40% in the fifth[32].

Developments within the construction industry such as digitalisation of processes, innovative construction materials & techniques and off-site manufacturing all offer opportunities for increased resource productivity, and the current Government wants to encourage the sector to capitalise on these new opportunities to both meet net zero and to reduce waste[33]. Adoption of new materials, techniques and supply chain structures can be encouraged through embodied carbon standards and targets, as modelled in this analysis.

Material consumption

In this scenario, there is an assumption of a 50% decrease in the construction sector's use of all products. This results in a significant decrease in all material consumption across the economy as a whole, in particular industrial minerals (over 5%) and wood (over 6%) by 2035 (see Figure 3.9).

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[29] First steps towards a circular built environment - Arup

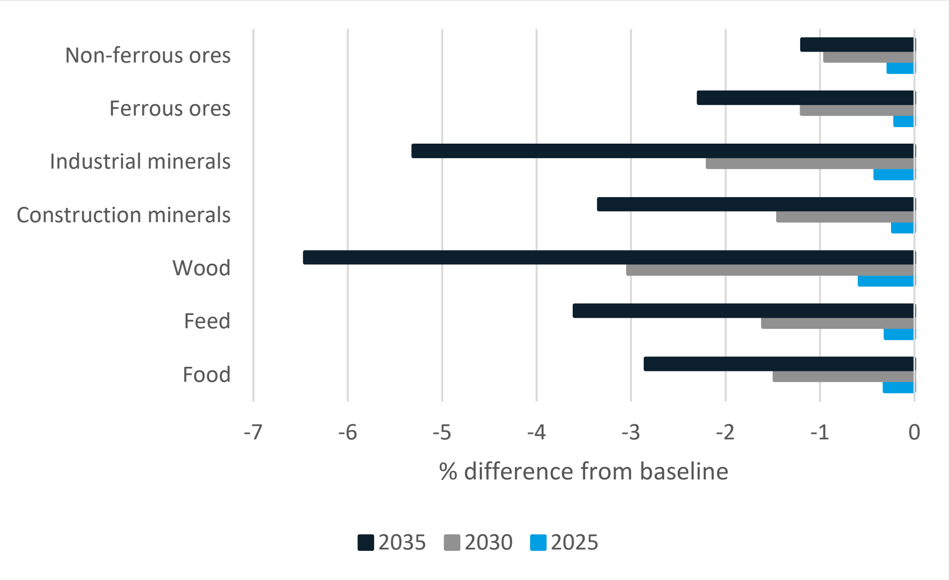
[30] UK Statistics on Waste (publishing.service.gov.uk)

[31] Waste Prevention Programme for England consultation document.pdf (defra.gov.uk)

[32] Less_in_more_out.pdf (green-alliance.org.uk)

[33] Waste Prevention Programme for England consultation document.pdf (defra.gov.uk)

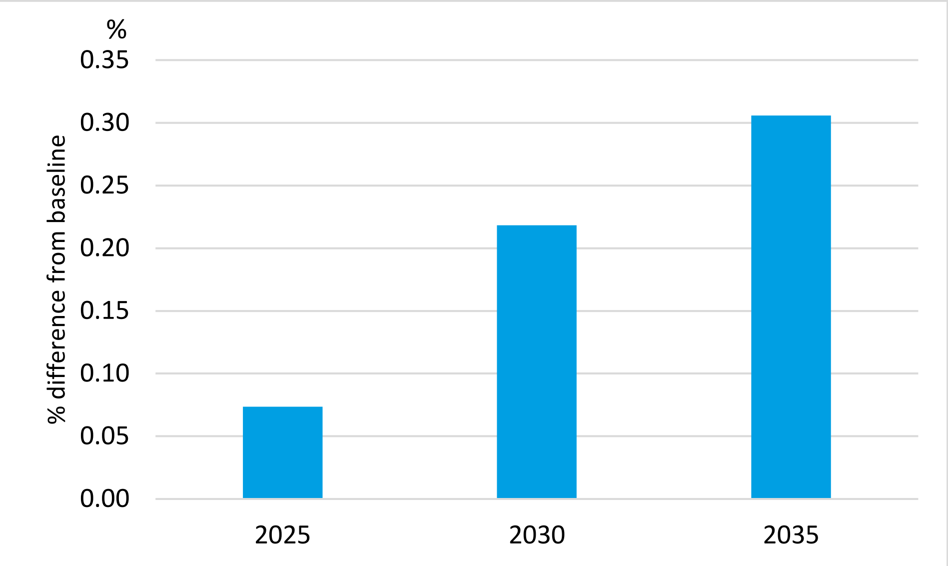
Figure 3.9 Material consumption impacts by material type, Policies in construction sector



Economic impacts

As a result of the increased resource productivity in this scenario, GDP is increased. Reduced demand for raw materials in the construction sector cuts costs considerably[34] leading to increases in demand, profits and economic output. By 2035, GDP is 0.3% higher than in the baseline (see Figure 3.10).

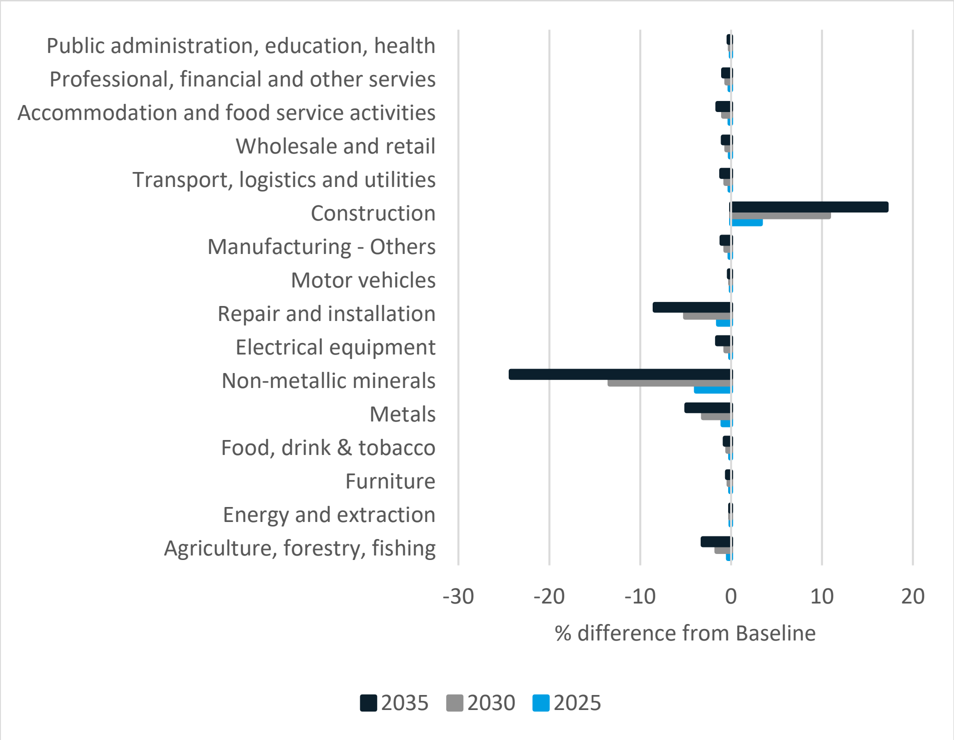
Figure 3.10 GDP impacts, Policies in construction sector



[34] The scenario inputs in this case include a reduction in raw material consumption that cuts costs and reduces demand, output and employment in the associated supply chain. We do not take account of any possible more labour-intensive processes for specialised bespoke design of buildings, for example, which could offset some of the negative employment effects we see in the construction sector supply chain.

In this scenario, value added of the construction sector is over 15% higher in 2035 compared to baseline (see Figure 3.11), which sector accounts for 6.5% of the total GVA in 2020, so substantial changes in this sector can lead to changes at the whole-economy level. This results from decreasing material consumption, which cuts industry unit costs, meaning that margins (and therefore value added) can increase. Despite this, gross output decreases in this sector due to reduced purchases of intermediate construction goods and services. The largest decrease in value added is in manufacturing of non-metallic minerals (by around 25% compared to baseline by 2035), which directly results from the reduction in demand from construction sector. The manufacturing of non-metallic minerals accounts for 0.3% of the total GVA in 2020 so changes in this sector will not have large impacts on the economy as a whole.

Figure 3.11 Value added impacts by sector, Policies in construction sector



3.5 Policies to increase resource productivity in the Vehicles sector

Introduction to the sector

From the mining of ores and minerals, the production of metals and components, the transport of materials and to final assembly, all stages of the vehicle production process add to the high levels of emissions embodied within a vehicle before it leaves the manufacturing plant. Car transport remains the most common mode of transport in the UK, with 58% of trips made by car in 2020[35]. As well as 85% of households having access to a car or van, the proportion of households with access to more than one car or van has also been increasing, from 8% in the early 1970s to 35% in 2019[36], partly driven by greater affordability of vehicles. Despite growing demand for larger, less efficient vehicles, the average occupancy of a vehicle on any given trip is

[35] National Travel Survey: 2020 - GOV.UK (www.gov.uk)

[36] Transport Statistics Great Britain: 2019 (publishing.service.gov.uk)

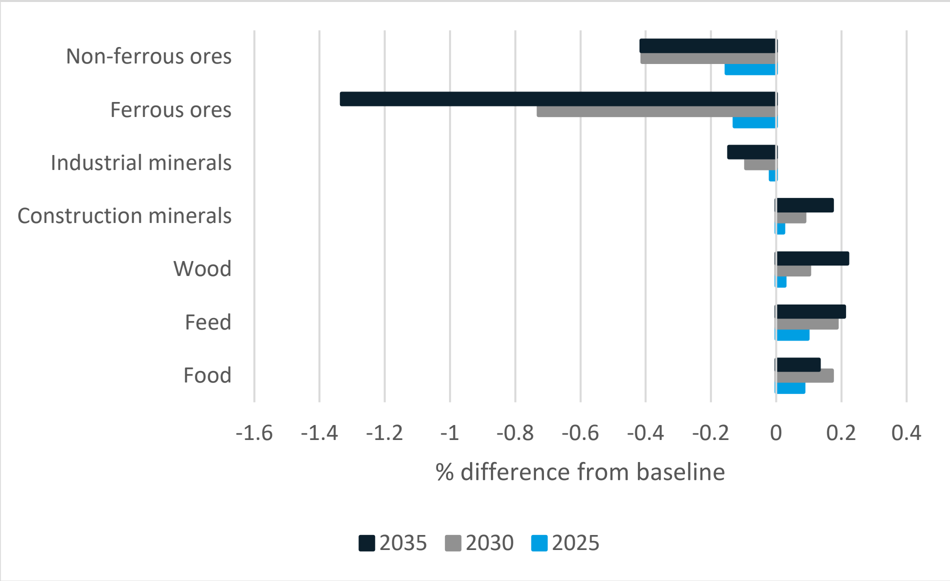
just 1.5 passengers, with 65% of all trips taken by a lone driver. More encouragingly, the market for second-hand cars is strong in the UK[37], and new business models such as ride sourcing and car sharing are growing in popularity[38].

Increasing resource productivity associated with vehicles requires addressing the use of materials in the manufacture of vehicles, while also addressing the demand for vehicles. In this analysis, policies to improve resource productivity such as car-sharing initiatives, consumer information campaigns and extended producer responsibility are modelled.

Material consumption

In the vehicles scenario, there is a reduction in the motor vehicles industry purchases of other metals. This leads to a decrease in use of ferrous ores (by around 1.5% by 2035 compared to baseline, see Figure 3.12), and a decrease in non-ferrous ores and industrial minerals use (by around 0.4% by 2035 compared to baseline).

Figure 3.12 Material consumption impacts by material type, Policies in vehicles sector



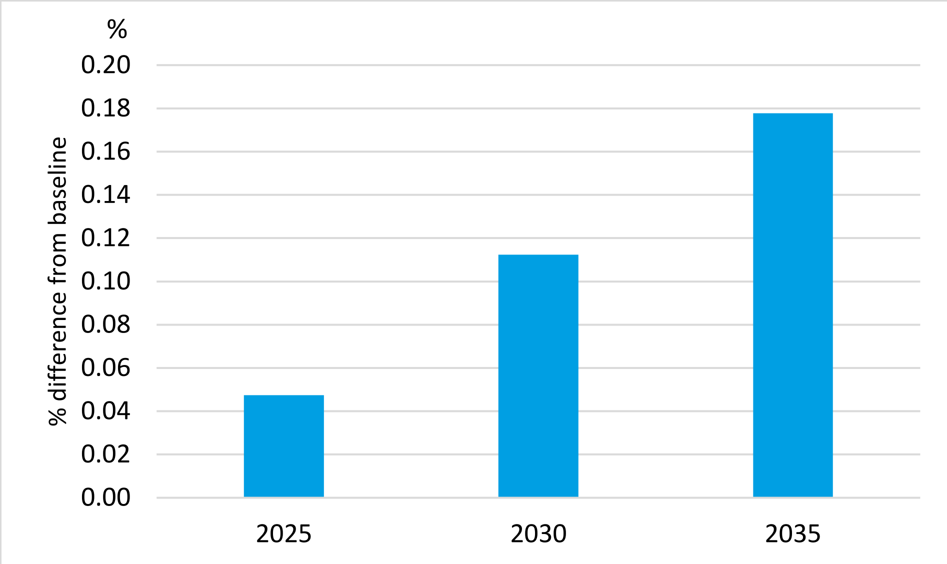
Economic impacts

There is a small positive effect on GDP which increases over time, reaching 0.18% by 2035 in the vehicles scenario (see Figure 3.13). This is a result of the reduction in imports of vehicles and metals, more efficient manufacturing processes and greater investment.

[37] Just over 5.9m used cars were bought in the UK between January-October 2021 (Used Car Sales Data - SMMT quarterly data archive), compared to 1.4m new cars in the same period (UK new car registration data, UK car market - SMMT).

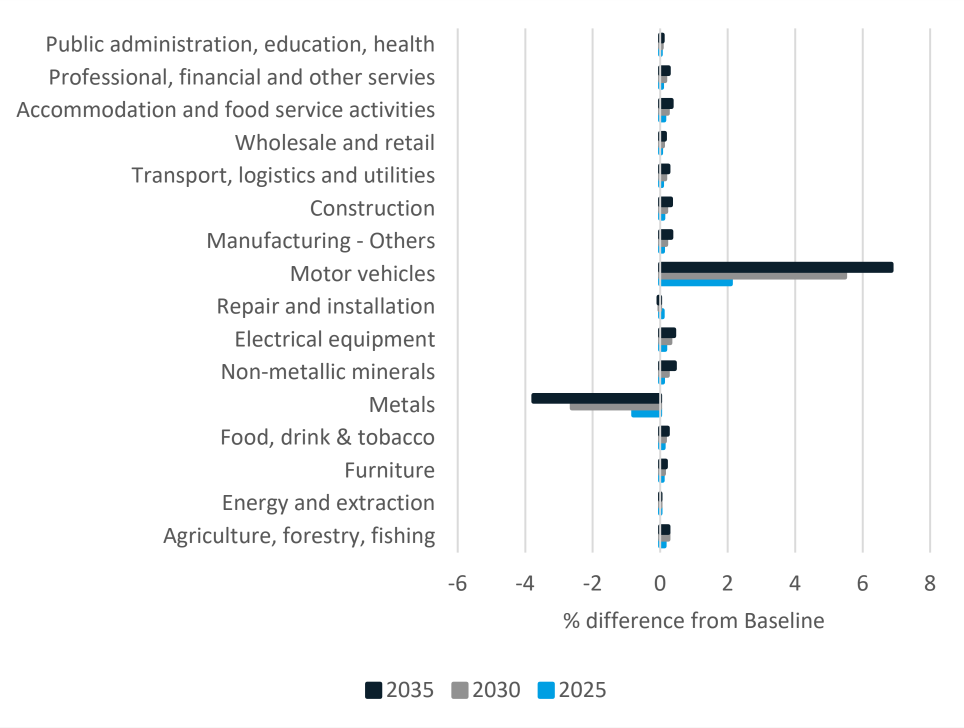
[38] Future of Mobility Review of the UK passenger road transport network (publishing.service.gov.uk)

Figure 3.13 GDP impacts, Policies in vehicles sector



The largest increase in value added in the vehicles scenario is in the manufacturing of motor vehicles (more than a 6% increase by 2035 compared to baseline, see Figure 3.14). This sector accounts for 0.8% of the total GVA in 2020, so changes in this sector will not have large impacts on the economy as a whole. While there is a decrease in gross output due to the reduction in material inputs required and efficiency improvements in the manufacturing process, leading to a reduction in industry costs. The largest decrease in GVA is in the metals sector (almost 4% by 2035 compared to baseline), due to the reduction in use of metals for the manufacture of vehicles, as well as a reduction in consumer demand for vehicles resulting from car-sharing initiatives. The metals sector accounts for 1% of the total GVA in 2020, which implies that impacts in this sector alone will not be substantial in the wider-economy context.

Figure 3.14 Value added impacts by sector, Policies in vehicles sector



3.6 Policies to increase resource productivity in the Electricals sector

Resource productivity in the electrical sector

The electricals sector has a substantial impact on the environment, both in terms of resources used in the production of, and the emissions embodied in, electrical products, and in terms of the volume of waste created. In the UK, the total lifecycle emissions attributed to all electrical items purchased each year is 196 MtCO2e[39], while at the same time large volumes of electrical waste are generated annually; for example in 2015 over 1.5m tonnes of electrical waste was disposed of[40]. However, research by WRAP indicates that nearly 25% of electronics disposed of (either via landfill or recycling) are suitable for reuse and that 55% of people would be willing to buy used items instead of new. Green Alliance research indicates that improving resource productivity in the electrical sector, through reducing material consumption in manufacturing, increasing remanufacturing and encouraging the reuse of electronics and sharing initiatives, could cut carbon emissions by 16 MtCO2e between 2023 and 2032, reducing the emissions overshoot by 11% in the fourth carbon budget and 8% in the fifth[41]. In our modelling assessment, we evaluate the economic impacts of policies aimed at improving resource productivity in the electrical sector including eco-design standards for electricals to increase product lifetimes, extended producer responsibility, kerbside collections and consumer information campaigns.

Material consumption

There is a reduction in use of ferrous and non-ferrous ores and industrial minerals in this scenario, reflecting the assumed lower production of electronic goods. The increase in food and feed reflects the shift in consumer spending

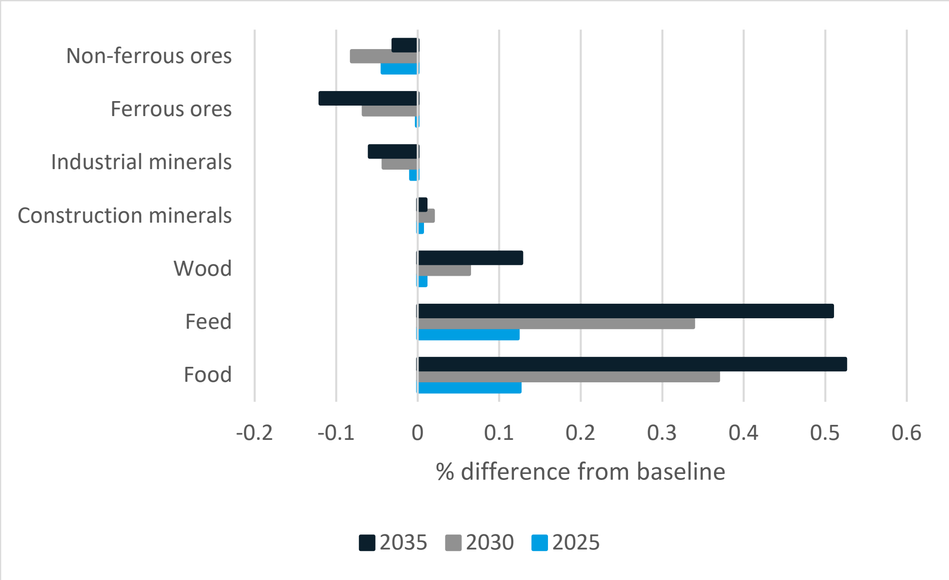
[39] Switched on to value: Powering business change | WRAP

[40] Ibid.

[41] Less_in_more_out.pdf (green-alliance.org.uk)

away from electrical goods and towards other goods and services (see Figure 3.15).

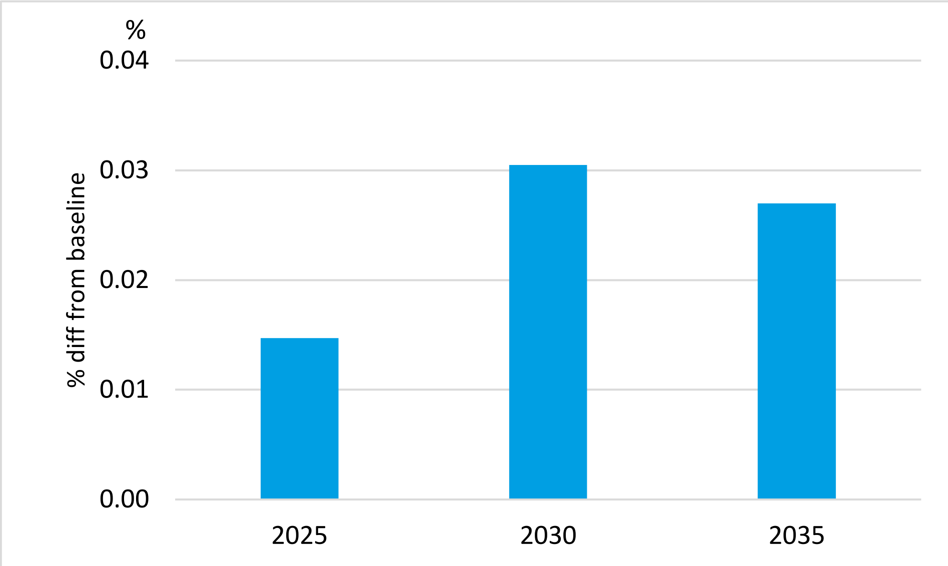
Figure 3.15 Material consumption impacts by material type, Policies in electricals sector



Economic impacts

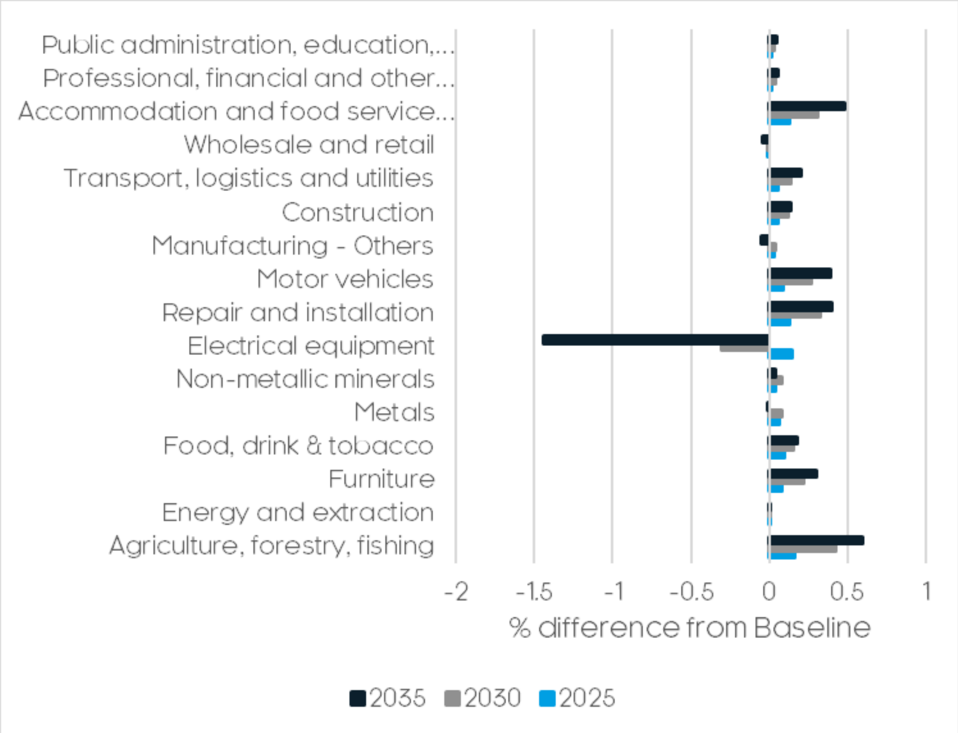
In this scenario, there is a shift in spending patterns by households. Due to the shift in spending away from electronic goods (with a relatively high import content), and towards services and other goods with a lower import content, the UK's trade balance improves resulting in a slight increase in GDP compared to baseline (see Figure 3.16).

Figure 3.16 GDP impact, Policies in electricals sector



The largest fall in sectoral GVA is in electrical equipment (almost 1.5% by 2035, see Figure 3.17), and reflects the reduced demand for new electrical equipment. The electrical sector accounts for 0.3% of the total GVA in 2020, so changes in this sector will not have large impacts on the economy as a whole. The largest increase in value added is in the accommodation and food service sector (around 0.5% higher than baseline by 2035), and it is a result of shifts in consumption towards this sector. The food service sector accounts for 1.7% of the total GVA in 2020, so changes in this sector alone will not have large impacts on the economy as a whole.

Figure 3.17 Value added impacts by sectors, Policies in electricals sector



3.7 Policies to increase resource productivity in the Furniture sector

Extended producer responsibility for the furniture sector

The Resources and Waste Strategy for England identifies bulky waste (of which 42% is furniture[42]) as a priority waste stream to target with extended producer responsibility (EPR) and product standards, in a bid to encourage resource productivity[43]. Research by WRAP in 2012 estimated that over 20% of furniture collected at the kerbside could be reused in its current condition, while a further 25% could be reused with slight repair. Meanwhile, around 50% of the furniture collected at household waste and recycling centres could be as reused in its current condition or with slight repair[44]. As well as using large amounts of resources such as wood and metals, the furniture sector also represents 1% of the UK's total carbon footprint on a consumption basis[45] Encouraging waste prevention in the furniture industry will not only reduce material consumption and reduce GHG emissions, but also reduces the risks of chemical pollution due to the high chemical content used in many items (e.g. fire retardants).

In our modelling, we examine the impacts of extended producer responsibility for furniture. An EPR scheme would place responsibility on producers of furniture for the waste generated by their products. In practice, an EPR scheme could lead to producers improving product design and durability

[42] Technical Report Standard FINAL (wrap.org.uk)

[43] Our waste, our resources: a strategy for England (publishing.service.gov.uk)

[44] Study into the re-use potential of household bulky items | WRAP

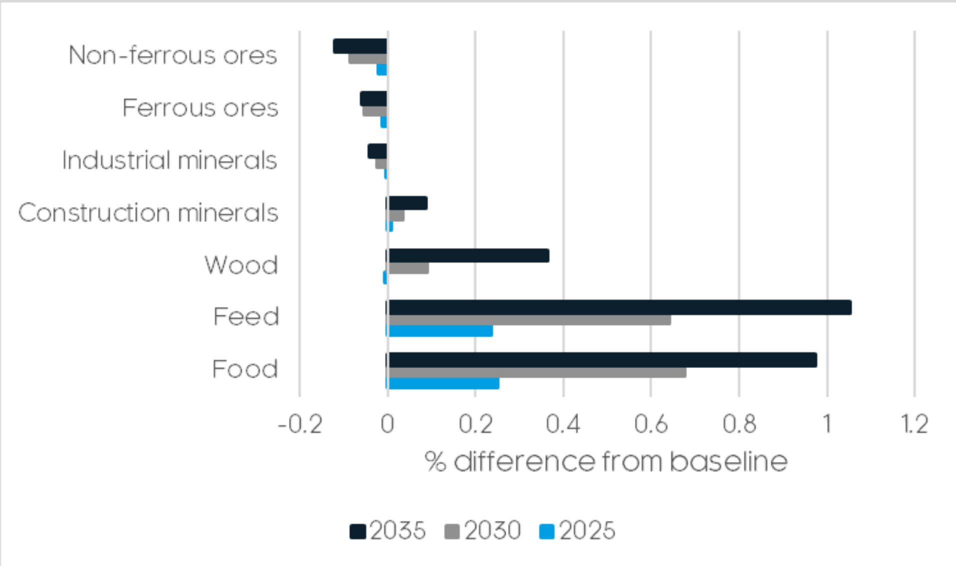
[45] Waste Prevention Programme for England consultation document.pdf (defra.gov.uk)

and/or establishing take-back or waste collection schemes, enabling furniture products to be recycled, repurposed or disposed of responsibly by the producer.

Material consumption

Due to cost increases in the furniture sector, there is a shift in consumer spending away from this category and towards products and services with a lower import content, which increases domestic economic activity. This increases the demand for some materials, like food and feed (see Figure 3.18)[46]. On the other hand, demand for some materials is decreasing, such as for ores and industrial minerals, as a result of the falling demand for furniture and through linked supply chains.

Figure 3.18 Material consumption impacts by material type, Policies in furniture sector

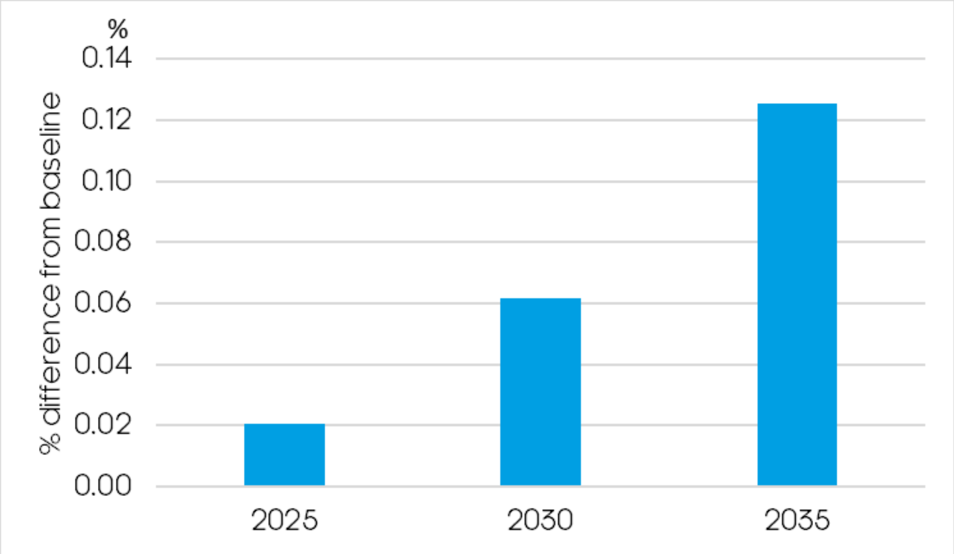


Economic impacts

There is a small positive impact on GDP which is increasing over time (see Figure 3.19). The reason behind this is the shift in spending away from furniture products, which has a relatively high import content, and towards services and other goods, which have a lower import content, thereby improving the balance of trade and boosting GDP.

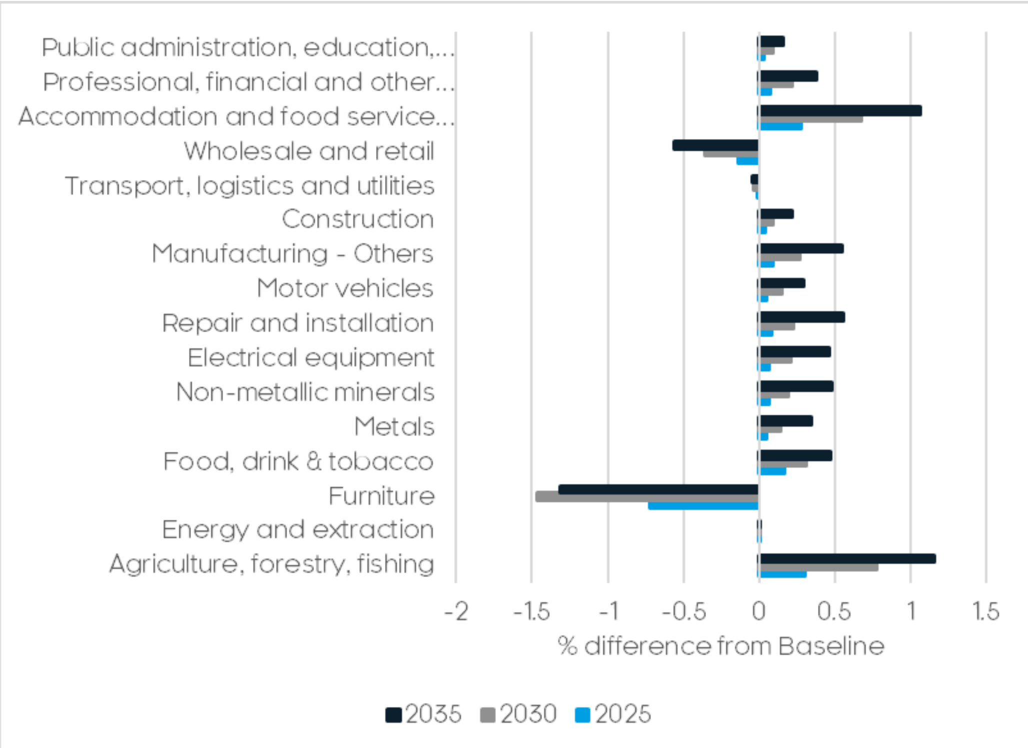
[46] One important caveat to these results is that Furniture manufacture is classified within a broader 'Other Manufacturing' sector in E3ME, and so the assumed changes to intermediate purchases of the furniture sector are based on the supply chain characteristics of this broader sector that is represented in the model. This explains why the model result for an EPR in Furniture does not show the expected negative impact on wood consumption, which is an important input to the manufacture of furniture, but not as important as a raw material in the context of the wider 'Other manufacturing' industry. The small increase in wood consumption in this scenario comes about due to induced effects (i.e. higher net income driving increases in demand for materials).

Figure 3.19 GDP impacts, Policies in furniture sector



The value-added results in this scenario also reflects the shift in consumer spendings (see Figure 3.20). The demand for furniture products decreases as a result of the increase in costs associated with the EPR scheme, thus the value added of the furniture sector is decreased, which accounts for 0.6% of the total GVA in 2020, so changes in this sector will not have large impacts on the economy as a whole. Consumer spending shifts instead to increased demand for accommodation and food services, which accounts for 1.7% of total GVA in 2020, as well as for agriculture and forestry fishing (0.7% of total GVA), resulting in an increase in the value added in these sectors. Although in most of the sectors there is a positive GVA impact, the changes are small which leads to relatively small impacts on the economy as a whole.

Figure 3.20 Value added impacts by sector, Policies in furniture sector



3.8 Policy to increase prices of virgin materials

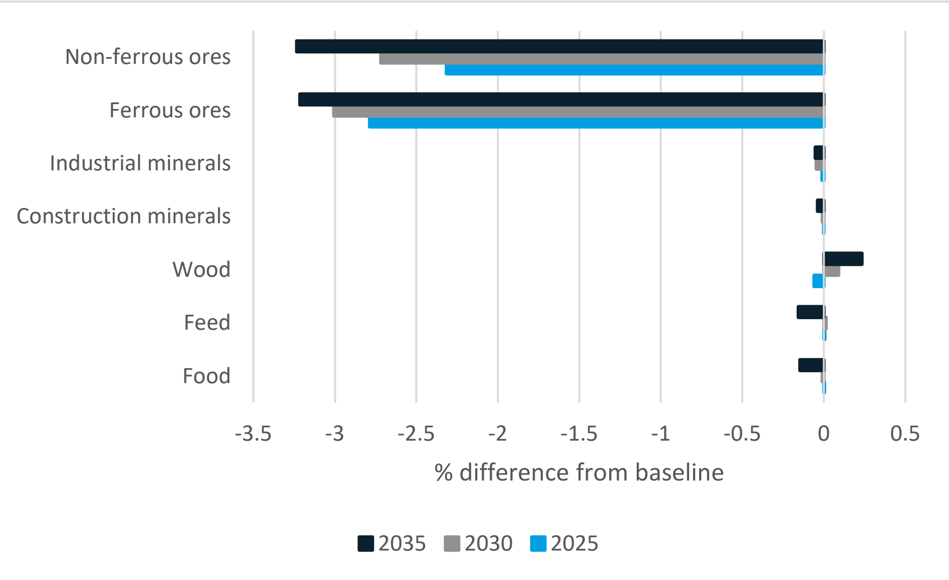
Introduction

Aggregate materials such as sand, gravel and rock are vital inputs for the construction industry, used for both building and maintaining infrastructure. However, there are many harmful impacts on the environment which result from the mining or dredging for these materials, such as the effects of land use change, loss of natural habitat, noise and air pollution. The extraction of virgin materials can be reduced, and instead the recycling of such materials encouraged, by increasing the price of virgin materials through measures such as the Aggregates Levy. To keep costs down, sectors which use these materials will be encouraged to either reduce the amount of materials used in production, or alternatively source cheaper, recycled materials. In this study we model the impacts of increased prices of aggregate materials and metallic ores. We also examine the impacts of simultaneous government investment in initiatives to further encourage the creation of a circular economy, such as industrial symbiosis schemes, whereby waste or by-products of one industry are used as inputs to another industry, local circular economy hubs[47] and direct financial support to recommerce businesses.

Material consumption

As a result of the assumed introduction of a materials tax, material consumption decreases. Due to substantial increases in taxes on ores, of 8 pp per year in real terms, the use of ferrous and non-ferrous ores is around 3% lower than baseline by 2035 (see Figure 3.21). There is a small increase in the aggregates levy compared to baseline, which drives a marginal reduction in the use of other minerals.

Figure 3.21 Material consumption impacts by material type, Policies of virgin materials



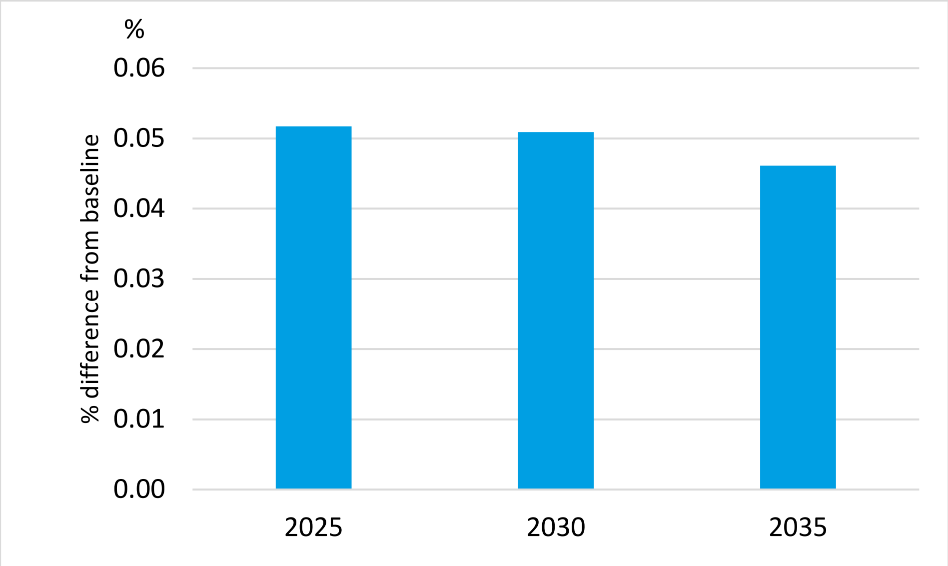
Economic impacts

The extra materials tax revenues are used to fund additional government investment. Although higher taxes decrease disposable income and increase

[47] These are physical spaces that provide resources and services to enable the development of circular economies, for example through networking and knowledge sharing, or a physical workspace for those investigating circular economy practises.

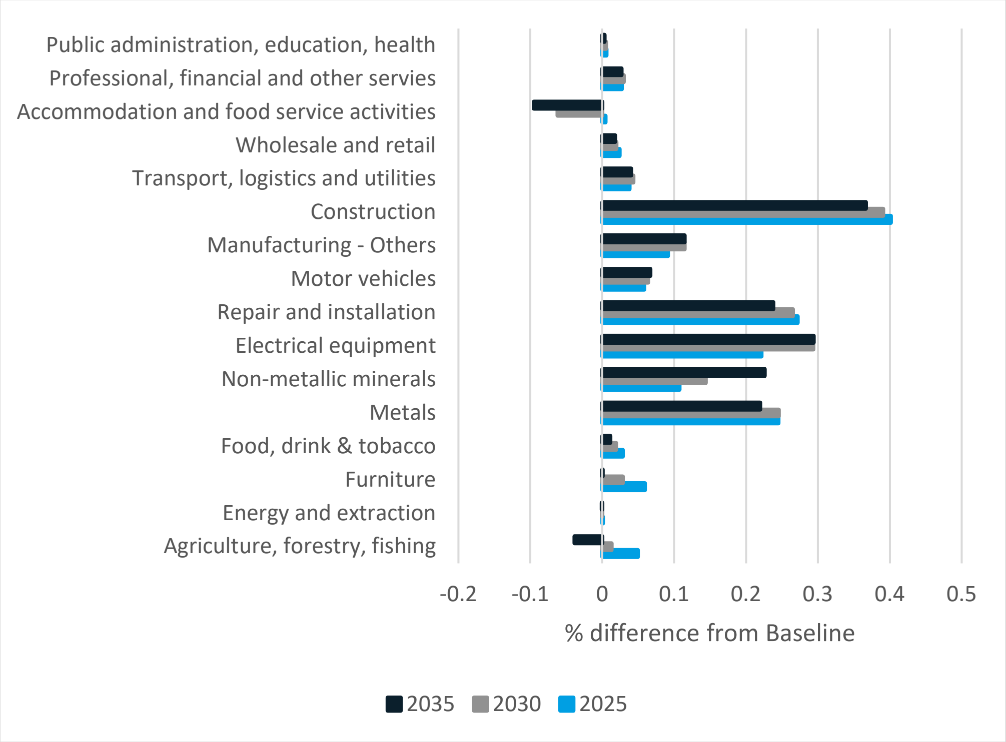
industry prices, the recycling of the revenues lead to small positive GDP impacts (see Figure 3.22).

Figure 3.22 GDP impacts, Policies of virgin materials



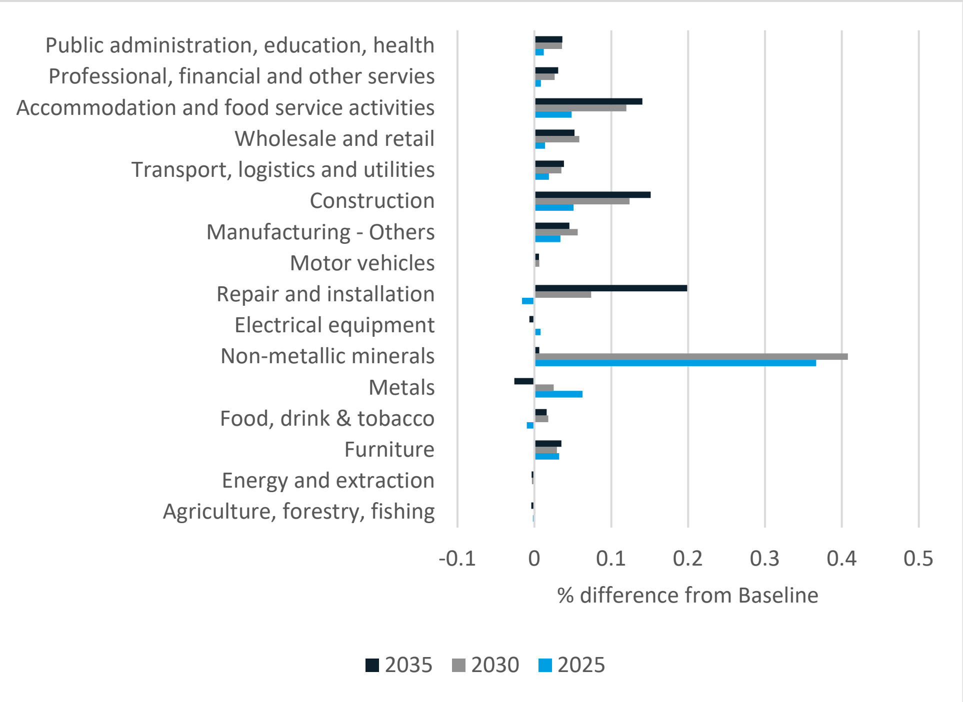
Domestic industries suffer from a loss of competitiveness due to higher prices of virgin materials which leads to higher costs, but this impact is more than offset by the effect of increasing public investment from recycling material tax revenues. The largest positive impact occurs in sectors which have high share in government investments, such as the construction sector, which accounts for 6.5% of the total GVA in 2020, where GVA is around 0.4% higher than baseline by 2035 (see Figure 3.23), as well as the electrical equipment sector which is 0.3% higher than the baseline (and 0.3% of the total GVA). While the electrical equipment sector is relatively small in terms of total GVA economy-wide, the construction sector is relatively large, therefore substantial GVA impacts in construction can lead to changes at the whole-economy level.

Figure 3.23 Value added impacts by sector, Policies of virgin materials



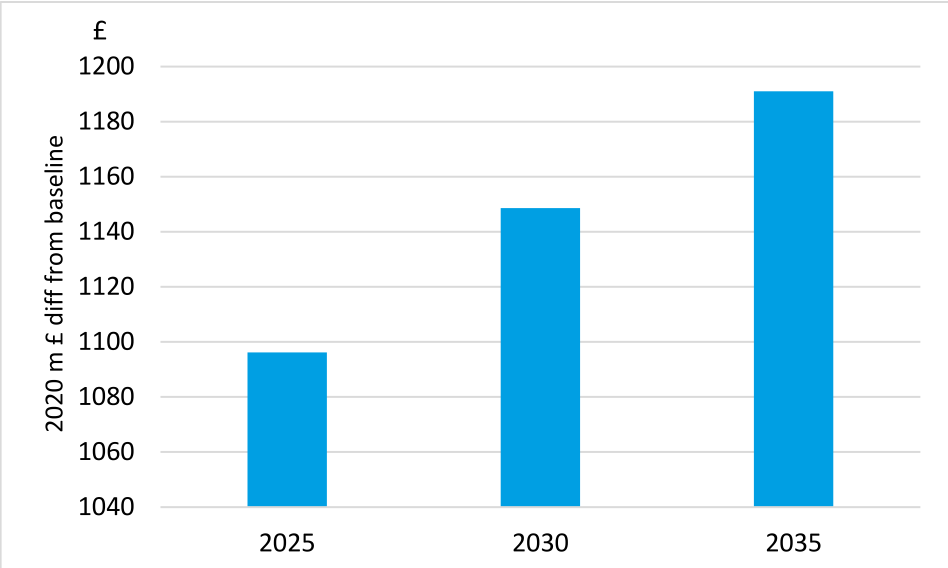
Industry prices increase in all sectors due to the materials tax increase. As expected, the highest increase is in non-metallic minerals in line with the tax raised on these materials (see Figure 3.24).

Figure 3.24 Industry prices impacts by sector, Policies of virgin materials



There is an additional £1.2bn in tax revenues in 2035 compared to baseline (Figure 3.25). These revenues are used to fund additional government investment, creating further positive economic effects.

Figure 3.25 Impacts on material tax revenues, Policies of virgin materials



3.9 Policy to increase prices of waste disposal

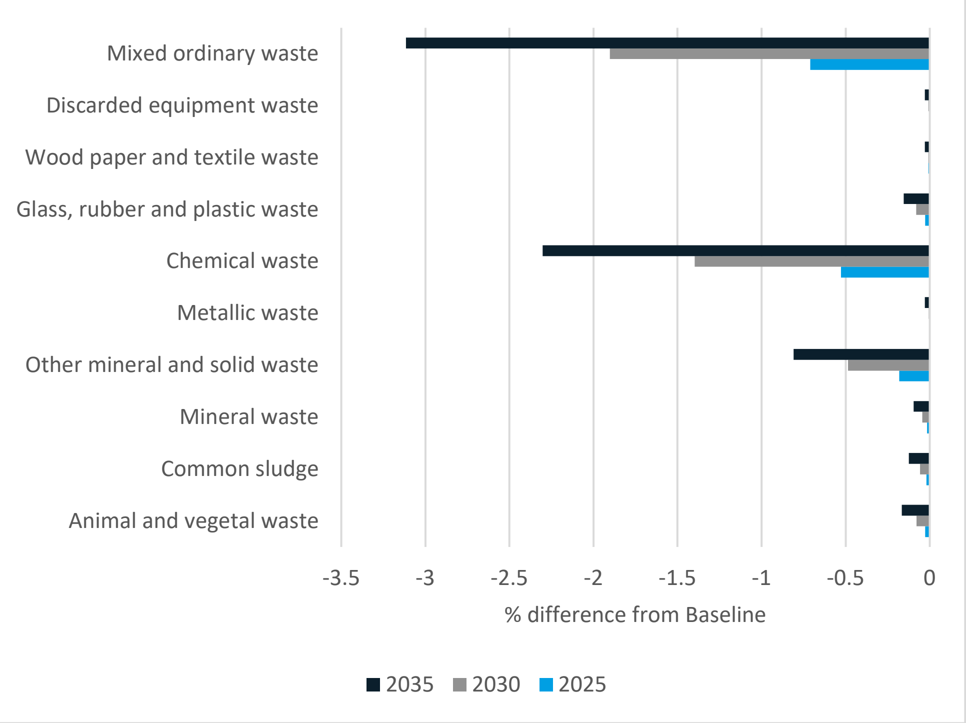
Introduction

Alongside the resource inefficiencies associated with disposing of waste via landfill, landfill sites also produce harmful emissions of methane and carbon dioxide. Increasing the price of waste disposal via landfill therefore acts as an effective incentive to increase the rate of reuse and recycling, to encourage a more circular economy and to reduce emissions. In our analysis, we examine the impacts of increasing the price of disposing of all material types via landfill, while simultaneously investing public funds in circular economy initiatives such as industrial symbiosis schemes, local circular economy hubs and direct financial support to recommerce businesses.

Waste generated

In the waste tax scenarios, there is an assumed increase in landfill taxes on all waste types. Minerals and construction minerals have smaller increases (2 pp per annum real increase) than the other types (8 pp per annum real increase). The waste generation results reflect the net impacts of the large reduction in waste to landfill (around a 10% reduction by 2035, see Figure 3.26), and a small increase in waste disposed of in other ways (incl. energy and other recovery). The waste generation impacts are largest in waste types where the share that goes to landfill is highest, such as mixed ordinary waste and chemical waste.

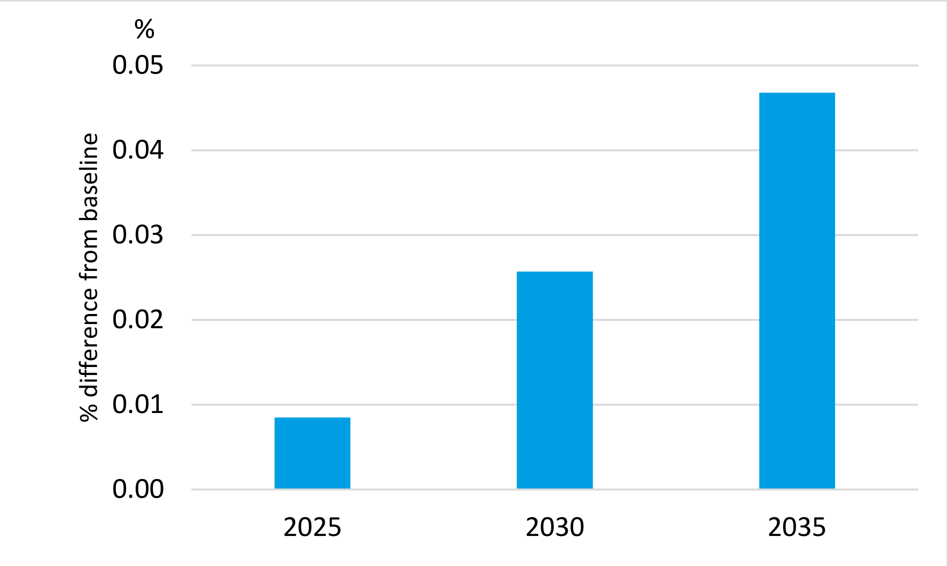
Figure 3.26 Waste generation impacts by waste type, Policies of waste disposal



Economic impacts

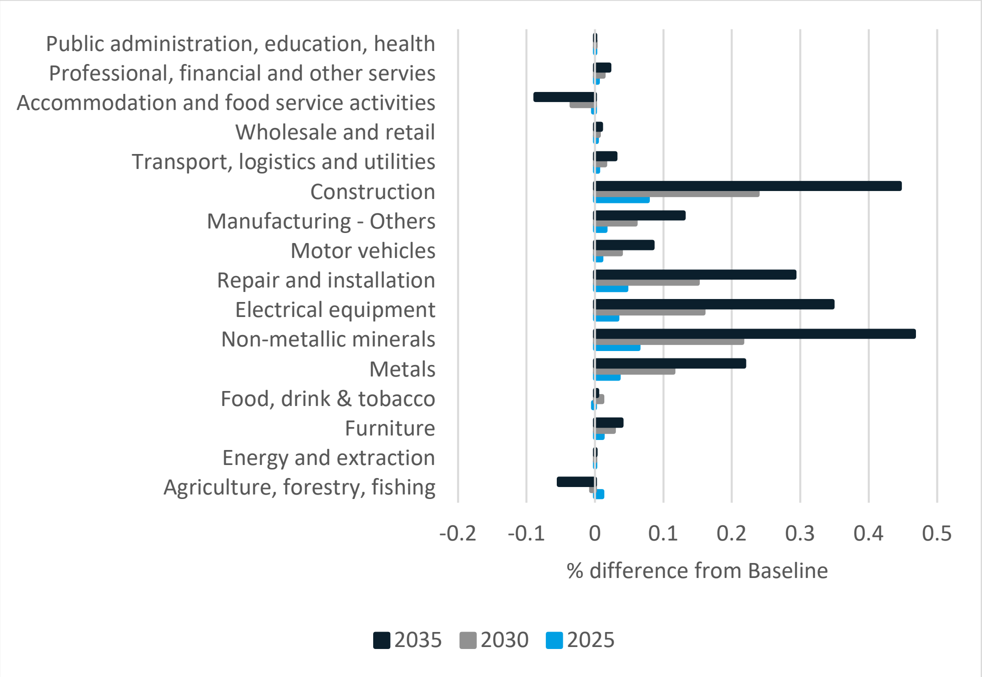
In the waste tax scenarios, industry prices increase, and as a result costs to consumers increase and real consumer expenditure falls, although these effects are offset by the recycling of the extra government revenues. These revenues are used to fund additional government investment, which boosts GDP and turns the net effect slightly positive in the scenario (see Figure 3.27).

Figure 3.27 GDP impacts, Policies of waste disposal



Domestic industries suffer from a loss of competitiveness due to the waste tax which leads to higher costs, but this impact is more than offset by the effect of increasing public investment from waste tax revenues. The largest positive impacts occur in sectors which receive a high share of government investments, such as the construction and non-metallic minerals sectors, where GVA is around 0.4-5% higher than baseline by 2035 (see Figure 3.28).

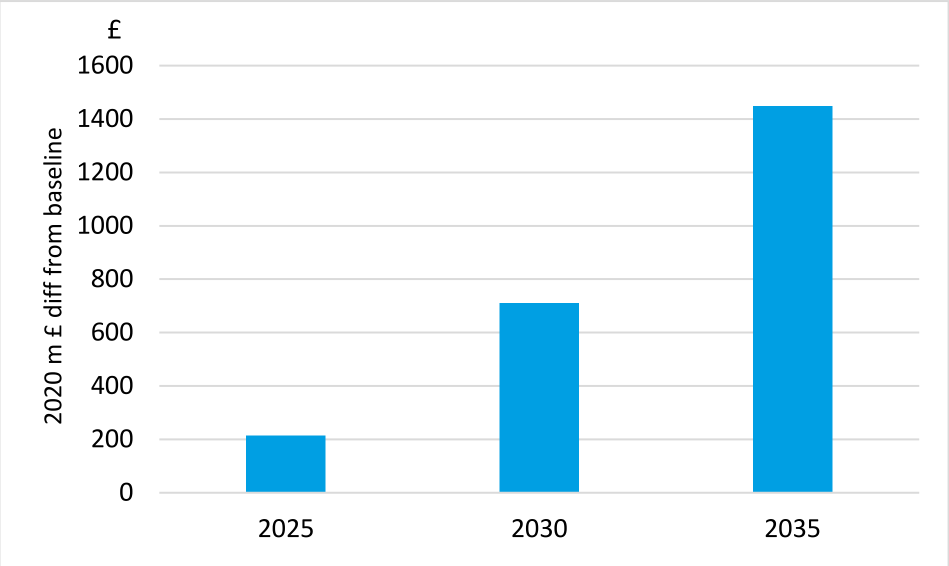
Figure 3.28 Value added impacts by sector, Policies of waste disposal



To give some context, the shares of total GVA in 2020 are 6.5% for construction and 0.3% for non-metallic minerals. While the non-metallic minerals sector is relatively small in terms of total GVA economy-wide, the construction sector is relatively large, therefore substantial GVA impacts in construction can lead to changes at the whole-economy level.

In the waste tax scenario, there is an additional £1.4bn revenue in 2035 compared to baseline (see Figure 3.29). These revenues are used to fund additional government investment, creating further positive economic effects.

Figure 3.29 Impact on waste tax revenues, Policies of waste disposal



3.10 Policy to increase prices of waste disposal and virgin materials, without revenue recycling

As discussed in the combined scenario results section, the additional waste- and materials tax revenues are recycled into additional government investment. These government investments are assumed to be targeted at circular economy initiatives such as industrial symbiosis schemes, local circular economy hubs and direct financial support to recommerce businesses. Since there is no rebound in material consumption or waste generation due to the circular-economy nature of the increased government investment, the material consumption results with or without revenue recycling are the same.

The macroeconomic impacts without the revenue recycling are lower than in the scenarios with revenue recycling, but not substantially. The reason behind this is the relatively small volume of revenues raised, which do not notably change the macroeconomic results when redistributed. However, the introduction of policy to increase the prices of waste disposal leads to a negative impact on GDP unless revenues are recycled. This is because without revenue recycling, the increased industry prices and resulting increased prices for consumers lead to reduced consumer expenditure. Revenue recycling offsets the fall in consumer expenditure, and there is a small boost to GDP instead.

3.11 Reduced VAT for repaired, refurbished or second-hand goods

Introduction

Repairing or reusing goods are key elements of a circular economy (see Figure 1.1) and are two of the key actions within the six ‘Rs’ of sustainability (see Figure 3.30), which could be considered by consumers before buying something new, and be prioritised before recycling. Before buying new or disposing of an item through recycling, a consumer could consider whether they can reuse an existing product instead; for example, could they use something for a different purpose (e.g. using a jam jar as a pen pot), or could they buy second-hand goods, such as second-hand clothes, instead of new. Similarly, before disposing of an item because it is damaged or faulty and replacing the item with something new, consumers could consider whether the damaged or faulty item could be repaired. A reduction in the VAT rate applied to repaired, refurbished or second-hand goods is a simple and effective way to lower the price of these products for consumers, creating more demand for them and therefore a bigger and more active marketplace. In this analysis we consider a reduced VAT rate for repaired, refurbished or second-hand goods in the furniture, electricals and construction sectors in particular.

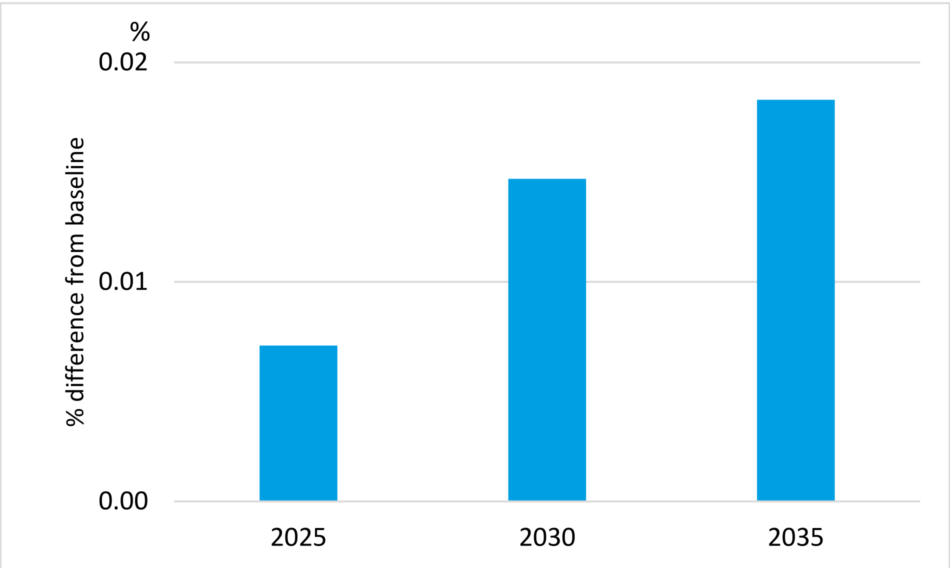
Figure 3.30 The 6 Rs of sustainability

Source: https://theveganreview.com/the-6-rs-of-sustainability-what-does-sustainable-really-mean/

Economic impacts

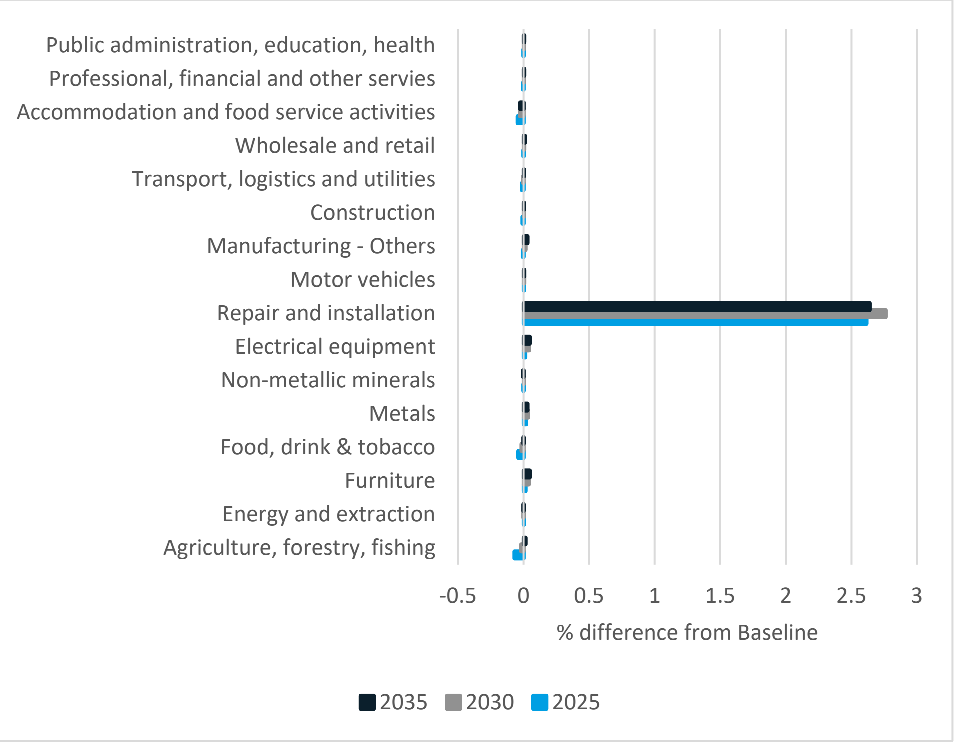
The assumed decrease in the VAT rate results in a decrease in real consumer prices, as the VAT cut effectively cuts prices paid by consumers. Lower prices lead to higher demand and higher economic activity. This leads to a small positive GDP effect in the scenario (see Figure 3.31).

Figure 3.31 GDP impacts, Policies of VAT



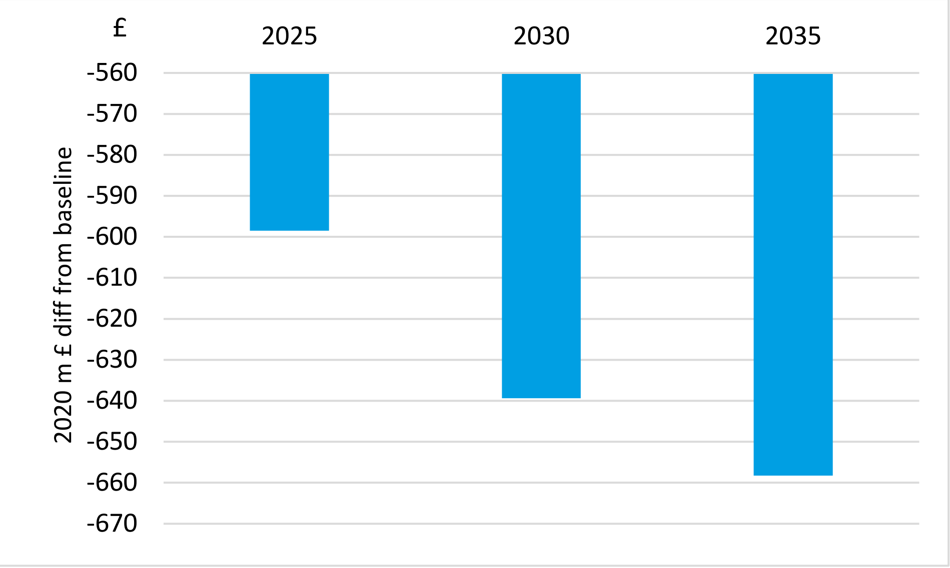
In this scenario, the GVA of the repair and installation sector increases by 2.5% by 2035 compared to baseline (see Figure 3.32). To give some context to this result, the repair and installation sector accounts for 0.4% of the total GVA in 2020, which implies that impacts felt in this sector alone do not lead to substantial impacts economy-wide. The lower VAT rate in this sector increases demand, as prices are lower, and drives up total output.

Figure 3.32 Value added impacts by sector, Policies of VAT



Government revenues are some £660 million lower as a result of the VAT decrease (see Figure 3.33). However, there is no revenue balancing in this scenario; the deficit is assumed to result in increased government debt without further macroeconomic impacts.

Figure 3.33 VAT tax revenues impact, Policies of VAT



4 Policy implications

The exploitation of natural resources has become unsustainable, and is contributing to climate change, biodiversity loss and is threatening the health of ecosystems and the health and well-being of people. Policy interventions to increase resource productivity and reduce waste are needed to incentivise households and firms to use less resources, recycle, repair and reuse products and materials more, and as a result, for the UK economy to become more circular. Improved resource productivity places less pressure on the natural environment, reduces biodiversity loss and can contribute to the pathway to net zero through reduced emissions from both industry and waste disposal. **This analysis has demonstrated that at the same time, policy pathways for increasing resource productivity can also lead to economic gains**.

4.1 The findings of this analysis

There is no silver bullet solution for increasing resource productivity across the economy, as different industrial sectors and economic agents will require different incentives to reduce material consumption or to consider reusing, repairing or recycling products before buying new. In this analysis a variety of policies, aimed at increasing resource productivity across a range of sectors, were modelled. These policies can be categorised into either regulation-based policies, or measures which lead to increased prices of materials or waste disposal.

Differing policy pathways lead to varying degrees of economic gains

The analysis demonstrates that the magnitude of the economic gains varies depending on the specific policy pathway applied, with the regulation-based pathways leading to greater gains in GDP compared to the fiscal policies. Regulations such ecodesign standards, extended producer responsibility and embodied carbon standards would lead to improvements in the efficiency of manufacturing processes (and therefore lower costs for producers), reductions in imports of materials and instead an increase in spending on other goods and services with higher domestic content. Furthermore, the investment required to make changes to production processes also provides a boost to the economy, and the jobs created lead to additional consumer spending in other sectors such as retail and leisure.

Regulation-based policies in the construction and vehicles sectors lead to largest economic gains

Of the regulation-based policies, the policies aimed at improving resource productivity in the construction and vehicles sectors see the largest economic gains in terms of GVA and GDP. Within the construction sector, these gains are driven by the large efficiency gains and cost reductions that result from reduced material consumption. In the vehicles sector, the economic gains are driven by the reduction in imports of vehicles and metals, and more efficient manufacturing processes.

Investment associated with improving resource productivity is a key driver of economic gains

In both cases, the investment required to move towards more efficient production processes have a large part to play in the economic gains. Without this necessary investment, resource productivity and resulting lower material consumption would lead to declines in the output of sectors that make up the supply chains of targeted sectors, and the overall economic impact of the resource productivity policies could be negative.

Reduced material consumption and the negative effect this has on the output of supply chain sectors can also clearly be seen in the results of the policy scenarios modelled without revenue recycling. In the combined scenario, when revenue is not recycled in the form of investment in circular economy initiatives, the GDP effect of the combined regulatory and fiscal policies is slightly negative. Revenue recycling is an important consideration for policymakers, to ensure that the environmental gains from resource productivity policy pathways do not come at a cost to the economy. At the same time, ringfencing the revenues to specifically invest in circular economy-related initiatives ensures that increased public spending does not simply result in greater material consumption (for example if revenues were used to fund road infrastructure). The results of this analysis clearly demonstrate that using revenues to invest in carefully targeted initiatives leads to reduced material consumption overall, at the same time as achieving economic growth.

4.2 Successful design and implementation of policy

Each measure analysed in this study has a positive impact on the environment through reduced material consumption and the economy, and a combination of these policies should form the basis for an overall strategy to improve resource productivity across all sectors. A policy strategy should be carefully designed to mitigate any adverse effects, such as reduced employment resulting from reduced output in supply chains, as well as through investment to stimulate and support developing green industries and jobs within a circular economy. Successful implementation of the policies will depend on consultation and collaboration with both the industries affected and consumers. Furthermore, stability in the policy strategy to increase resource productivity creates certainty and boosts the confidence of investors to invest in both new production techniques and materials and the reuse, remanufacturing and recycling sectors.

Ecodesign and embodied carbon standards

The initial design of a product greatly influences its lifetime carbon footprint or environmental impact, and **introducing ecodesign standards** is an effective way to incentivise producers to incorporate sustainable thinking into their design processes. Ecodesign standards can include mandates related to the designing a product in such a way that it is made from more sustainable materials or its durability is improved, or mandates related to the energy efficiency or recyclability of a product. In our analysis ecodesign standards were considered as part of a package of policies aimed at improving the resource productivity of the electricals sector. Within the construction sector this analysis explored the economic effects of introducing embodied carbon standards, which led to a substantial reduction in material consumption. **Embodied carbon standards** would impose limits on the emissions associated with the production of and materials used within the built environment, incentivising the sector to use resources more productively and to use a higher recycled content.

For successful implementation of both ecodesign and embodied carbon standards, alongside the stability in the policy approach mentioned previously, policymakers should be mindful of the uncertainties regulations may create for producers within affected sectors such as electricals (for example through incomplete or confusing information) or of the rigidities in supply chains (for example because of existing contracts), which hinder the ability or timeliness of producers to alter their designs or material inputs[48], and should therefore communicate with and support such industries accordingly. Collaboration within sectors, achieved with the help of government, can also lead to collective problem solving and help to overcome technical barriers[49].

Increasing the prices of virgin materials or waste disposal

The price of virgin materials does not necessarily reflect their true cost because of the environmental damage caused by their extraction. **Increasing the prices of virgin materials** such as aggregates would incentivise sectors to use a higher proportion of recycled materials in production. **Increasing the prices of waste disposal** provides incentives to reduce waste and to increase rates of recycling. The findings of this analysis clearly show reduced material consumption and waste generation as a result of increased virgin material and waste disposal prices respectively, which when combined with increased public spending on circular economy initiatives, leads to positive economic outcomes. To mitigate any adverse economic effects, industries affected by such changes in prices and therefore costs of production should be supported in the same ways outlined for above.

Extended producer responsibility schemes

Producers currently have little incentive to use recycled materials as inputs or to ensure that their products are designed in such a way that they can be reused, remanufactured or easily recycled. **Extended producer responsibility** (EPR) can include producer responsibility for collecting products at the end of their life or packaging from products, and either recycling or responsibly and sustainably disposing of these. Since producers then bear the costs of the end-of-life treatment of their goods (rather than local councils and the taxpayer), producers are encouraged to design products with the environmental impact of the product and it's packaging as a consideration. This leads to better design in terms of durability and recyclability, possibilities for repair and refurbishment, and the use of less packaging. In our analysis extended producer responsibility is included within the resource productivity policy packages aimed at the furniture, electricals and vehicles sectors. Similarly to the implementation of ecodesign standards, policymakers should work closely with these targeted industries, recognising the impact and scale of the changes in production and processes required to comply with extended producer responsibility. Besides firms in these sectors, there are many other stakeholders that policymakers must engage with and gain buy-in from for an EPR system to be successful. The waste disposal sector is a key stakeholder and should be supported, since an adequate recycling infrastructure needs to be in place. Households must have adequate information to understand their role in supporting an EPR system (for example by returning products correctly using the waste infrastructure in place). It is important that policymakers

[48] See for example Industry attitudes towards ecodesign standards for improved resource efficiency - ScienceDirect

[49] Green Alliance Completing the circle (green-alliance.org.uk)

establish comprehensive and stable EPR laws, creating a reliable legal framework within which all stakeholders can act[50].

Targeting consumer behaviour

As well as firms, households have their part to play in reducing material consumption through applying the 6 Rs of sustainability (see Figure 3.30) and helping the UK economy to transition to a more circular system. Across the general public there is a growing awareness of the climate crisis, and how everybody can do their part to reduce their individual carbon footprint and lead a more sustainable life. This awareness can be capitalised on with further information campaigns, improved labelling of products and packaging, and through the use of market-based instruments such as lower VAT rates for second hand, refurbished or repaired goods, all measures aimed at **influencing consumer behaviour**. The findings of this study show a positive economic impact overall from introducing a lower VAT rate for such goods, in this case within the furniture, electricals and construction sectors. Awareness campaigns may be most effective if messages are tailored to account for different demographic groups, cultural differences or values, while high-profile climate influencers or celebrity climate activists can assist with framing and disseminating messages to the public in an inspiring way (particularly younger generations) through a variety of channels including social media.

4.3 Conclusion

The recommendations proposed here all relate to considerations for successful policy implementation, to ensure that the resource productivity policy pathways achieve their aim of reducing material consumption and the pressure this puts on the natural environment, while also achieving positive economic outcomes.

[50] how_to_implement_epr___briefing_for_government_and_business.pdf (panda.org)

Appendix A Quality Assurance

This appendix outlines the quality assurance checks carried out throughout the modelling analysis carried out in this project.

Description of the check	How the check will be carried out	Comments	Name of the analyst who checked	Signoff
Model validation: is the methodology appropriate?	Confirm that E3ME is a suitable model to use in the context of this project.	E3ME has been frequently applied to model resource productivity and tax policies, in peer-reviewed academic papers and impact assessments for the European Commission and national governments in Europe and beyond. The model includes a materials use module and a waste generation module, for assessment of the impacts of materials and waste tax policies. The granular sectoral classification and dynamic input-output structure at the heart of the model means that it is well-suited to assessment of the wider economic impacts of resource productivity policies.	Jennifer Dicks	1/10/2021 Sophie Heald
Check and validate E3ME baseline data	• Use E3ME graphical user interface to check that baseline growth in GDP, sectoral output and materials demand are realistic and consistent with observed trends. • Check for smooth trajectories in projections and ensure no anomalies in the baseline data. • Compare E3ME baseline materials use data against Leeds University baseline and confirm that within +/-15% by 2030. • Check model function specifications are appropriate.	E3ME baseline data validated.	Alexandra Pavelka	28/10/2021 Sophie Heald

Check scenario inputs and ensure correct implementation of scenarios	• Check scenario input data and assumptions are plausible. • Check model scenario files and shocked variables against input data and scenario descriptions, to ensure all aspects of scenarios have been correctly incorporated	Scenario input data checked and validated against scenario narratives.	Alexandra Pavelka	21/10/2021 Sophie Heald
Check macroeconomic and sectoral results are in line with theory and expectations	• Check sign and scale of impact on sector level output and GDP are in line with expectations, given scenario inputs. • Check scale of direct and indirect effects from resource productivity policies, and that sector shocks are in line with expectations, given structure of supply chain implied by input-output tables. • Investigate cases where sector shocks differ from a priori expectations. • Check that investments are coming through in the resource productivity scenarios and that the implied multiplier effect is within a plausible range. • Check scale of increase in industry prices consequent to increases in materials and waste taxes. • Check and validate scale of revenues from materials and waste taxes.	Macroeconomic modelling results checked and confirmed in line with expectations, given modelling framework and scenario design.	Alexandra Pavelka	29/10/2021 Sophie Heald
Ensure results are realistic/plausible within the timeframe	• Spot checks on data points at specific time intervals, e.g. 2025, 2030, 2035, visualising data. The plausibility of the differences from baseline results will be considered.	Scale of impacts in line with expectations when compared to baseline over entire modelling period.	Alexandra Pavelka	03/12/2021 Sophie Heald

Check implementation of government revenue neutral scenarios	• Check net zero impact on government revenues when compared to baseline • Check scale of reduction in materials use and waste generation compared scenario variants without revenue recycling • Check scale of economic benefits associated with increased government investment (compared to the equivalent scenario variant without revenue recycling)	Confirmed implementation of government revenue neutral scenarios leads to expected economic and materials use outcomes.	Alexandra Pavelka	29/11/2021 Sophie Heald
Ensure calculation of England-specific impacts has been correctly implemented	• Compare baseline projections against published data for England, where available. • Check that the England/UK results give back the shares we applied • Confirm that sector-level shocks (in percentage difference from baseline) are consistent in the England-specific results and in the UK results • Ensure aggregate impacts presented for key variables are consistent with impacts when summed across sectors	Confirmed consistency of results for England, with those derived at the UK-level.	Alexandra Pavelka	29/11/2021 Sophie Heald
Ensure the Excel-based tool meets the client's requirements.	• Carry out discussions with the client before constructing the tool, to understand requirements. • Confirm input options with the client, and outputs to visualise. • Present the draft tool to the client via a Teams call, to walk through its design and functions. • Incorporate the client's formal feedback on the first draft of the tool to ensure that it is tailored to their needs.	Confirmed requirements, including policy input options and scenario outputs to visualise. Walked the client through the tool via a Teams call, after which we incorporated some of their feedback into the first draft, delivered on 15/12/2021. Formal feedback still to come.	Ornella Dellaccio/ Jennifer Dicks	15/12/2021 Jon Stenning

Ensure the Excel-based tool is user-friendly	• Incorporate user guide/ information within the tool. • Check formatting (e.g. visual appeal, spell check etc.) of the tool • Internal checking of usability by various members of the project team, comments and feedback incorporated into a further iteration of the design.	Usability checked by senior members of the project team, formatting and functionality checks carried out.	Jennifer Dicks, Jon Stenning	15/12/2021 Jon Stenning
Excel-based tool data is consistent with E3ME modelling	• Aggregation of impacts sums up to impacts of individual policy options • Random checks on Excel-based tool results	Confirmed consistency with the results of the E3ME modelling		
Results in Excel-based tool refer to selected policy options	• Construct matrix of selected policy options and check consistency with user selections			

Appendix B Policy assumptions

This appendix outlines the policy assumptions used in the modelling.

Policy type	Policy	Policy short name	Input assumptions
Regulatory	**Policies to reduce Food and drink waste**	Food_Drink	From 2023: - 1% reduction in the food sector’s use of all products - 7% reduction in the hotels and catering sector’s use of all products - 7% reduction in household spending on food and drink
	Policies to increase resource productivity in the Construction sector	Construction	From 2023: - 50% reduction in construction sector’s use of all products
	Policies to increase resource productivity in the Vehicles sector	Vehicles	From 2023: - 63% reduction in motor vehicle’s purchases of other metals - 13% reduction in all sectors’ purchases of motor vehicles - 15% reduction in household purchases of vehicles

	Policies to increase resource productivity in the Electricals sector	Electricals	From 2023: - 9.5% reduction in all sectors’ purchases of electrical products - 9.5% reduction in household purchases of electrical products
	Policies to increase resource productivity in the Furniture sector	Furniture	From 2023: - 0.5% reduction in all sector’s purchase of furniture products - 0.5% reduction in household purchase of furniture products
Fiscal	**Policies to increase prices of virgin materials**	MaterialsTaxes	From 2023: - 10% increase in the cost of metallic ores - 2 pp yearly increase of the aggregates levy for construction and industrial minerals
	Policies to increase prices of waste disposal	WasteTaxes	From 2026: - 2 pp annual real (i.e. growth over inflation) increase in landfill taxes on inert waste (minerals and construction minerals) From 2023: - 8 pp annual real increase on landfill taxes on all other material
	Reduced VAT for repaired, refurbished or second-hand goods	VAT_decrease	From 2023: - 5% VAT rate for certain products in the furniture, electronics, construction and repair sectors