eurelectric

equality

Shaping an inclusive energy transition

With scientific contribution from

enel Foundation

Study realised by

Guidehouse

cambridge econometrics

clarity from complexity

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Executive summary

The European Union (EU) has set itself the goal of becoming carbon neutral by 2050, an objective which is at the heart of the European Green Deal and its commitment to the Paris Agreement. Achieving this goal will require the introduction of ambitious and stringent climate policies. The costs associated with these policies will need to be minimised and distributed across different sectors to ensure that the most vulnerable groups within our society do not carry an unequitable share of the financial burden. Therefore, it is essential to assess the potential economic impacts key decarbonisation policies could have on different income groups. Where costs disproportionately affect low-income households, suitable counter measures should be implemented to avoid the creation of inequality and—in the process of doing so— facilitate public support for the decarbonisation transition.

This study combines detailed economic modelling with an assessment of existing policy best practice approaches to analyse the distributional effects of the EU's[1] key decarbonisation policies until 2050, and identify measures that could be put in place to mitigate the potentially regressive effects[2]. The results will help policy makers to better understand how climate policies will affect different sections of the economy and provide best practice examples of policy tools which could be deployed to ensure the decarbonisation of the EU's economy is fair and equitable. The analysis includes an assessment of the short-term effects of the macroeconomic shock linked to COVID-19 on the final results.

Key findings

The key decarbonisation policies needed for Europe to achieve its climate goals will have a mix of progressive and regressive effects. Some policies will result in lower-income households financially benefiting more than other income groups (progressive effect), while others will result in lower income households being disproportionately burdened by costs (regressive effect). Decarbonisation policies which directly increase costs such as energy taxes have the most regressive effects, while policies that reduce costs or energy consumption such as energy efficiency measures are found to be the most progressive.

A number of policy options exist that could effectively reverse the regressive effects of the decarbonisation policies so that the net effect is progressive. In other words, it is possible for

[1] The 27 countries of the European Union plus the UK

[2] Where lower income households are left economically worse off

decarbonisation policies to both help achieve needed climate goals and financially benefit lower income households to reduce inequality.

The study identifies four key policies which could be introduced to counteract the regressive effects of climate policies. The four options[3] are:

1. **Lump-sum transfers or equivalent tax relief measures.** Direct financial rebates to citizens have already been applied by jurisdictions such as Switzerland and Canada as an effective way to recycle the revenues raised from revenue- generating decarbonisation policies (such as carbon pricing) and reduce inequality. In an EU[4] context, the study identified that a lump-sum direct rebate option recycling the revenues from key decarbonisation policies—including carbon pricing and fossil fuel taxes—would see an average sum of €260 going to households across the EU every year. This amount represents a 4.2% increase in household disposable income for the lowest-income households and an 0.8% increase for the highest-income households. For jurisdictions where a direct rebate would not be politically feasible, the recycling of carbon revenue to offset reductions in taxes such as value added tax (VAT) or electricity taxes would also be a viable alternative resulting in similar financial benefits to lower-income households.

2. **Targeted energy efficiency measures.** Leveraging the policy and institutional infrastructures that exist throughout EU countries in the form of energy efficiency obligation schemes and subsidies that direct more funds to low-income households and ensure future energy savings. The programmes should include upfront subsidies to help overcome the initial investment costs which are often barriers to implementing energy efficiency measures for the most vulnerable households. The financing could leverage recycled revenue raised from decarbonisation policies and/or could be co-funded through government funding. The amount of funding required is 1–3 billion EUR per annum for the EU as a whole.

3. **Job retraining programmes,** focused on industrial sectors impacted by decarbonisation. This is a preventative option that aims to stop people from falling into poverty due to the significant shifts in the economy that are needed to achieve carbon neutrality. Programmes should be set up early and pre-emptively to reskill and upskill workers, while reflecting the impacts on the local labour market conditions. Programme administrators should work with industry to identify labour shortages and reskill workers to fill gaps in these sectors, and leverage the job creating potential from the energy transition and digitalisation. Funding can be via carbon revenues or general tax revenue.

[3] The impacts the four options could have on household disposable incomes across Europe were tested using a macroeconomic model. To identify policy interactions, the four options were run as a combined package in the model.

[4] EU 27 countries plus the UK

4. **Fund low-carbon technology subsidies via general taxation or carbon revenue.** Low-carbon subsidies are a progressive decarbonisation policy, if not funded through a surcharge on electricity users.[5] This study finds that the costs for low-carbon technology subsidies could be balanced more equitably by funding subsidies for low-carbon technologies, such as renewable energy support schemes, through rising income tax rates for high incomes or carbon revenue earmarking, rather than through a surcharge on electricity consumption.

These policy options could increase the longevity of climate policies by achieving greater public acceptance. Policies that increase income equality are more likely to maintain public support and options such as the direct lump-sum rebate approach can make a very visible point about the potential for decarbonisation policies to reduce inequality. Furthermore, the policy options identified by the study do not face significant legislative barriers in their implementation, as many are within the powers of the EU member states and/or align with EU directives such as the Energy Efficiency Directive (EED). As these policy options are administratively straightforward to implement, the infrastructure and institutional capacity required are often already in place. What is needed now is the political will and ambition to act and make the changes needed to address the distributional impacts of the critical decarbonisation policies the EU needs to combat climate change. The decarbonisation transition can and should be an equal one for all citizens of Europe.

The following subsections summarise the main findings of the key steps taken to reach the above conclusions.

Distributional impacts of key decarbonisation policies

Existing studies—such as Eurelectric's 2018 Decarbonisation Pathways study—have identified the suite of decarbonisation policies and their level of ambition that Europe would need in order to reduce emissions to levels compatible with the Paris Agreement and achieve carbon neutrality by 2050. Taking into account the overlaps in the function and coverage of the various identified decarbonisation polices, this study identifies six groups of decarbonisation policy types (set out in Table 1) that are key to ensuring Europe can meet its climate goals.[6] Understanding the effects

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5 Existing literature documents the regressive impacts an electricity surcharge funding approach could have, for example; McInnes, 2017, Understanding the Distributional and Household Effects of the Low-carbon Transition in G20 Countries. EEA, 2011, Environmental tax reform in Europe: implications for income distribution

6 It is important to note that the study is not suggesting these decarbonisation policy types alone will be sufficient for Europe to attain carbon neutrality by 2050, but rather these policies will play major roles and can be—or already are—the cornerstones of EU decarbonisation plans.

that these six key policy types will have on different societal groups will help policy makers shape an equitable policy mix.

Table 1: Key decarbonisation policy types needed for Europe to achieve carbon neutrality

Policy type	Policy description
Carbon pricing	Covers all policies introducing a carbon price, such as the EU ETS (European Union Emissions Trading Scheme) or a carbon tax
Taxation of energy vectors	Covers all policies regarding taxing fossil fuels in heating, road transport and taxation of electricity
Emission performance standards	Covers all policies regulating emission standards such as emission standards for cars or household appliances.
Subsidies for low-carbon technologies	Covers all policies that support low-carbon technologies in energy production and heating.
Phase out of fossil fuel subsidies	Covers the phase out of all fossil fuels subsidies in energy, heating and transport such as heating oil and diesel.
Energy efficiency measures	Covers all of energy efficiency obligation and support schemes under article 7 of the EU EED

Through the use of the E3ME macroeconomic model, this study finds that the key decarbonisation policies required for Europe to achieve its climate goals will have mixed progressive and regressive impacts on European citizens. Specifically, in the context of disposable household incomes, some of the policies will result in impacts that financially benefit the general public from lower-income groups more than those from higher income groups, these policies reduce income inequality and are considered to be ‘progressive’. However, others will see lower-income groups being financially worse off, resulting in increased inequality, these policies are considered to be ‘regressive’. The result of the of macroeconomic model is shown in Table 2. Note that this particular impact analysis looks at only the elemental decarbonisation component of the various policies. In other words, the model looks at the impacts of the policies based on how they are designed to reduce emissions. Other policy implementation elements, such as recycling of revenues, are looked at later stages.

Table 2: Expected distributional impacts of individual decarbonisation policy types[7]

Decarbonisation policy type	Modelled distributional impact
Carbon Pricing	Regressive (Medium/High)
Taxation on energy vectors	Regressive (High)
Subsidies for low-carbon technologies	Progressive (Low)
Phase out of fossil fuel support	Regressive (Low)
Emissions Performance standards	Progressive (High)
Energy efficiency measures	Progressive (High)

Box 1 The Gini coefficient

The Gini coefficient is a measure of statistical dispersion intended to represent the income or wealth distribution of a nation's or region's residents. It is the most commonly used measurement of inequality. A Gini coefficient of 0 expresses perfect equality, while a Gini coefficient of 1 expresses complete inequality. For this study, a negative change to the Gini value (i.e. the Gini value decreases as a result of a policy) reflects an improvement in equality, making the policy causing it a progressive one.

The study finds that comparatively (as shown in Figure 1) the most regressive policies—those which likely will increase financial burdens for low-income households more than they would for higher-income households—are those that directly impose higher costs, such as taxation of energy vectors, which increases the cost of transportation and heating fuels. The policies which show progressive impacts—those which will increase financial burdens for low-income households less than they would for higher-income households or even result in lower income households financially better off—are those that lower the energy cost for consumers through lower energy prices (such as subsidies) or that reduce overall energy expenditure (such as energy efficiency measures).

The results of this step should not be misinterpreted as labelling decarbonisation policies are 'good' or 'bad', and it would be incorrect to take the oversimplified interpretations that decarbonisation policies with regressive impacts are bad or less effective than those with

[7] Based on the Gini coefficient for disposable income after energy and policy costs

progressive impacts. Rather, the key point is that ALL six types of decarbonisation policies are needed in order for Europe to achieve its climate goals, but a policy that makes sense from a climate point of view can create regressive distributional effects, i.e. negative effects that impact low-income households unequally if these effects are not taken into consideration. Therefore, it is important that these negative effects are acknowledged, and proper counter measures are introduced to mitigate them, making citizens feel like they are part of the energy transition instead of victims of it.

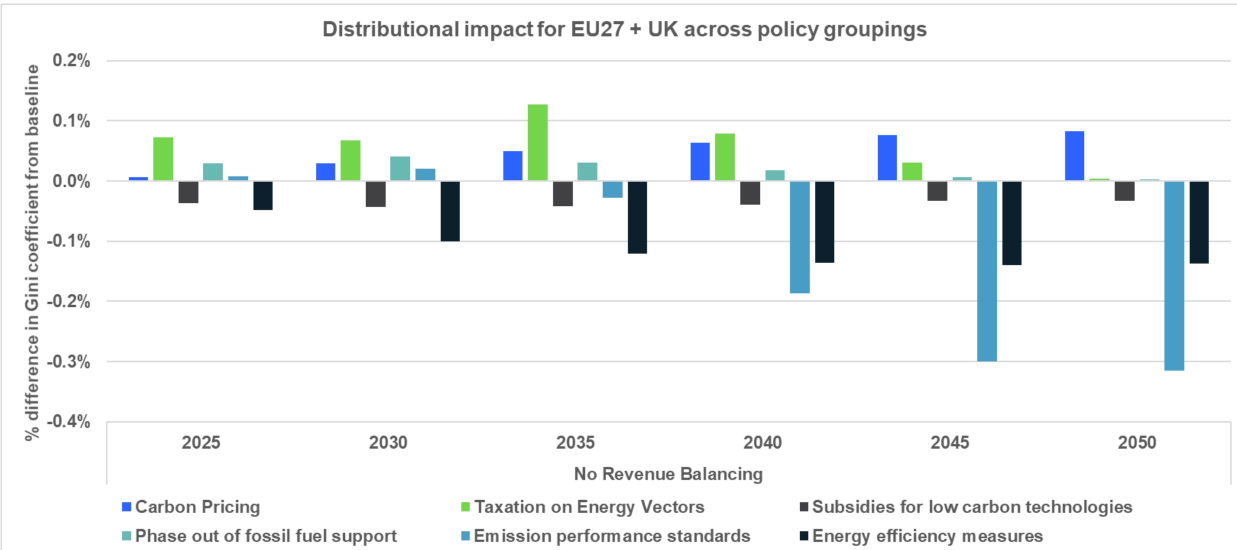

Figure 1: Modelled distributional impact of individual key decarbonisation policies in the EU context[8]

Policy options to address distributional impacts

An examination of measures undertaken to address regressive effects of various decarbonisation policies by over 16 jurisdictions revealed that, if designed correctly, effective measures can be successfully introduced that reduce and even reverse the regressive effects.

Most of the jurisdictions who have successfully addressed regressive effects have used a 'counter measure' – a policy implemented specifically to counter the regressive impacts of a decarbonisation policy. These are popular as counter measures do not seek to change the design of decarbonisation policy itself (e.g. its coverage) and hence do not adversely impact the decarbonisation policy's ability to achieve climate goals. Although for the sake of clarity the study treats decarbonisation 'policies' and 'counter measures' separately, it is important to note that the latter is often an implementation element of the former and hence in practice, they are intrinsically linked.

[8] Includes the UK

If implemented correctly, revenues raised by carbon pricing and energy taxes can be redistributed in a way that reverses the policies' regressive tendencies and increases progressiveness. This finding, taken from the experience of various governments and jurisdictions around the world, shows that redistribution of the revenues raised by the decarbonisation polices often form the centrepiece of measures seeking to mitigate the regressive impacts of the transition to decarbonisation.

Based upon the initial macroeconomic modelling results and an assessment of real world policy examples, four key policy options are chosen for their simplicity, transferability to the EU context and effectiveness in ensuring that the energy transition has more equal distributive effects are:

- **Lump-sum transfer.** Recycling revenue through lump-sum transfers to the general public. This option directly addresses the additional costs places upon households by providing a counter balancing payment funded by revenues raised by decarbonisation policies and can provide the financial relief needed by low-income households until more affordable alternatives to traditional polluting technologies become available. Additional conditions could be introduced to ensure the direct transfer can only be spent on decarbonising activities if rebound effects are a concern. However, these are likely to face implementation challenges and are not necessary for decarbonisation, since—in the EU context—interactions between decarbonisation polices will greatly curtail rebound effects. For example, any concern that the lump-sum transfer would be spent on an old polluting vehicle would be addressed by climate policies such as the phase out of fossil fuel vehicles.[9] For jurisdictions where a direct lump-sum would not be politically viable, a reduction in VAT / electricity taxes should be considered, as these are likely to have the same effect. However, tax reduction measures would lack the high visibility of a lump-sum transfer and hence do not have the additional co-benefit of improving public perception of decarbonisation polices.

- **Targeted energy efficiency measures.** Implementation of energy efficiency measures with no upfront costs, specifically targeting low-income households. Targeted energy efficiency measures help low-income households reduce energy consumption and therefore costs. The provision of upfront financing for energy efficiency improvements (funded through carbon revenues) removes one of the key barriers to uptake of energy efficiency measures.

- **Job retraining programmes.** Focused on industrial sectors impacted by decarbonisation to prevent people from falling into poverty. A preventative measure that differs from the other options which seek to counter-balance the additional costs from decarbonisation or reduce energy consumption. Job retraining is an important policy option that seeks to

[9] In addition, in the context of a decarbonising economy, the macroeconomic model results showed economic activity in the combined policy option scenario as increasing by up to 2.5% relative to baseline. Even if all the growth went to carbon intensive activities, it would not be enough to undermine the overall reduction in emissions brought on by the suite of decarbonisation policies.

prevent people from losing out as a result of decarbonising the economy. Additionally, the job-creation potential of the transition and digitalisation could be leveraged by providing training in these sectors.

- **Fund low-carbon subsidies via general taxation.** Currently most funding for low-carbon technologies are through surcharges on energy consumption, which unfairly penalizes lower income households who end up spending a greater proportion of their income on energy. A switch to funding through general taxation or high-income tax would make low-carbon technology subsidies a more progressive policy. Carbon revenues could also be a source of funding.

Impact of counter measures

The study finds that when combined, the policy options can completely reverse the regressive impacts of the decarbonisation policies Europe needs to achieve its climate goals, making them progressive. As shown in Figure 2, if implemented as a package, the policy options would benefit all income groups but the lowest income households would benefit the most.

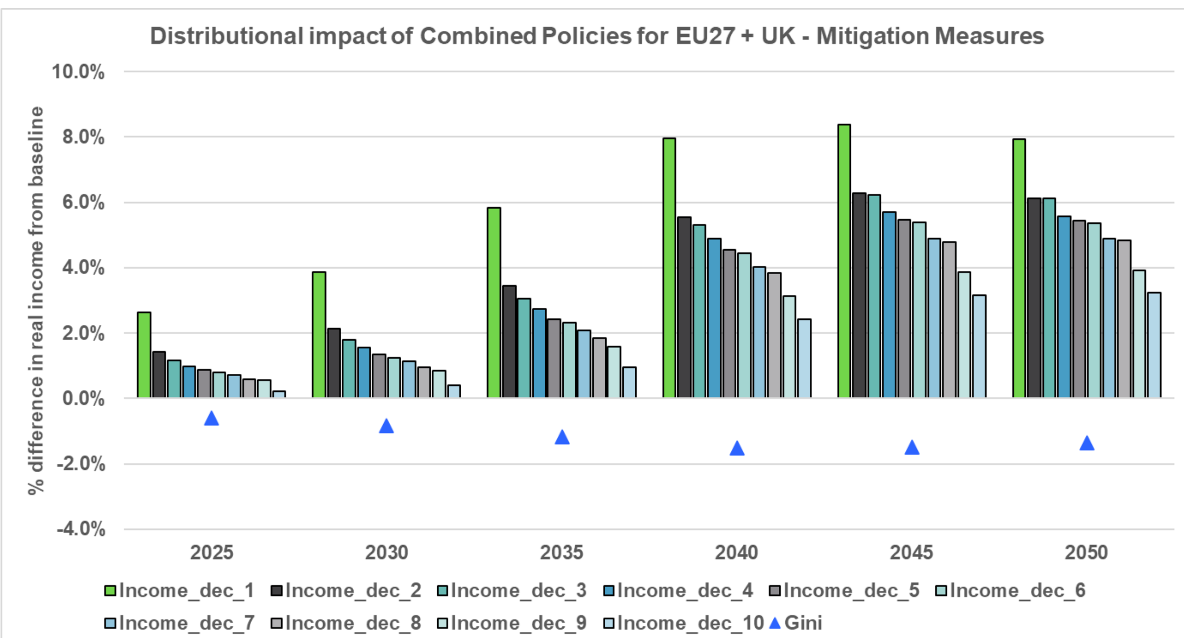

Figure 2: Modelled distributional effects of the combined policy options

Furthermore, the model predicts that the greatest benefits in terms of reduced income inequality due to the identified policy options would be felt by citizens in southern Europe and central and eastern Europe. This is partially due to the number of policies addressing decarbonisation and distributional impacts already in place in other parts of Europe.

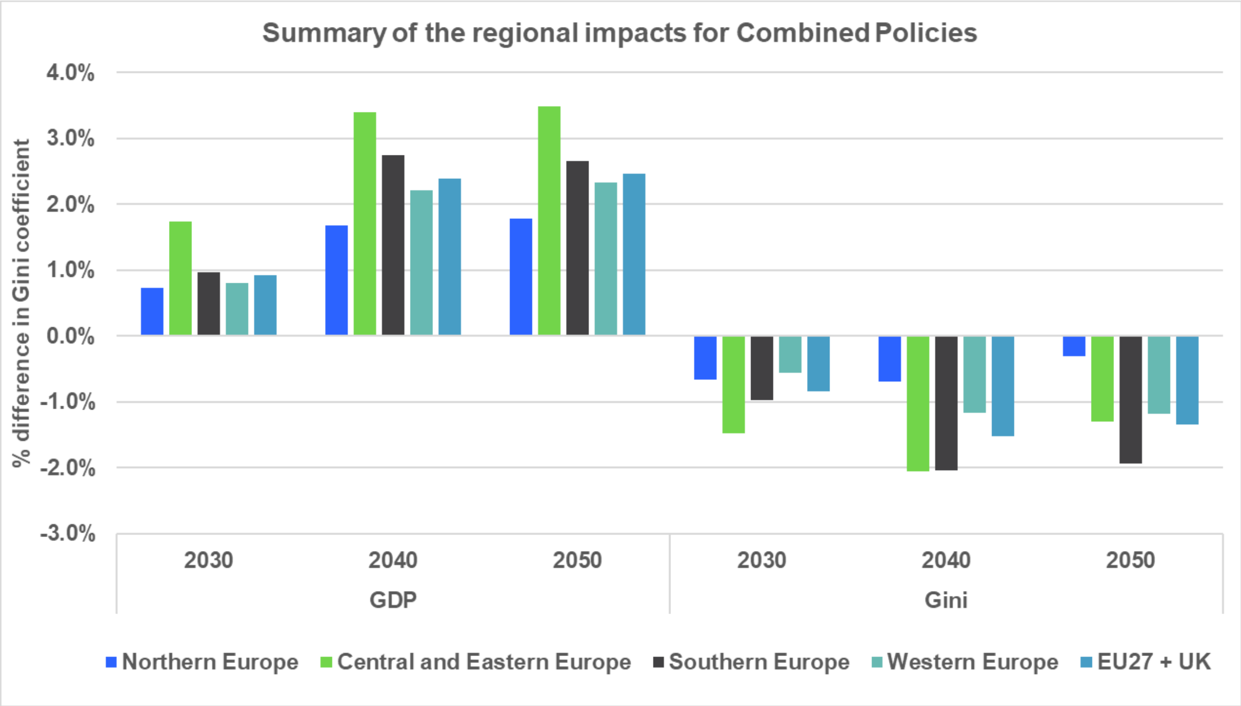

Figure 3: Regional differences in the modelled distributional effects of the combined policy options

The Covid-19 pandemic and the measures that were taken to limit its spread are currently having major impacts on the economy and on society. Thus, the impacts of the four identified policy options were tested in a sensitivity analysis that simulated the shocks of the Covid-19 pandemic on the European economy. The assumptions are based on the emerging literature on the impacts that Covid-19 and lockdown response has had on the global economy.

As shown by Figure 4, the differences between distributional impacts with and without Covid-19 scenarios are small. It is important to keep in mind though that the results presented here capture the distributional effect of the policy measures contained in the identified policy options and not the distributional effect of the Covid-19 shock. The differences are small, because the model is looking at the effects of the policy options against a baseline where the policy options are not implemented and in both cases the Covid-19 shock was taken into consideration.

Overall, the study finds that the addition of the Covid-19 shock does not have a substantial impact on the distributional effects of the decarbonisation policies or the effectiveness of the identified policy options to counter regressive effects. There is a small reduction in the progressive impact throughout the period from now to 2050 as the scale of the change in real income under the Covid-19 shock is slightly reduced. The main driver of the smaller progressive impact is the reduction in climate policy revenues that are allocated to the lump-sum transfer, which are lower with the Covid-19 shock in 2021.

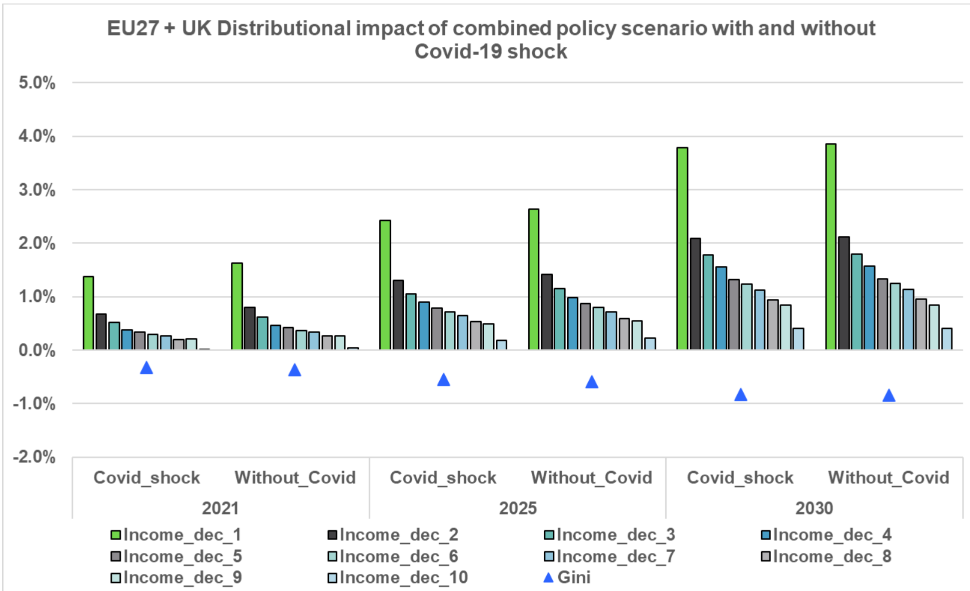

Figure 4: Distributional impacts of the identified policy options in a post Covid-19 context

Implementing the measures

From an initial view on potential implementation in an EU context, there is no significant legislative or technical barrier for the identified policy options to address the regressive impacts of decarbonisation policies. However, some of the options, such as the lump-sum rebate, will unlikely have an EU-level solution and will instead have to be implemented at the member state level. The main issue regarding implementation efforts of the EU towards a lump-sum transfer—or a reduction in VAT or electricity tax— is that tax-related issues are under national jurisdiction of each member state. In the absence of a single European-wide solution, the European Commission can provide guidance for best practice for member states. Such guidance could take the form of case studies and suggestions for each member state of how a lump-sum transfer on national level could be implemented.

The situation is different for targeted energy efficiency measures. Through a revision of the EED article 7 or a delegate act further specifying the modes of energy efficiency implementation, the EU could stipulate a minimum of savings that needs to be achieved or support to be paid for low-income households. Further stipulations could be made for the special consideration of low-income households, to be reflected in each member state's long term renovation strategy.

The EU already supports job retraining programmes in member states through one of its structural funds and its social transition agenda, which is part of the Clean Planet for All package. The Modernisation Fund also has a special bracket for a just transition in carbon dependent regions, which could provide support and retraining for affected lower-income member states. As such, it is expected that job retraining programmes would synergise and be readily compatible with the existing legislative frameworks.

Conclusions

If appropriate policy measures are not taken, some EU cornerstone climate policies such as carbon pricing, phase out of fossil fuels and subsidies for renewable energy are likely to have regressive effects—either immediately or in the future—until full decarbonisation is reached in 2050. However, policy measures could be introduced to make the energy transition inclusive which would be both technically feasible and highly socially acceptable.

The time to act on ensuring climate polices' regressive effects are counterbalanced is now, as many decarbonisation polices are already in force, scheduled for implementation and/or due to be strengthened in line with the net zero decarbonisation goal. Decarbonisation policies are developing in a context of a globally increasing gap between the richest and the poorest in society. This gap is potentially exacerbated by the economic effects of Covid-19. The EU Green New Deal and the recovery measures that EU leaders are preparing should be oriented so that inequalities are not made worse, but rather addressed. Not addressing the unintended consequences that policy design may have on citizens will reduce public support, which is critical to ensuring the longevity and overall sustainability of climate policies.

1. Introduction

Meeting Europe's climate goals and the aims of the Paris Agreement will require the decarbonisation of Europe's energy supply. This unprecedented transition to a low-carbon society requires strong decarbonisation polices and inevitably involves transition costs. Eurelectric members are at the heart of this challenge and have strongly welcomed the political impetus provided by the Paris Agreement, committing to achieving a carbon neutral electricity mix in Europe well before mid-century. To support this objective, Eurelectric has developed scenarios[10] which demonstrate necessary conditions to reach feasible technical decarbonisation pathways and the different accompanying policy approaches that would need to be implemented.

Climate policies can affect different sectors of the economy in different ways and consequently different societal groups bare an unequal share of the transition costs. To be successful and maintain public support, any policy designed to decarbonise the economy must ensure the cost of the transition is allocated fairly through balancing its environmental objectives against any regressive effects arising from the implementation of that policy. Progressive decarbonisation policies are more likely to garner public support which in turn would impact the longevity of the policy as well as potentially providing opportunities to increase decarbonisation ambition.

This study by Guidehouse and Cambridge Econometrics, supported by a project team including Eurelectric and the Enel Foundation, has two key objectives:

1. Analyse and understand the distributional impacts on EU citizens of the different climate policies most needed for Europe to achieve climate goals in line with the Paris Agreement; and

2. Present policy options to minimise the regressive elements of the climate policies so that the greenhouse gas (GHG) reduction goals consistent with Europe's commitments under the Paris Agreement are met in a fair and equal way.

The study combines detailed research of key existing literature, macro-economic modelling, structured stakeholder consultations and real-life experiences from a series of case studies.

An overview of the key steps of the methodological approach are laid out below:

1. Identify the key decarbonisation policies needed by Europe to achieve climate goals aligned with the Paris Agreement through analysis of relevant existing pathways.

[10] Report: https://cdn.eurelectric.org/media/3457/decarbonisation-pathways-h-5A25D8D1.pdf, Full study results: https://cdn.eurelectric.org/media/3558/decarbonisation-pathways-all-slideslinks-29112018-h-4484BB0C.pdf

2. Establish the expected distributional impacts (in terms of the effects on household incomes and expenditure) of the identified key decarbonisation polices, using a comprehensive macro-economic model.

3. Develop policy options which could be used to mitigate the regressive impacts of the key decarbonisation policies, drawing on a combination of real-life case studies, stakeholder consultations and wider research.

4. Re-run the macro-economic model with the combined policy options to test the effects and identify potential changes to the distributional impacts of the key decarbonisation policies.

5. Provide a commentary of how the combined options could be implemented in a European Union (EU) context and some of the efficiencies or challenges that could be expected.

The outputs of this study should provide policymakers with options which could help EU institutions minimise the potential regressive effects of climate policies on EU citizens, whilst retaining decarbonisation objectives.

2. The distributional effects of decarbonisation policies

Key findings:

- Six types of decarbonisation policies are crucial to help the EU achieve Paris Agreement aligned climate goals:
  - Carbon pricing, which places a cost on carbon emissions
  - Taxation of energy vectors, that taxes fossil fuel use
  - Emission performance standards, which mandates the phasing out of emission intensive technologies
  - Subsidies for low-carbon technologies, which provide financial incentives for the deployment of renewable energy
  - Phase out of the subsidies for fossil fuels
  - Energy efficiency measures, which facilitate the implementation of energy efficiency
- Taken in isolation and based upon the way they reduce emissions, if not designed accordingly these decarbonisation policies would have a mix of regressive and progressive impacts on household disposable incomes
- All decarbonisation policies modelled are needed for EU to achieve Paris Agreement aligned climate goals and regressive effects should not be misunderstood as making the policy ineffective. More important is the need to introduce measures to counteract the regressive element so climate goals can be achieved in a more egalitarian manner.

A wide range of climate policies are available to policymakers to reduce emissions. The design, scope and stringency of different policies will determine the speed and magnitude of emission reductions, as well as the scale of distributional effects arising from the implementation of these policies. The first part of this study establishes the distributional effects of different climate policies. The findings can better inform policymakers of the potential implications of different policy choices, although these depend quite significantly on implementation details.

The first step establishes the level of ambition (i.e. 95% emissions reductions by 2050) in line with current EU targets, and then identifies the polices and the stringency of those policies, required to achieve the targeted emissions reductions. Macroeconomic modelling is then used to determine which policies have the most significant regressive and progressive impacts on the household disposable incomes of the various incomes groups within the EU. Using the policy design parameters established in the first step (design, scope, stringency), each policy is modelled within a separate scenario to test its distributional effects. These are then compared to establish which policies have the most significant impacts. Please see section 2.2 for additional details on the modelling process.

The objective of the study is to assess the distributional effects of policies as if they are part of a wider policy package to achieve decarbonisation in the EU rather than find the most cost-effective pathway to decarbonisation. For each policy scenario, a selection of scenario inputs is made to represent a level of ambition consistent with that of a wider policy package to achieve decarbonisation. However, the decarbonisation policies analysed in the study, by themselves or combined, are only a subset of the policy changes needed to achieve full decarbonisation.

The study focuses on the policies that are expected to play a major role in Europe's decarbonisation journey, however full decarbonisation will require more than these policies alone.

2.1 Decarbonisation scenarios and key climate policies

The starting point for the study was the Eurelectric 2018 Decarbonisation Pathways study, which identified three increasingly ambitious decarbonisation pathways for Europe's electricity sector (80%, 90% and 95% by 2050 from a 2015 baseline).[11] The most ambitious, 95% decarbonisation goal was selected as the target ambition level as it is closely aligned with the Paris Agreement's aim of keeping global temperature rises well within 1.5 degrees and is consistent with the EU's most recent decarbonisation targets.[12]

To supplement the Eurelectric study, additional decarbonisation pathways covering a broad range of decarbonisation policies in line with a 95% decarbonisation of EU's emissions by 2050 were examined to identify the key policies necessary to achieve the required ambition, and the stringency of those policies. This established the decarbonisation policies that are consistently considered instrumental for the EU to meet its climate policy goals as laid out in credible existing decarbonisation pathway scenarios. [13]

These climate policies often have areas of significant overlap both in terms of the way they function and their coverage (i.e. different implementation approaches of the same policy type). To add value to the study, policies where there are overlaps in their target sectors and similarities in effects were aggregated under one policy group type, for example carbon pricing policies, which includes all price-based mechanisms such carbon taxation and emissions trading. This grouping ensured that later work focuses only on deriving distributional impacts of the key decarbonisation policy type (as opposed to a variation in the implementation[14] thereof) and

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[11] Eurelectric, 2018, "Decarbonisation pathways". Available under https://cdn.eurelectric.org/media/3558/decarbonisation-pathways-all-slideslinks-29112018-h-4484BB0C.pdf

[12] European Commission, 2020, Climate strategies and targets – 2050 long term strategy. https://ec.europa.eu/clima/policies/strategies/2050_en

[13] These decarbonisation policy types are seen playing a major role to help Europe achieve the aforementioned climate goal. It is not to suggest that these decarbonisation policies alone will be sufficient, but rather looking at their distributional effects would provide the most value.

[14] The intent here is to determine which policies are inherently regressive in the way they reduce emissions regardless of implementation measures which could include elements such as revenue balancing that addresses distributional impacts

allowed the report to cover a broader range of different individual policies. The results of this grouping exercise are the subsequent key types of decarbonisation polices as shown in Table 3.

The distributional effects of these policies have been assessed through the modelling exercise described in the following sections.

Table 3: Policy groupings and covered decarbonisation policies

Policy Group	Decarbonisation Policy
Carbon pricing	Covers all policies introducing a carbon price, such as the European Union Emissions Trading Scheme (EU ETS) or a carbon tax
Taxation of energy vectors	Covers all policies regarding taxing fossil fuels in heating, road transport and taxation of electricity
Emission performance standards	Covers all policies regulating emission standards such as emission standards for cars or household appliances.
Subsidies for low-carbon technologies	Covers all policies that support low-carbon technologies in energy production, transport and heating.
Phase out of fossil fuel subsidies	Covers the phase out of all fossil fuels subsidies in energy, heating and transport such as heating oil and diesel.
Energy efficiency measures	Covers all of energy efficiency obligation and support schemes under article 7 of the EU Energy Efficiency Directive (EED)

2.2 Modelling the distributional impacts of decarbonisation policies

2.2.1 Modelling approach overview

The modelling approach for this study has been designed to assess the distributional effects of decarbonisation policies, considering different options for revenue recycling and interactions between the decarbonisation policies. The macroeconomic model used is the E3ME model. E3ME is a global, macro-econometric model that is designed to model the impact of policy addressing the major economic, social and environmental challenges that the world is facing. Developed and expanded over the past 25 years, it is one of the most advanced models of its type today. For additional information on the E3ME model please refer to Appendix A.

To assess the impact of a policy measure or a combination of policy measures, a conventional difference-to-baseline approach is used. For such an approach, it is necessary to define:

a) a baseline projection / counterfactual case, i.e. what would happen in the absence of the policy.

b) one or more alternative policy scenarios, i.e. what would happen in the case new policy measures are introduced.

The impact of the decarbonisation policy is then identified by comparing the differences in the values between the baseline projection and the alternative scenario for selected output indicators, i.e. all differences can be attributed to the policy measures being assessed. When results are presented, values of a selected variable between the baseline and a policy scenario are compared for the same point in time, rather than changes over time. In other words, assessments on the distributional impact are made by comparing household incomes in the baseline projection with household incomes in the policy scenario.

In a first stage in section 2.3, the distributional effects of individual policies on household incomes are simulated separate from each other and without making any assumption around the use of potential revenues by government or how the policy costs are paid for by government. This is to assess whether a policy tends to be regressive or progressive without revenue balancing, mitigation measures, or interactions between policies. In addition, the further impact the redistribution of costs and revenues could have on the distributional effects of the decarbonisation policies is assessed. This is carried out by assessing the government costs and revenues of each of the policies and conducting sensitivity analysis in which income taxes and VAT are adjusted to compensate for revenues lost or gained (i.e. to maintain a neutral impact on government finances):

- if a policy generates revenues, the government can use the additional revenue generated to lower other taxes (or use the revenues for other policies, e.g. mitigation measures)

- if a policy requires spending, the government needs to increase the revenue from other taxes (or reduce government spending elsewhere)

The revenue balancing will itself have redistributive effects. Depending on the sensitivity, revenue balancing will likely moderate or enforce the distributional effect of a policy grouping.

In the second stage in section 5, a combination of all the policy inputs from the individual decarbonisation policy scenarios is modelled alongside additional measures to mitigate potential regressive effects. This allows for the assessment of the net distributive impacts of a wider policy package.

It should be noted though that even the combined policy options do not represent a full set of policies to reach a full decarbonisation pathway. The selected climate policies are a subset of the policy package required to achieve full decarbonisation of the EU's economy.

Please see Appendix D for additional information with respect to the methodological approach.

2.2.2 Baseline scenario assumptions

A baseline can be defined as a combination of projections for model variables, representing a business as usual situation that does not introduce bias into the scenario results (i.e. no new policy is implemented).

The standard E3ME model baseline is largely consistent with the 2016 EU Reference Scenario (DG Energy, European Commission 2016) and includes projections for demographic indicators, employment, labour supply and GDP growth, sectoral production and trade, energy system developments and CO_2 emissions. These projections are currently calibrated to be consistent with the following inputs:

- Eurostat Europop 2015 population projections for EU regions. For non-EU regions in the model, the UN population projections have been used.
- For EU regions, GDP projections consistent with AMECO 2017 release for the short-term, and with the 2016 EU Reference Scenario (PRIMES) over the long term. Gross value added (GVA) is disaggregated by sector to be in line with the PRIMES Reference Scenario assumptions. For non-EU regions GDP assumptions from the International Energy Agency (IEA) World Energy Outlook 2016 have been used.
- For EU regions, energy balances and EU ETS prices are consistent with the EU Reference Scenario (PRIMES). The PRIMES reference focuses on the EU energy system, transport and greenhouse gas (GHG) emission developments, including specific sections on emission trends not related to energy, and on the various interactions among policies in these sectors. It includes policies and measures adopted at EU level and in the member states by December 2016. For non-EU regions the energy balances are consistent with IEA World Energy Outlook 2016 Current Policies Scenario.
- Global fossil fuel prices are consistent with World Energy Outlook 2016 Current Policies Scenario assumptions.
- EU sectoral employment projections are consistent with CEDEFOP's[15] latest projections created by Cambridge Econometrics (projection reference E3ME 6.1 C174 from January 2018) under the framework contract 201 6-FWC4/AO/DSLJVKVET/skills forecasts/00 1/16.

For policy scenario assumptions please see the individual decarbonisation policy entries in the following section.

[15] European Centre for the Development of Vocational Training

2.2.3 Revenue balancing scenario assumptions

The aim of the revenue balancing is to explore the sensitivity of the distributional impact to adjustments in different taxes. Total net costs/revenues from each policy are used to adjust average tax rates for income tax, employers' social security contributions and Value added tax (VAT). The balancing of overall government revenue is done with the E3ME model and the results of this revenue balancing feed through into the distributional impact analysis.

The following rates of rebalancing allocated to each tax are applied:

	Central Revenue balancing	All to Income Taxes	All to VAT
Income tax	33.4%	100%	0%
Employers' social security contributions	33.3%	0%	0%
VAT	33.3%	0%	100%

Table 4: Revenue balancing assumptions - rebalancing rates

Through these sensitivities, we can test the relative distributional impact for direct taxes vs VAT. For VAT, the changes in VAT rates are already factored into E3ME's calculation of consumer prices. As such the revisions to VAT feed into the distributional impact analysis by the change in consumer prices for goods and services for which VAT is applied to.

For income taxes, an additional step is introduced to account for the differing effective income tax rate by income group and member state. Data from Eurostat on the distribution of income taxes paid by households as a percentage of their gross income by income quintile[16] is used to calculate the relative impact of a change in average income taxes on each income decile.

When adjusting income tax rates, the average income tax rate is adjusted and thus all income tax bands proportionally. In reality, governments may tailor the adjustment of income taxes in a way that alters the distributional impacts further. For example, if tax reductions are implemented only in the lowest income tax bracket, this would benefit the households in lower tax bands more. This would make the adjustment more progressive compared to a proportional adjustment.

[16] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=icw_tax_06&lang=en

2.2.4 Output indicators

Results are presented for the following output indicators:

a) Distributional impact:

- Changes in real income by decile (including accounting for changes in energy expenditure and policy costs)
- Changes in the GINI coefficient

b) Economic impact:

- Changes in GDP
- Changes in total employment

All results are presented as % difference from the baseline scenario, for the EU 27 and the UK, Northern Europe, Southern Europe, Central and Eastern Europe and Western Europe[17].

GDP and employment are standard outputs from E3ME and are calculated for the 5 regions by aggregating the results across member states. For the distributional impacts, as we are looking at average effects on incomes by decile across multiple member states, member state results are aggregated using weights based on population of each member state. This ensures that changes in real income for each member state are treated equally.

For more details on how real incomes by decile and the GINI coefficient are calculated, see Appendix D.

2.3 Expected distributional impacts of selected climate policies

A detailed overview of each decarbonisation policy type and their expected distributional impacts through the E3ME model is provided in the following subsections with the results and a comparison of the results across the policies shown in section 2.4. For the expected economic impacts please see Appendix B.

[17] Northern Europe: Denmark, Estonia, Finland, Latvia, Lithuania & Sweden
Central and eastern Europe: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovenia & Slovakia
Southern Europe: Cyprus, Greece, Italy, Malta, Portugal & Spain
Western Europe: Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, United Kingdom

2.3.1 Carbon pricing

Carbon pricing refers to a policy that puts an explicit price on the emission of GHGs usually expressed as a monetary value per tonne of carbon dioxide (CO_2) or carbon dioxide equivalent (CO_2e). Carbon pricing can be implemented through two main mechanisms, an emission trading scheme, such as the EU ETS, or a carbon tax.

In this study, the carbon price is modelled as a carbon tax and reflects a coverage that is slightly broader than the current EU ETS by also including energy use from construction and transport sectors other than road transport..

2.3.1.1 Key assumptions

- A steadily increasing carbon price reaching €350/ tonne CO_2 is imposed in line with the European commission's long term strategy[18]. The coverage of the carbon price reflects a coverage that is broader than the current EU ETS by also including energy use from construction and transport sectors other than road transport which is covered separately through the scenario related to taxation on energy vectors.

- The carbon price is modelled as a carbon tax on the sectors targeted and is assumed to be paid by the relevant industry. This policy is not assumed to have any cost directly imposed on consumers, which are instead indirectly affected through industry and energy prices.

2.3.1.2 Impact assessment results (without revenue balancing)

Overall, as can be seen in Figure 5 the impact of Carbon pricing is regressive as lower income households are worse off than higher income households resulting in an increase in the Gini coefficient. This regressive impact increases over time as the carbon price increases in real terms over time.

[18] European commission: IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773 - A Clean Planet for all A European long term strategic vision for a prosperous, modern, competitive and climate neutral economy

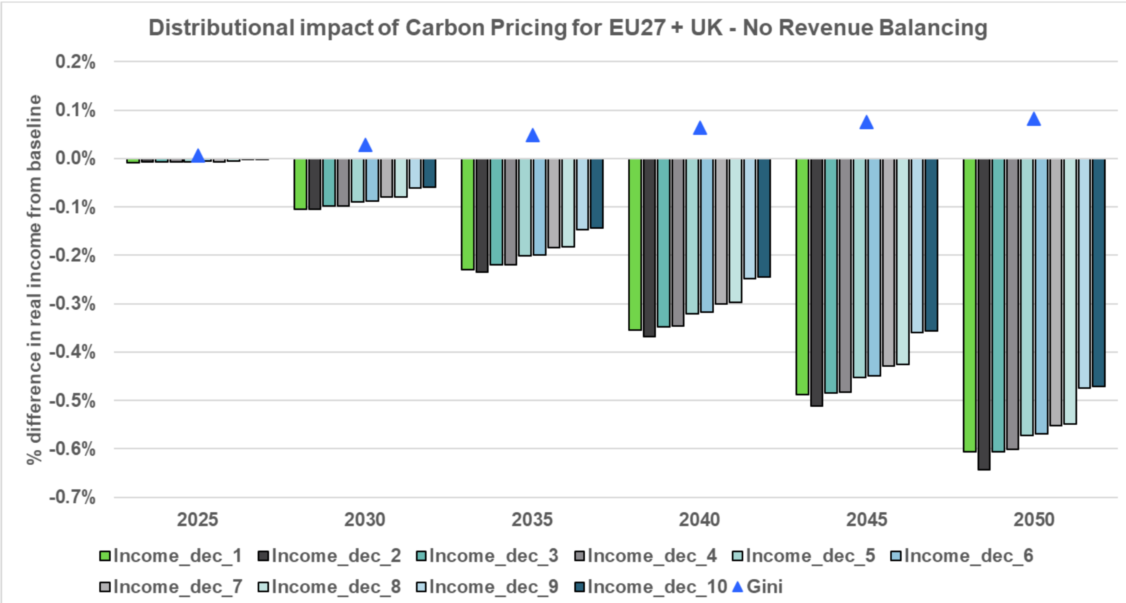

Figure 5: Modelled distributional effects of carbon pricing

Although a carbon price is not imposed directly on households, it still leads to a regressive impact indirectly through two main channels:

1. Carbon pricing targets a wide range of industries which feeds into consumer expenditure on a wide range of goods and services. As the impact is spread across goods and services, the impact of prices on households is well distributed. However, the overall increase in consumer prices will impact lower income households more as they have a higher aggregate propensity to consume from income, whereas higher income households save more of their income.

2. Despite carbon pricing incentivising some decarbonisation in the power sector, while not achieving full decarbonisation by itself, the high carbon price leads to higher electricity prices across the EU. The impact of this price rise is assumed to be passed through fully to the consumer prices and as lower income households spend a higher portion of their income on electricity than higher income households this impact will have a proportional greater impact on these households.

2.3.1.3 Impact assessment results (with revenue balancing and tax sensitivities)

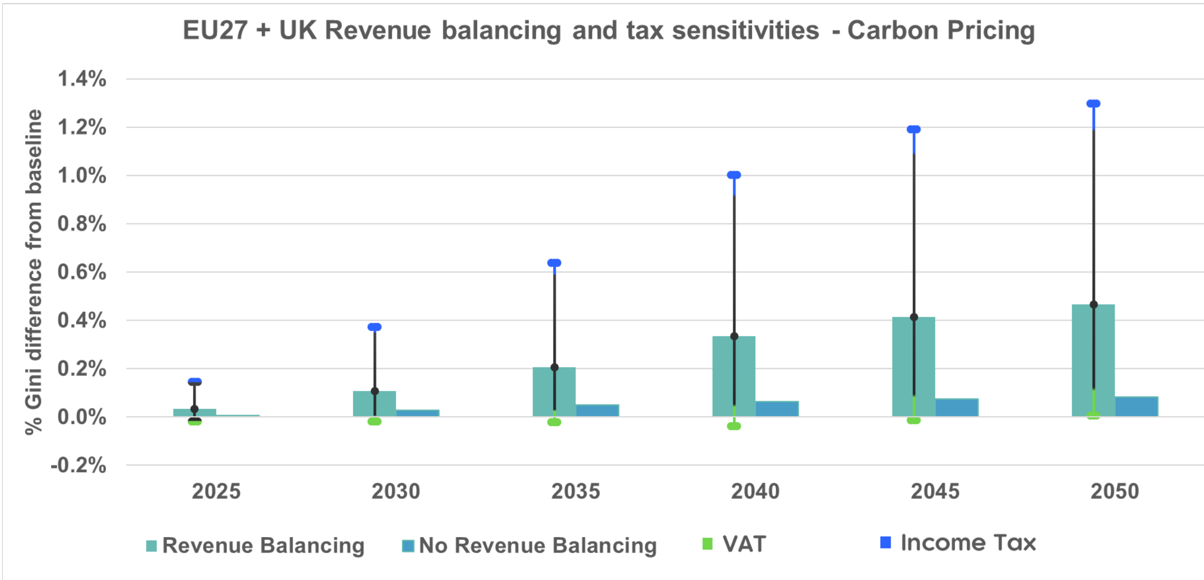

Figure 6: Modelled distributional effects of carbon pricing with revenue balancing

In the modelled carbon pricing scenario, the increasing carbon price generates revenues over time that can be reallocated as part of revenue balancing and used to reduce taxation. As can be seen in Figure 6 if this revenue is used to reduce income taxation in the central revenue balancing scenario, this has a net regressive effect compared to a scenario with no revenue balancing, i.e. the Gini coefficient increases by more than without revenue balancing. This is primarily due to:

- low-income households below the base income tax threshold missing out on the benefits but still having to deal with the costs.
- the benefit of the revenue balancing increases with the average income tax rate of each decile

The scale of the regressive impact increases over time as the revenues from carbon pricing increase overtime.

When variations in the revenue balancing options are considered (income taxes vs VAT), this shows that the type of tax used matters significantly for the distribution of the impact. Due to the large levels of revenue generated, the variation between revenue balancing through average income taxes and VAT is quite large, with income tax having a regressive impact compared to a progressive impact of VAT when lowered for the same amount of revenue allocated. This difference in scale is due to the progressive nature of income tax, hence lowering this tax for all households proportionally has the opposite effect.

2.3.2 Taxation of energy vectors

Taxation of energy vectors includes all topics on taxation and levies on consumption of electricity, fossil fuels for heating, electricity and transportation. As a policy, energy taxation is widespread across EU member states with all countries applying a tax to at least one energy vector. From a climate perspective, taxes on fossil fuels should incentivise lower fuel consumption, and therefore lead to a reduction in GHGs.

Three policy inputs were included in the model: taxation on fossil fuel use for heating (coal, oil gas), taxation on fossil fuel use for road transport (petrol and diesel), and redistribution of electricity levies to general taxation. Fossil fuel use in the electricity sector is covered by the carbon pricing policy.

2.3.2.1 Key assumptions

For the taxation of energy vector scenario, a selection of taxation policies that have a direct impact on end user prices for fuel use by consumers is assessed. The policy scenario is made up of three policy inputs:

- **Taxation of fossil fuel heating**: A tax on fossil fuel use for heating is applied. The level of the tax steadily increases over time between 2020 and 2050 and is broadly proportional to the ambition of the carbon prices applied in the carbon price policy and as such by 2050 varies between 4 (Natural gas) and 7 (Coal) euro cents / kWh.
- **Taxation of fossil fuels for road transportation:** A tax on fossil fuel use for passenger road transport is applied. The level of the tax steadily increases over time between 2020 and 2050 and is broadly proportional to the ambition of the carbon prices applied in the carbon price policy and as such by 2050 reaches 3 euro cents / MJ
- **Redistribution of electricity levies to general taxation:** The current level of renewable energy sources (RES) support financed by end users[19] is projected forward, factoring in both the level of renewables to be deployed in the baseline scenario and an assumption that the RES support will be phased out by 2035. The RES support is taken off end user energy prices and then reallocated to an increase in general rates of taxation.

2.3.2.2 Impact assessment results (without revenue balancing)

The taxation on energy vectors policy overall shows a regressive impact as shown in Figure 7. The main causal element of this policy type is that it raises energy costs, specifically for households. The redistribution of electricity levies to general taxation can have an opposite effect (i.e.

[19] Based on study: **Energy Prices, Costs and Subsidies and their Impact on Industry and Households**, Trinomics, 2018

progressive effect) and thus mitigate some of the regressive effects from the taxation on fossil fuels.

- Taxation of fossil fuel heating imposes higher costs directly on household fuel use, which on average lower income households spend a higher share of their income on. However, over time, it incentivises switching to more efficient heating systems reducing the burden of the tax over time.

- Targeted taxation increases the costs related to fossil fuel-based road transport systems directly for households. The taxation alone is insufficient to lead to a substantial additional shift to lower emission vehicles, but a small shift to electric vehicles (EVs) in the baseline reduces the impact of the fuel tax over time.

- Redistribution of existing RES support to general taxation is modestly progressive; it reduces electricity prices for end users which benefits low-income deciles more than other higher income deciles. This explains why the regressivity peaks in 2035 when the levy is assumed to have been phased out. The redistribution of RES support to general taxation can be considered as a proxy of the effect that, more generally, the elimination of policy costs from electricity bills would have.

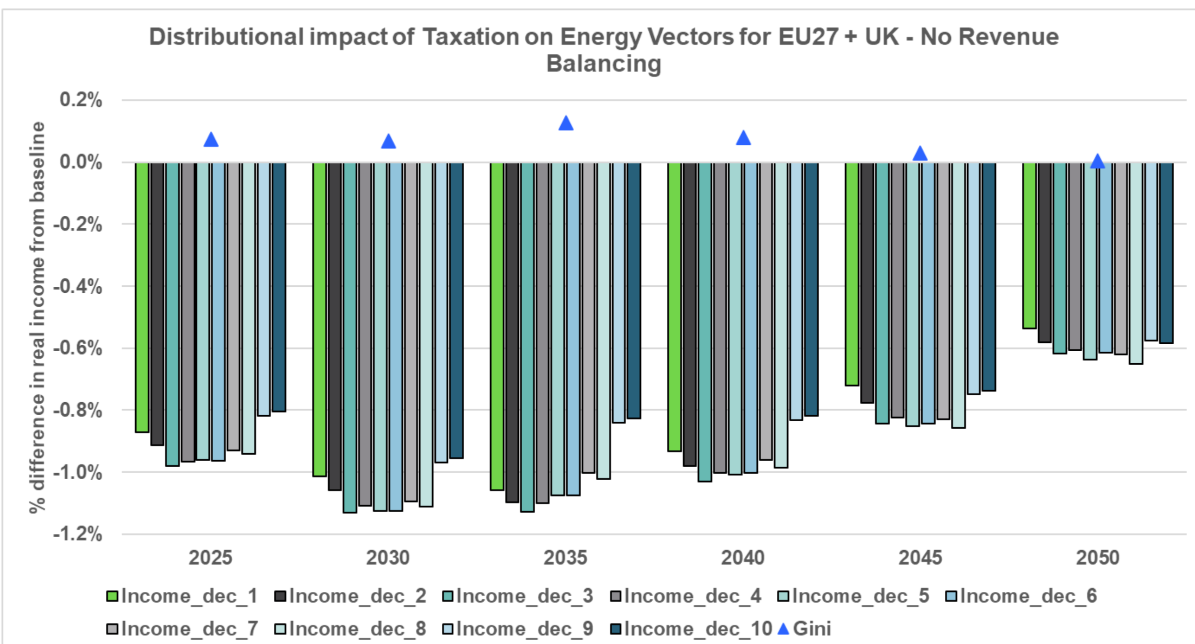

Figure 7: Modelled distributional effects of taxation of energy vectors

2.3.2.3 Impact assessment results (with revenue balancing and tax sensitivities)

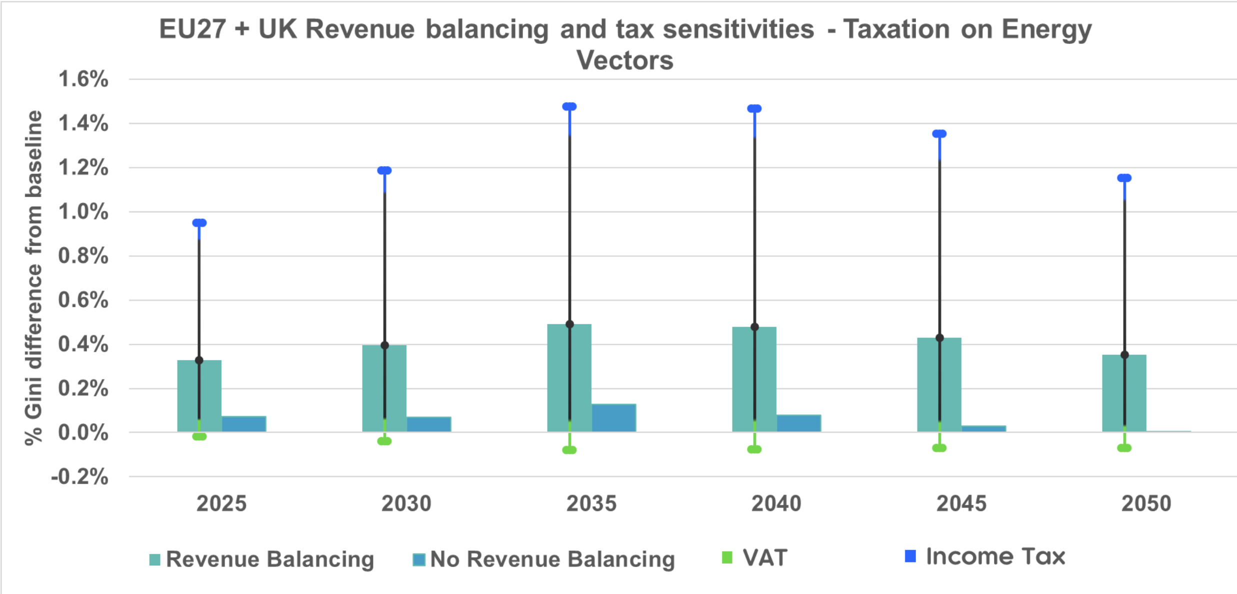

Figure 8: Modelled distributional effects of taxation of energy vectors with revenue balancing

In the taxation on energy vectors scenario, the higher taxation on fossil fuel heating and Internal combustion engine (ICE) vehicles generates additional revenues. Figure 8 shows if this revenue is used to reduce general taxation in the central revenue balancing scenario, this has a net regressive effect compared to a scenario with no revenue balancing, i.e. the Gini coefficient increases by more than without revenue balancing. The peak increase in regressivity of the policy is in 2040 after which the revenues from the taxation policies start to fall as decarbonisation of heating and transport partially offsets the increasing taxation rates. It should be noted that up to 2030, this policy grouping entails the redistribution of electricity levies to general taxation. When these costs are redistributed to general taxation, they provide a small progressive impact but is not enough to offset the regressive impact from the taxation on fossil fuels.

When variations in the revenue balancing options are considered (income taxes vs VAT), this shows that the type of tax used matters significantly for the distribution of the impact. If revenues are used to reduce average income tax rates (top red bar), the regressive effects are amplified significantly as a proportional increase in income tax will benefit higher income households more who face a higher average income tax rate than the lowest income households. Alternatively, if all the revenue is used to reduce VAT, then this can offset regressive impacts making the overall impact of the policy marginally progressive.

2.3.3 Emissions performance standards

Emission performance standards are a regulatory tool, to mandate a certain technological standard. In practice they are used to regulate everything from energy efficiency of household appliances, to heating technologies and vehicle emissions. In the model we assume the phase out of both carbon intensive heating technologies from 2025 and of ICE powered vehicle sales by 2035.

2.3.3.1 Key assumptions

Emissions performance standards are modelled as strict regulation to phase out carbon intensive technologies in road transport and residential heating:

- Gradual phase out of fossil fuel heating systems from 2025
- Phase out of ICE vehicles from new sales from 2035

This assumption comes from suggested policies required to meet the 95% decarbonisation pathway outlined by Eurelectric's 2018 Decarbonisation Pathways study.

For road transport, the modelling considers the change in type of vehicles sold. We are just exploring the impact of the change in the vehicle fuel use without analysing the required infrastructure investment required to support the regulation. Equally, we are not modelling any additional changes in vehicle prices under the assumption that from 2035, the cost of EVs has converged with ICE vehicles to make the regulation feasible as referenced in the McKinsey study. This contrasts with the PRIMES reference baseline which is a business as usual scenario and so the uptake of EVs does not progress.

We also assume that the demand for heating technologies and road transport stays consistent with the level of demand in the baseline. This is to allow us to isolate the impact of the transitions to low-carbon technologies on households' budgets. In reality, if the switch to low-carbon technologies leads to lower energy costs, there could be a potential rebound effect which would dampen the distributional impact from lower energy expenditure.

2.3.3.2 Impact assessment results (without revenue balancing)

The phase out of fossil fuel heating technologies slowly switches households onto more efficient low-carbon heating technologies. This leads to lower heating bills over time, but as can be seen in Figure 9 the effect is initially offset by higher upfront costs so the changes in income are minimal. Similarly, the ban on new sales of ICE vehicles from 2035 leads to a substantial reduction in household expenditure on road transport fuel expenditure in the long run.

For the longer term, it is important to highlight the importance of the assumption around fossil fuel prices. In the baseline, we use the IEA Current oil prices, which assumes oil prices growing in real terms reflecting continued increasing global fossil fuel demand over time. This means that as time goes on, the price of fossil fuel use grows faster than average consumer prices. Therefore, a shift to low-carbon technologies for both heating and transport will lead to stronger improvement in household budgets, compared to under a baseline with lower oil prices.

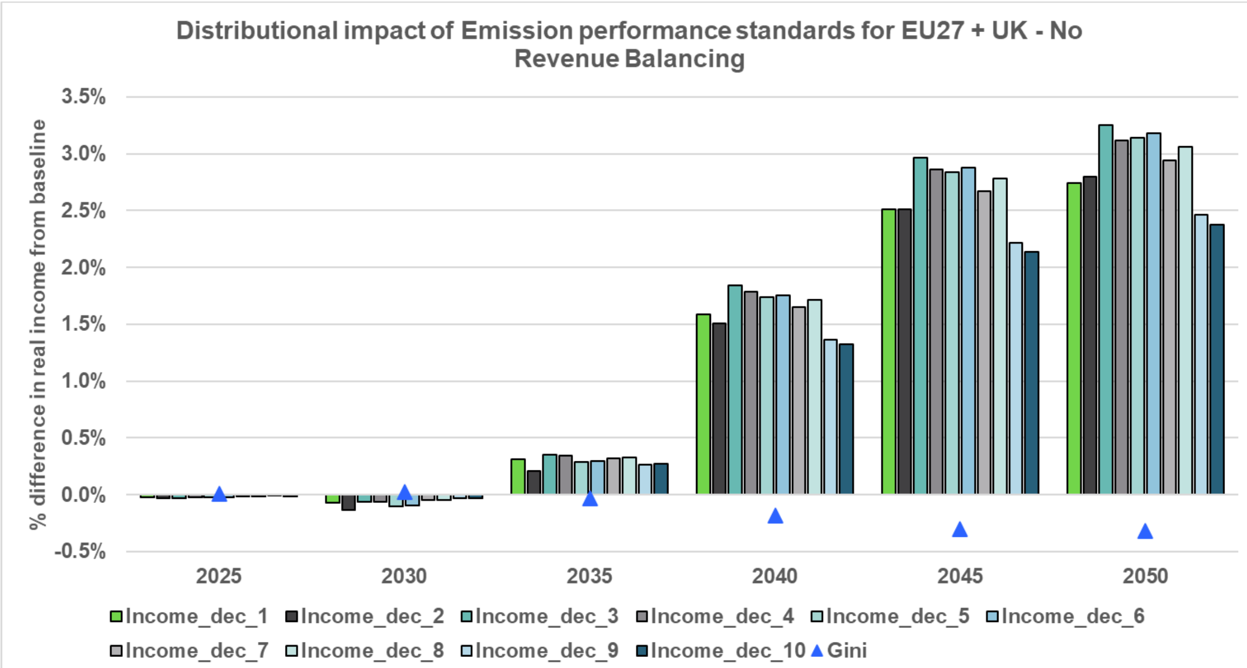

Figure 9: Modelled distributional effects of emissions performance standards

For the distribution of the impacts across deciles from emissions performance standards, the benefits for the lowest income deciles is greater than for the highest income deciles over the long term. This reflects that lower income households spend a higher proportion of their income on heating and transport. The benefits also accrue to the middle-income households across the EU which is largely driven by the expenditure on operation of road transport.

2.3.3.3 Impact assessment results (with revenue balancing and tax sensitivities)

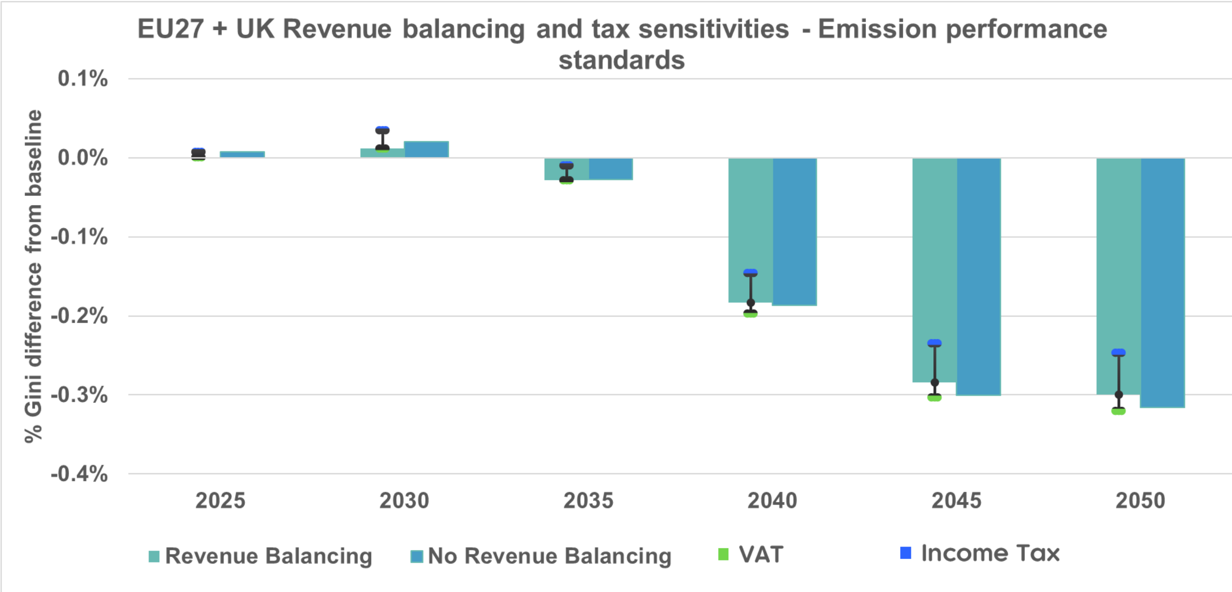

Figure 10: Modelled distributional effects of energy performance standards with revenue balancing

For emissions performance standards, as the policy is enacted solely through regulation, there are no direct revenues or costs to government from the policy. However, the policy indirectly leads to increased government revenues, generated from the ETS carbon pricing as electrification of household heating and road transport leads to increases in electricity demand. Figure 10 shows that the ETS effect increases significantly after 2035 when the phase out of ICE vehicles begins and electricity demand increases. As this effect increases revenues relative to the baseline, general taxation is reduced in the scenarios with revenue balancing. In the central case, the increase in the average income tax makes the scenario with revenue balancing less progressive and VAT makes the scenario slightly more progressive, compared to the scenario without revenue balancing.

2.3.4 Subsidies for low-carbon technologies

Subsidies for low-carbon technologies in the context of the model encompass two major types. Subsidies for renewable energy generation technologies, such as solar photovoltaic installations, wind farms and biomass plants and subsidies for renewable heating technologies. Both policies aim at increasing the take up of the low-carbon technology.

2.3.4.1 Key assumptions

For the subsidies of low-carbon technology, the impact of subsidising a range of low-carbon technologies for power generation and residential heating to support the take up of these technologies is assessed. It is assumed that the subsidies are financed through government support.

- Subsidies for renewable energy generation:
    - Solar and wind generation: feed in tariffs of around €55-60/MWh which are imposed for all EU countries but are stopped by either 2030 or 2035 depending on the region to reflect different starting points in the baseline. The overall early phase out reflects the already rapid reduction in generation costs will eventually mean support is no longer needed.
    - Biomass, Biogas and Geothermal: subsidies start at 80%, 20% and 50% of the investment cost respectively in 2020 and are gradually phased out to 0 by 2050
- Subsidies for renewable heating
    - A subsidy of 50% of capital investment costs for all renewable heating technologies in 2020 is introduced. The subsidy is gradually phased out by 2050.

2.3.4.2 Impact assessment results (without revenue balancing)

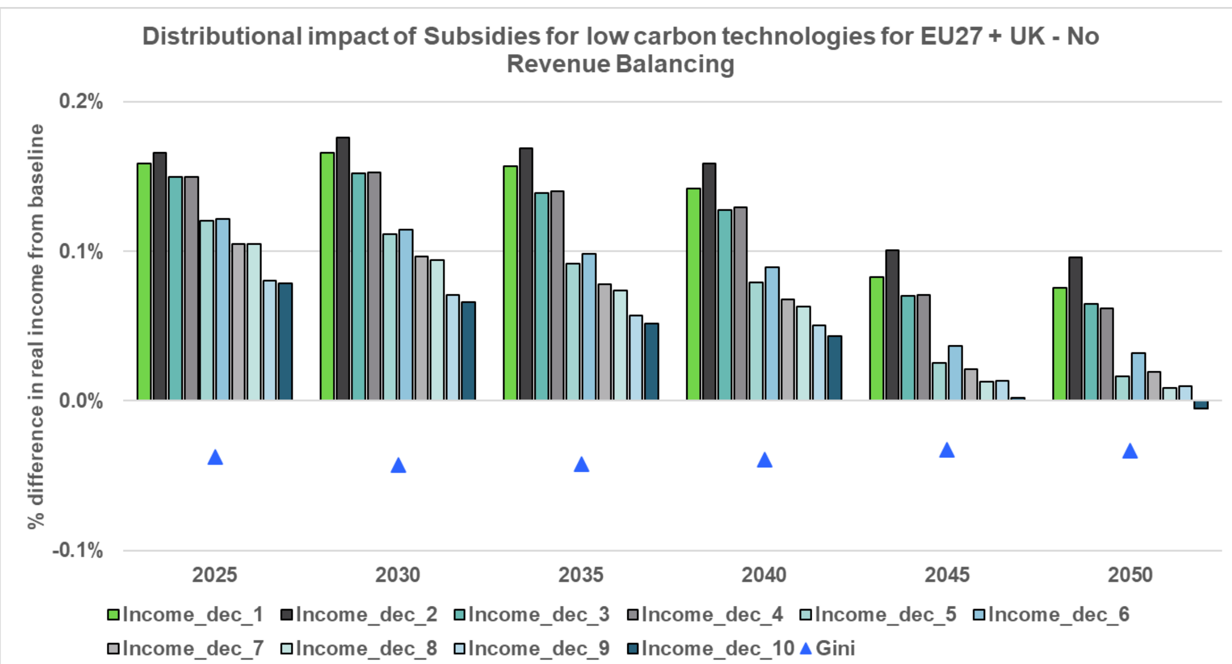

Figure 11: Modelled distributional effects of subsidies for low-carbon technologies

Given synergies with a low-carbon future, subsidies for renewable power generation should lead to a reduction in electricity prices. As can be seen in Figure 11 this benefits lower income deciles more than higher income deciles, because they generally spend a higher proportion of their income on electricity.[20]

Subsidies on low-carbon heating technologies support a shift to more efficient heating technologies. This reduces fuel expenditure for households which more strongly affects low-income households.

2.3.4.3 Impact assessment results (with revenue balancing and tax sensitivities)

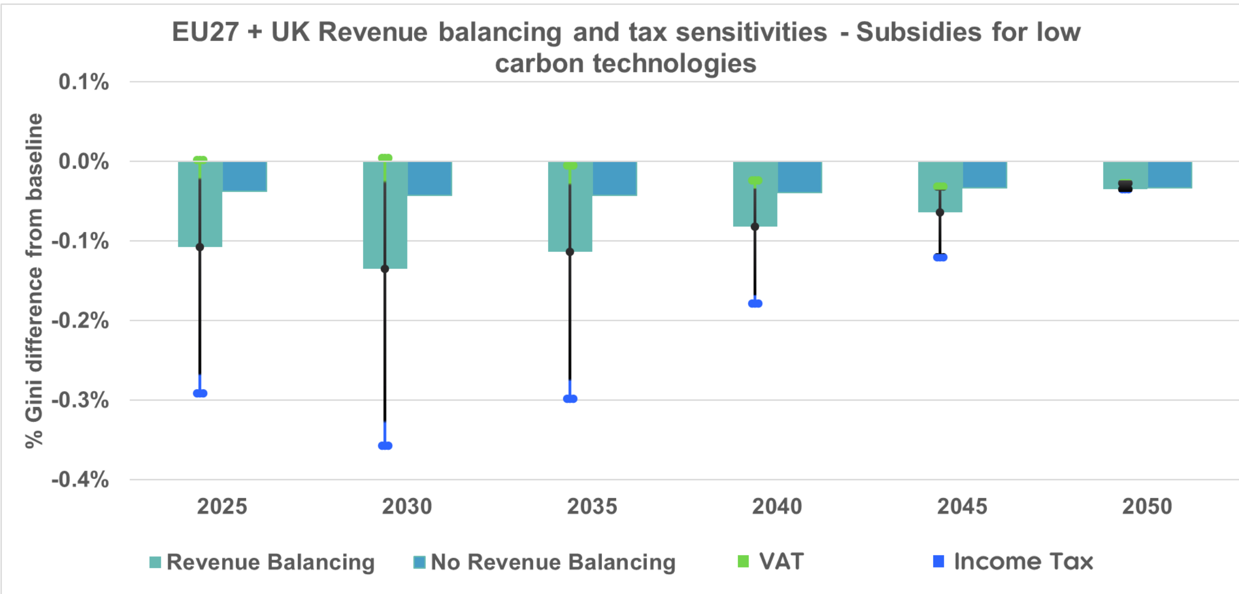

Figure 12: Modelled distributional effects of subsidies for low-carbon technologies with revenue balancing

For subsidies of low-carbon technologies, the model assumes that the subsidies are to be funded by government spending, these costs are recouped through additional taxation in the revenue balancing scenarios. Under the standard revenue balancing assumptions, the increase in taxes increases the progressivity of the policy. Figure 12 shows that the impact of the revenue balancing is largest between 2020 and 2035 where the largest levels of subsidies for low-carbon technologies are in place. Over the longer term, the subsidies are slowly phased out by 2050 and so the impact of the revenue balancing diminishes until there is no impact as seen where the difference between revenue balancing and no revenue balancing is zero.

When variations in the revenue balancing options are considered (income taxes vs VAT), this shows that an increase in average income tax rates leads to an increase in the progressivity of the

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[20] It is recognised that in practice subsidies for energy production are often funded via a surcharge on electricity consumption for households and industry which is uniform and sometime with exemptions for major users. This has been documented have a regressive by various sources found in the literature review. However, this is a design consideration of the policy as opposed to the innate way the policy functions. This is particular aspect of the subsidies for low-carbon technologies policy is explore in more detail in later sections with the results shown section 4.4.

policy scenario as higher income households face a higher average income tax rate burden than lower income households. However, if the subsidies for low-carbon technologies are financed through an increase in VAT, this makes the overall policy more regressive as lower income households spend a higher proportion of their incomes on purchasing goods and services for which VAT applies with respect to higher income households.

2.3.5 Phase out of subsidies for fossil fuels

Fossil fuels often still benefit from subsidies, which either take the form of tax exemptions or direct subsidies. The covered sectors of a phase out of fossil fuels subsidies are energy, heating (oil and gas) and transportation (gasoline and diesel).

2.3.5.1 Key assumptions

An average fossil fuel support across the EU27 + UK of 61bn[21] is estimated and shared out across all end uses of fossil fuels, resulting in an average level of support of €53 per tonne of oil equivalent (toe). This level of support is linearly phased out until the full level of support is removed by 2030. The removed support is added to the end user prices of fossil fuels raising costs.

2.3.5.2 Impact assessment results (without revenue balancing)

The removal of fossil fuel support leads to a small increase in energy prices, which feeds into prices for household fuel use. This affects lower income households more compared to higher income households.

Overall, the scale of fossil fuel support has a relatively small impact on incomes as much of the impact of the fossil fuel support removal is indirect (i.e. it is shared out across all fossil fuel use). The distributional impact increases up to 2030 as it is assumed to be phased out by 2030. Over the longer term, as can be seen in Figure 13, the distributional impact diminishes over time. There are several factors driving this. First, the impact of fossil fuel support on prices diminishes over time (as shown by lower income effect across all households) as the level of fossil fuel support falls in real terms and the economy becomes less carbon intensive in the baseline. Second, households respond to higher fuel prices and switch to low-carbon heating technologies.

[21] Based on: **Energy Prices, Costs and Subsidies and their Impact on Industry and Households**, Trinomics, 2018

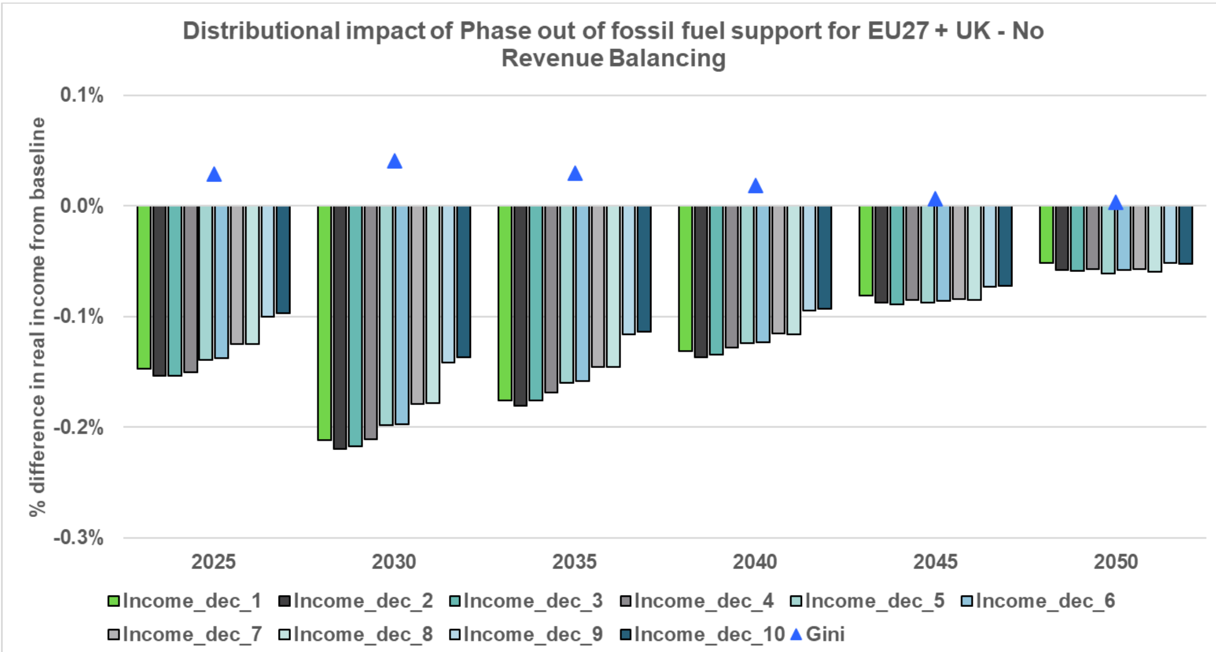

Figure 13: Modelled distributional effects of the phase out of fossil fuel subsidies

2.3.5.3 Impact assessment results (with revenue balancing and tax sensitivities)

When fossil fuel support is phased out, this frees up government expenditure which can be used to reduce taxation rates. Figure 14 shows that under the standard revenue balancing assumptions, the reduction in taxes makes the policy scenario more regressive. The distributional impact increases up to 2030, by which point most of the fossil fuel support is assumed to be phased out. Beyond 2030, the size of the fossil fuel support saved falls relative to growth in economic activity and income.

When variations in the revenue balancing options are considered (direct income taxes vs VAT), this shows that an increase in income tax has a relatively strong impact on the regressivity of the scenario. As the direct income tax is reduced proportionally, this benefits the higher income households more than lower income households. If revenues are balanced through VAT reductions, then this can offset the regressivity of the policy leading to a very marginal net progressive effect.

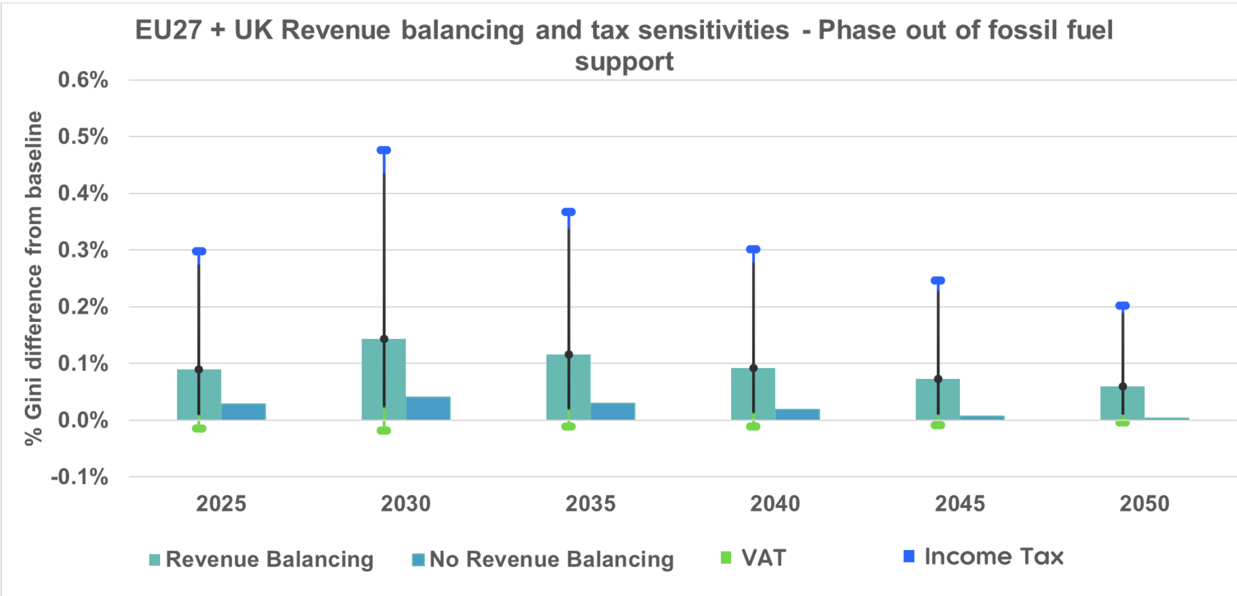

Figure 14: Modelled distributional effects of phase out of fossil fuel subsidies with revenue balancing

2.3.6 Energy efficiency measures

Energy efficiency measures mandate the obligated parties to achieve a quantitative energy savings target across their customer portfolio. The European Commission mandates member states in article 7 of the EED to implement either an energy efficiency obligation scheme (EEOS) or an alternative policy measure.[22] 15 member states decided to put an EEOS in place. Coverage by the model includes both obligation schemes mandating general household energy efficiency and efficiency improvements in industry.

2.3.6.1 Key assumptions

Energy efficiency measures are derived from the IEA World energy outlook 2015 450PPM scenario. To reflect the further ambition of the 95% decarbonisation targets, the level of energy efficiency is scaled up by a further 20%. Energy efficiency for households is assumed to be financed by the consumer and energy efficiency for industry is financed through industry.

- For industry
    - Annual exogenous energy efficiency investment of €30bn for the EU as a whole increasing steadily to €75bn by 2050 funded through higher industry prices.

[22] https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive_en

    - Exogenous reduction in energy demand equivalent to around 20% by 2050

- For households
    - Annual additional expenditure by consumers of €7bn increasing to €25bn by 2050 on energy efficiency measures
    - Exogenous reduction in energy demand reaching a reduction of around 20% by 2050
    - To allocate the energy efficiency investment in households to each income decile, the additional expenditure in the main scenario is allocated to expenditure on household maintenance. For each decile, it is assumed that the spending on household maintenance increases by the same in percentage terms.

It is assumed that the cost of energy efficiency measures is borne by the group that benefits from the energy efficiency savings directly such that households pay for household energy efficiency and industry pays the costs of industry energy efficiency investment. There is certainly a case that could be argued that Government may play a role in supporting energy efficiency investment. Thus by assuming households and industry bear the full costs, this could be considered the high end of how the costs are imposed.

2.3.6.2 Impact assessment results (without revenue balancing)

Energy efficiency measures in industry reduce costs which feed through into consumer prices. As shown in Figure 15, since lower income households spend a higher share of their income such price reductions have a larger impact on these households.

In addition, energy efficiency improvements in homes also proportionally benefit lower income households when these lead to savings in the energy bill. Finally, the overall energy efficiency improvements are large enough to shift fossil fuel prices leading to a substantial reduction in energy use across the whole EU which leads to a small reduction in energy prices from which lower income households benefit further.

It is important to highlight that the impact of the benefit of energy efficiency improvements across households depends on how the costs of the energy efficiency are distributed. In this scenario, the additional expenditure on energy efficiency measures for households is attributed as a percentage increase on spending on household maintenance. This spending is broadly even across household deciles, but in absolute terms, higher income households pay a larger share of the investment costs.

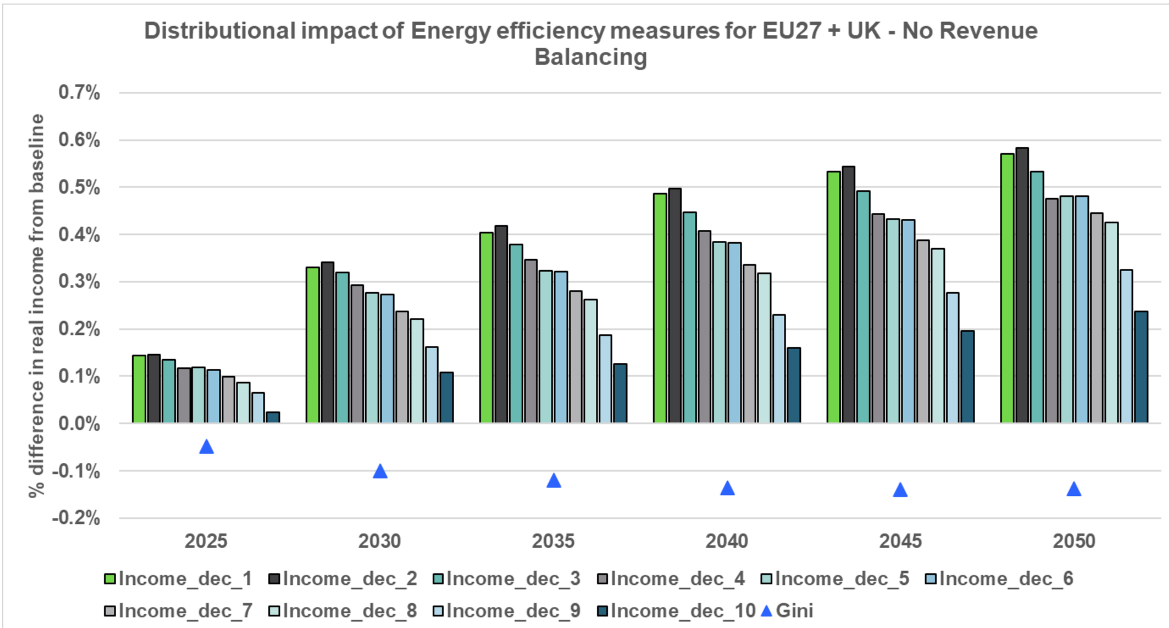

Figure 15: Modelled distributional effects of energy efficiency measures

2.3.6.3 Impact assessment results (with revenue balancing and tax sensitivities)

For energy efficiency measures, as the policy is enacted without any government support, there is no costs to be balanced under revenue balancing. However, the policy does indirectly lead to a reduction in government revenues. This is caused by the reduction of electricity demand from the energy efficiency measures in this scenario, which reduces revenues from the EU ETS relative to baseline. As this effect decreases revenues, under revenue balancing, general taxation is increased. When direct income taxation is increased, the scenario becomes more progressive. When VAT is increased, the scenario becomes slightly less progressive.

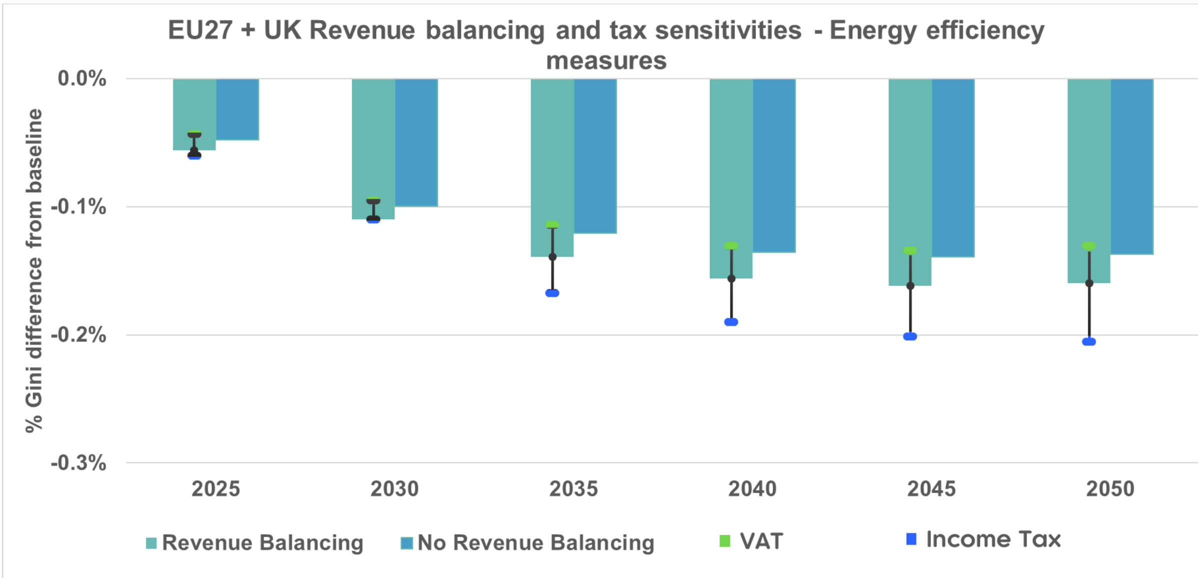

Figure 16: Modelled distributional effects of energy efficiency measures with revenue balancing

2.3.7 Regional differences in distributional impacts

While the focus of the analysis is on the EU27 + UK level results, results are presented for four European regions[23] to see if there are any significant regional differences.

2.3.7.1 Carbon pricing

Without revenue balancing, the trend in the regressive impact between regions is broadly similar, as shown in Figure 17. Northern Europe (NE) shows the smallest regressive impact reflecting the lower impact of carbon revenues from what is already a relatively low-carbon power sector. Conversely, Central and Eastern Europe (CEE), shows a much stronger regressive impact over most of the period. This reflects the higher carbon intensity of power generation in CEE as even with the accelerated phase out of coal relative to the baseline due to the higher carbon price, it still leads to higher electricity prices which most strongly affect the lowest income households.

When the carbon revenues are recycled with the central balancing methods previously described, the distributional effects are amplified across most regions proportional to the carbon revenues raised. However, if the revenues are recycled through VAT, the distributional

[23] Northern Europe: Denmark, Estonia, Finland, Latvia, Lithuania & Sweden
Central and eastern Europe: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovenia & Slovakia
Southern Europe: Cyprus, Greece, Italy, Malta, Portugal & Spain
Western Europe: Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, United Kingdom

effects of the carbon tax are offset for all regions, either becoming less regressive or more progressive.

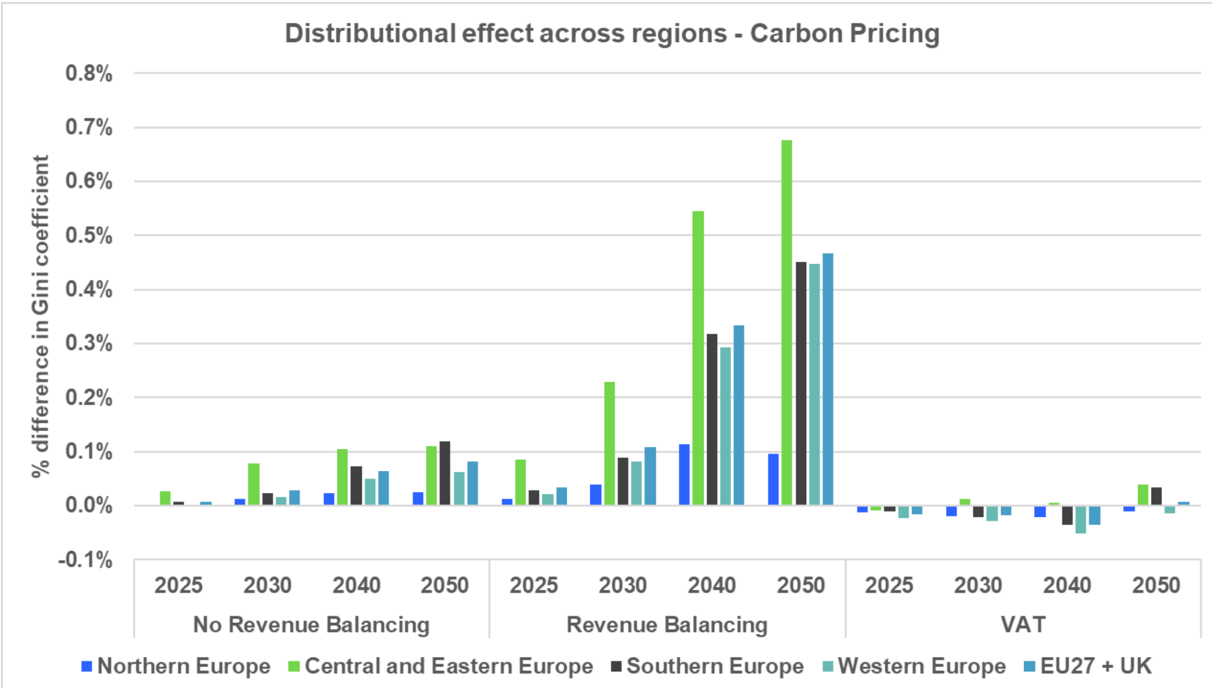

Figure 17: Regional differences in the modelled distributional effects of carbon pricing

2.3.7.2 Taxation on energy vectors

For the taxation on energy vectors, without revenue balancing, the distributional effects vary between regions. Figure 18 shows that in the short term, the taxation on energy vectors remains regressive but there are clear differences in the scale of the impact. Over the long term we see the impacts become progressive for CEE and NE. The main reason for this difference in distributional impact is that in these regions, higher income households spend a higher percentage of their income on private passenger transport than lower income households. This is the reverse of the wider EU level trend where transport energy expenditure makes up a larger share of income for low and middle income households. In addition, due to a very low share of fossil fuels in the heating fuel mix in NE, the taxation on fossil fuel heating has a much smaller regressive impact.

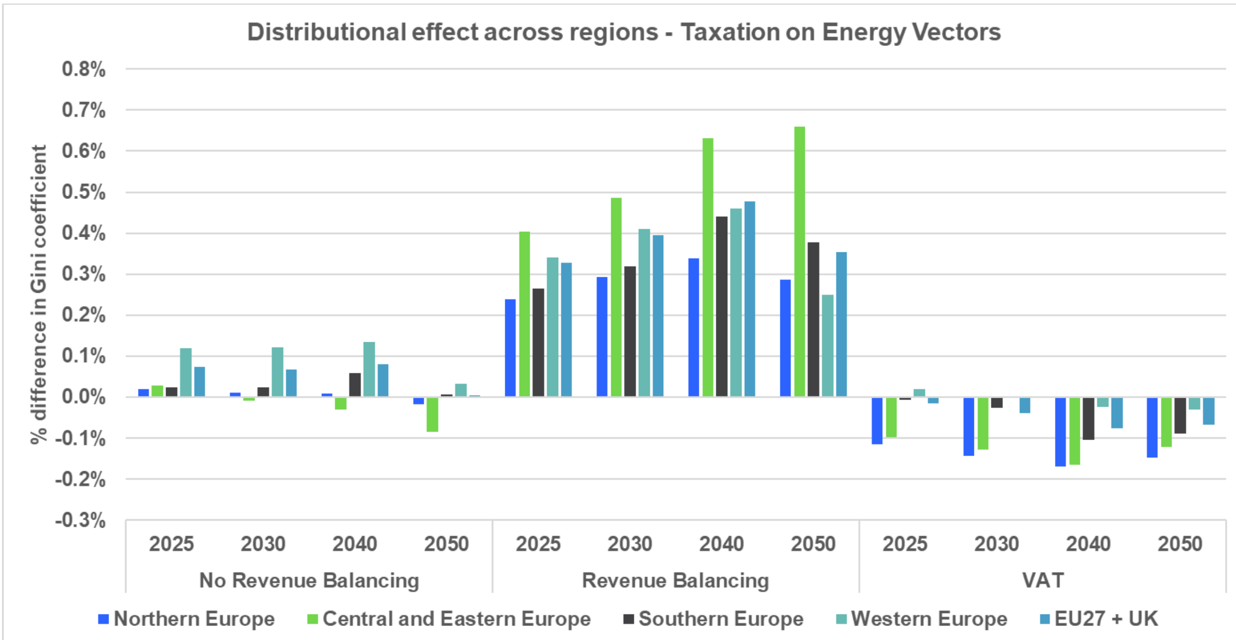

Figure 18: Regional differences in the modelled distributional effects of taxation on energy vectors

However, once revenue balancing is applied, the regional differences diminish. Under general taxation, reallocation of revenues has a strong regressive effect that offsets the distributional impact of the energy taxes. The regressive impact is due to the increase in income taxes the impact of which is broadly consistent across the EU. However, if the revenues were balanced just using VAT, this would help mitigate the regressive effects across all regions.

2.3.7.3 Subsidies for low-carbon technologies

For subsidies for low-carbon technologies, without revenue balancing, the distributional impact between regions is broadly similar across most regions: a small progressive impact driven by lower electricity prices. However, the scale of the impact varies as Figure 19 shows CEE, where in the longer term the renewables due to the feed-in-tariffs on wind & solar, which displaces the cheaper coal generation, leads to an increase in electricity prices once the subsidies are removed. Over the longer term, the uptake of low-carbon heating technologies stimulated by the subsidies leads to a reduction in energy expenditure for heating. SE sees the largest distributional impact due to larger reduction in energy expenditure (net of investment costs) due to subsidies in low-carbon heating technologies

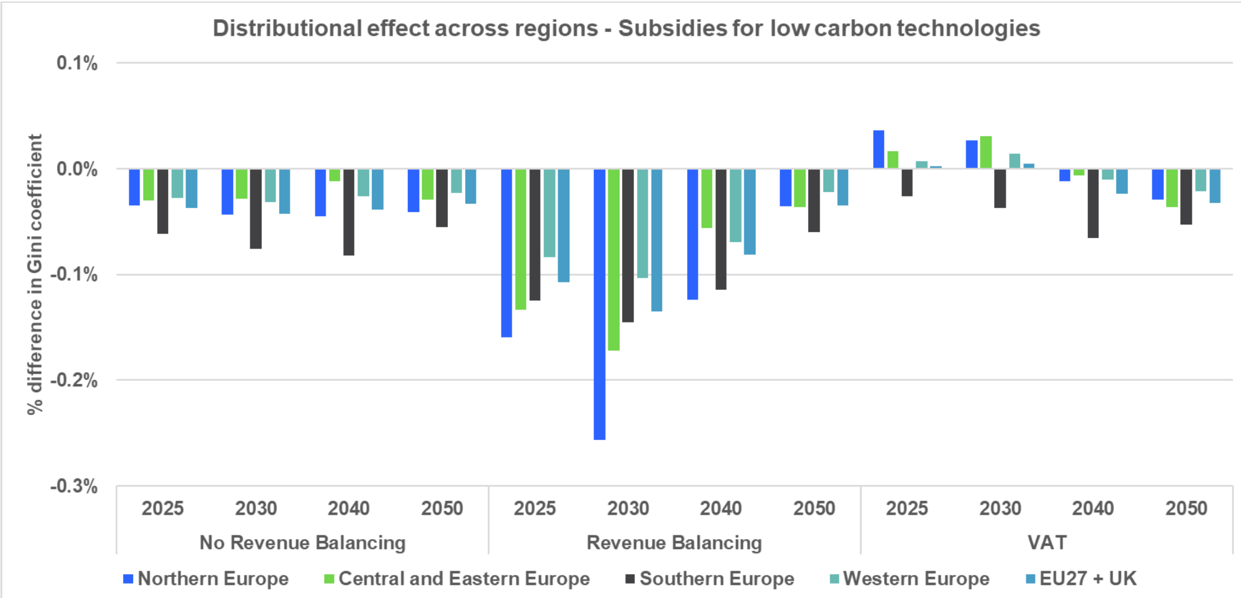

Figure 19: Regional differences in the modelled distributional effects of subsidies for low-carbon technologies

When balancing the cost of subsidies through general taxation is considered, the policy has a progressive impact across all regions. This is driven by the increase in average income taxes to pay for subsidies. Out to 2035, NE and CEE have the largest progressive impact from revenue balancing. This reflects that in most countries these regions, the feed in tariff support in the baseline for wind and solar is limited. Thus the level of support is proportionally larger in the policy scenario.

If the costs for subsidies is balanced through an increase in VAT, the net distributional impacts in the short term become more mixed with the impact in most regions being net regressive in the short term. Increases in VAT raises costs for low income household proportionally more than higher income households. For SE, the increase in VAT makes the distributional impact less progressive but is not enough to offset the reductions due the subsidies.

2.3.7.4 Phase out of fossil fuel subsidies

For the phase out of fossil fuel support, as shown in Figure 20 the distributional impact is broadly similar across regions because the level of fossil fuel support was distributed in proportion to fossil fuel use and leads to a regressive impact where the removal of fossil fuel support leads to an increase in household fuel prices. When revenue balancing is considered, the reduction in general taxation levels has a proportional impact across regions CEE shows the highest distributional impacts after revenue balancing reflecting a higher proportion of fossil fuels in the energy mix in the baseline.

If instead, the spending on fossil fuel subsidies is redistributed to reduce VAT, the removal of fossil fuel support becomes progressive for all regions.

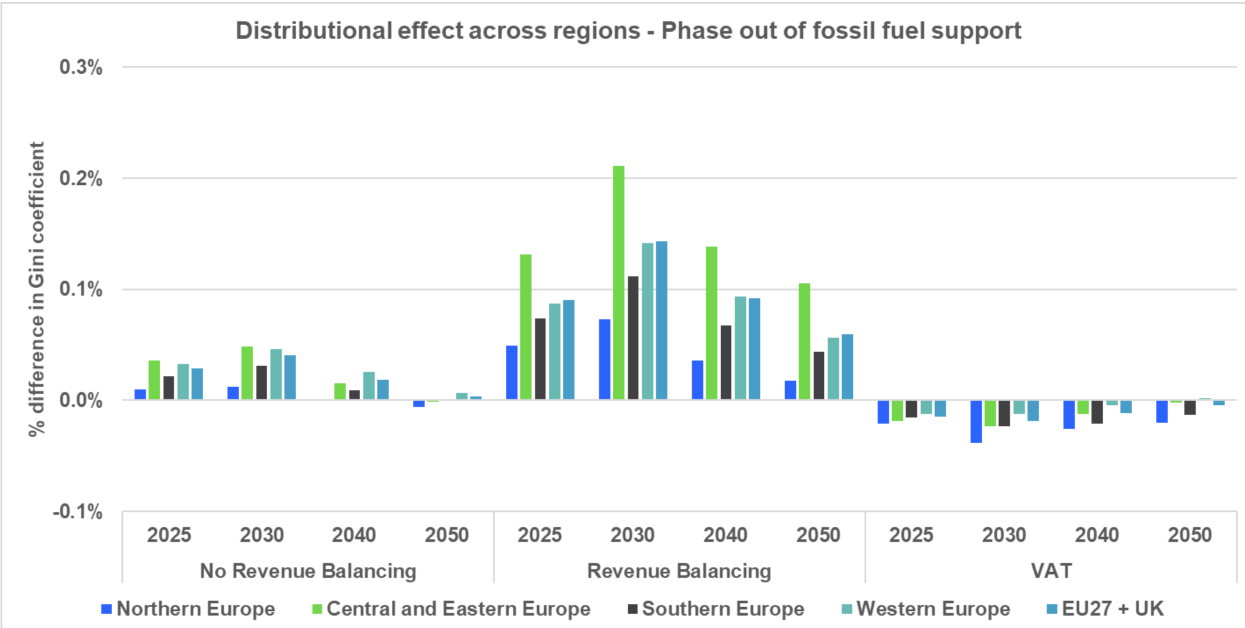

Figure 20: Regional differences in the modelled distributional effects of phase out of fossil fuel subsidies

2.3.7.5 Emissions Performance standards

For emissions performance standards, the distributional impact varies substantially between regions and as can be seen in Figure 21, particularly in the long term. This reflects the differences in the distribution of expenditure on private passenger transport. However, there is no direct impact on government revenues from the phase out of fossil fuel heating and road transport and so there is not a substantial difference in the distributional impact when revenue balancing in included.

Unlike in the case of household fuel use, which shows a regressive trend in terms of fuel expenditure as a share of income across the EU (lower income households spend a higher share of their income on heating energy than higher income households), the trend for road transport fuel use is not so uniform. SE has the most progressive impact from emissions performance standards. In SE Low-income households spend a higher share of their income on fuel and maintenance compared to higher income households and so benefit proportionally more from the fuel savings from the electrification of passenger cars. At the other end of the spectrum, in CEE, higher income households spend a slightly higher proportion of their income on the operation of passenger cars compared to low-income households. Hence a regressive impact is observed post 2035, as higher income households benefit more from the fuel saving in the electrification of passenger cars, relative to low-income households.

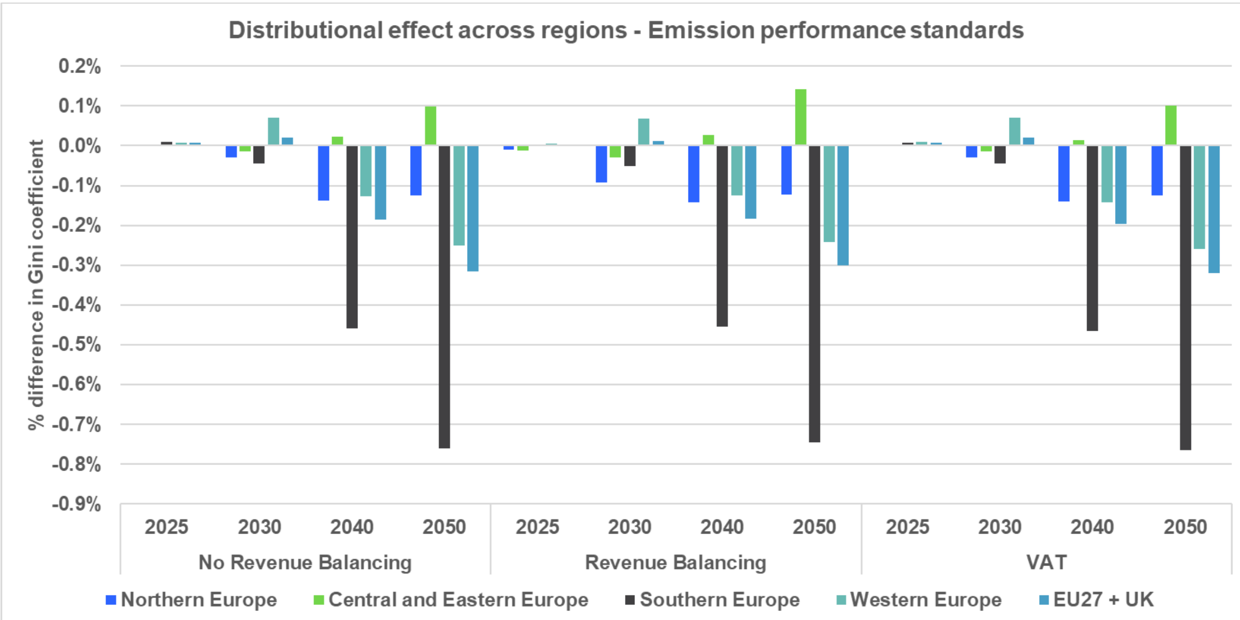

Figure 21: Regional differences in the modelled distributional effects of emissions performance standards

2.3.7.6 Energy efficiency measures

From Figure 22 it can be seen that the distributional impact of energy efficiency measures is broadly similar across regions, with a clear progressive impact for all regions even though the magnitude of the distributional effect varies. The smallest progressive impact can be observed in NE, reflecting a smaller ratio in the share of household heating fuels relative to the rest of the EU28. The largest progressive impact can be observed in SE, which reflects both a relatively high ratio between the share of consumption in household fuels and a higher reduction in prices relative to the rest of Europe. CEE sees a smaller progressive effect than the EU28 in most years, which reflects a smaller reduction in energy prices leading to a smaller shift in real incomes between deciles. NE has the smallest progressive impact. This reflects both that the energy efficiency measure leads to a smaller reduction in energy efficiency for households and that the difference in energy expenditure as a share of income between lower income and households and higher income households is narrower compared to the EU27 + UK average.

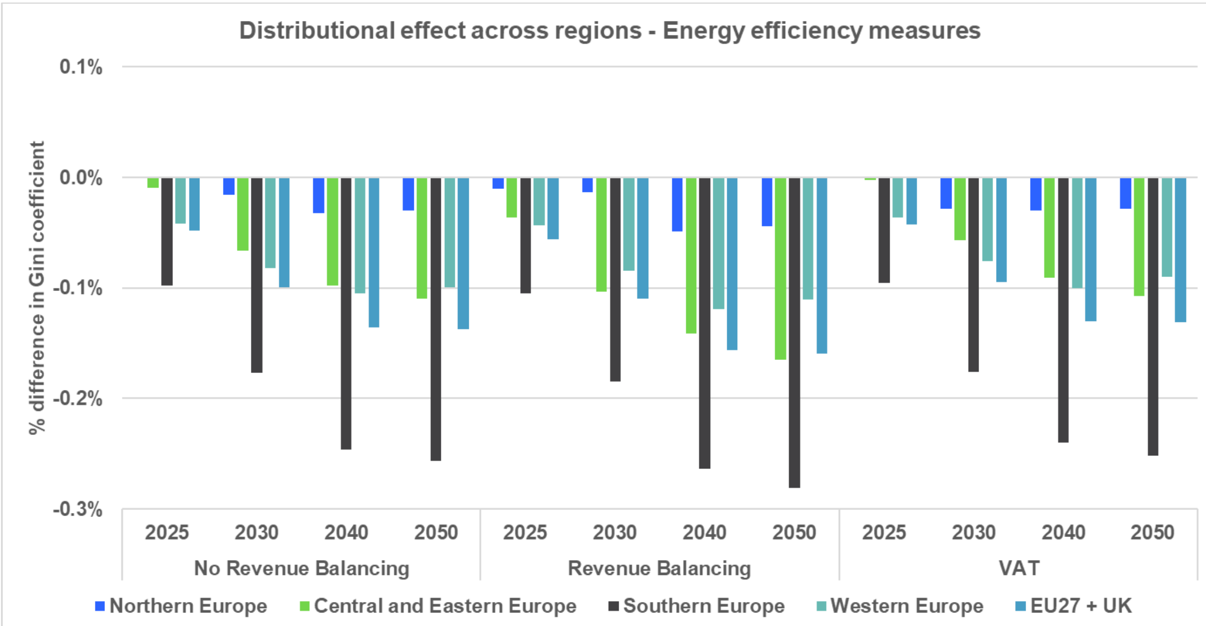

Figure 22: Regional differences in the modelled distributional effects measures

2.4 Summary of findings

It is important to bear in mind that the intent here is to identify the distributional effects of the policies in order for remedial measures to be identified. The model does not seek to make a judgement of which policies are 'good' or 'bad' and decarbonisation policies with regressive effects should not be seen as less effective at reducing emissions. Across the policy groupings, a mixture of distributional effects is observed (Figure 23). If modelled in isolation and without revenue balancing:

- The most regressive policies are those that impose costs on household energy use either directly (Taxation on energy vectors and Phase out of fossil fuel subsidies) or indirectly (Carbon pricing) as the lowest income households spend a higher proportion of their income on household energy use.

- The most progressive policies are those that lead to reductions in household energy expenditure (Energy efficiency measures or emissions performance standards) or energy prices (Subsidies for low-carbon technologies).

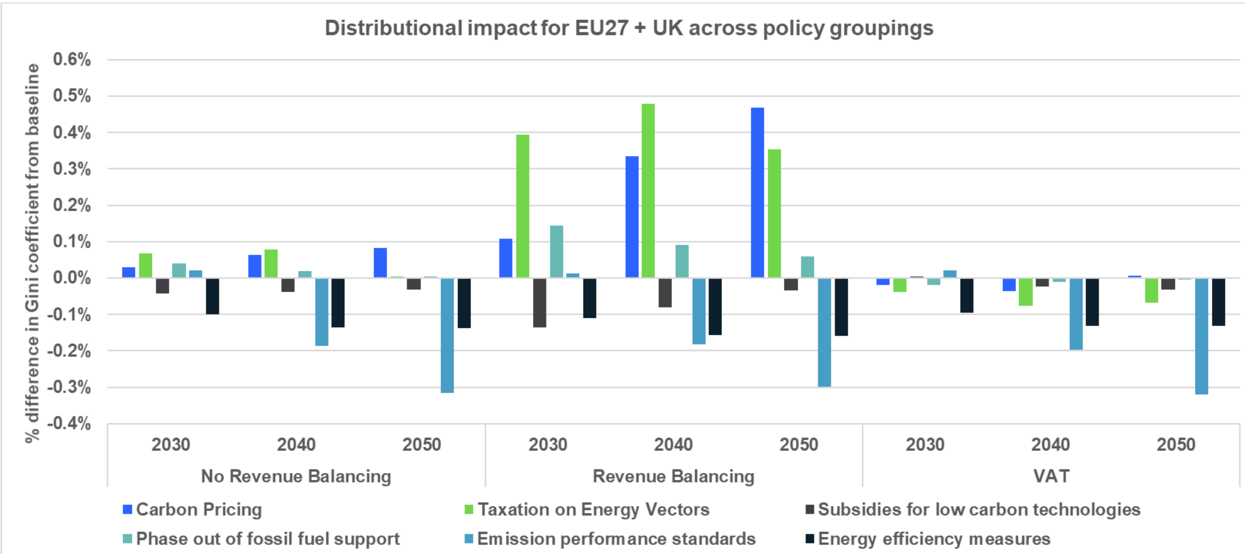

Figure 23: Comparison of the distributional impact across policy groupings

However, how the revenues and costs generated from climate policies are balanced by government matter considerably for the overall distributional impact of the policies. If modelled with standard revenue balancing assumptions, the distributional impacts of each policy are amplified by the adjustment in taxation:

- Revenue generating policies (carbon price, taxation on energy vectors and phase out of fossil fuel subsidies) become more regressive when balanced by reduction in income taxation. When balanced by a reduction in VAT, the impacts become less regressive and in some cases offset the regressive impacts.
- Cost incurring policies become more progressive (Subsidies for low-carbon technologies) when the spending is balanced by an increase in general taxation. However, if balanced through an increase in VAT, the impacts become less progressive.

The results from the modelling thus highlight that policymakers have an important role to play in managing the distributional impacts of climate policies. Potential regressive impacts of certain policies can be addressed by decisions that policymakers make around how any net revenues are reallocated across the economy or how additional spending is financed, or how different policies are combined. These are important drivers of the distributional impacts of climate policies.

3. Assessment and identification of potential measures to counterbalance the regressive effects of decarbonisation policies

Key findings:

- **A number of jurisdictions around the world have successfully enacted measures to counter the regressive elements of key climate policies.**
- **Measures successfully deployed include, lump-sum transfers, tax reductions and rebates, energy efficiency measures, job retraining and compensation funds.**
- **Recycling revenues (raised through carbon pricing or fossil fuel energy taxation) through, for example, lump-sum transfers, rebates or tax reductions—is a popular and effective approach to counteracting regressive policy effects if designed correctly.**
- **Where measures are introduced to counteract regressive effects, they need to be carefully designed to ensure that the lowest income groups do not face barriers to accessing finance.**

The previous sections examined the expected distributional impacts of different climate policy types and identified that some of the key policies within the EU's core policy package to reach Paris Agreement compatible climate goals are generally regressive if taken in isolation. Therefore, measures need to be taken to counterbalance these regressive effects in order to ensure the effectiveness of the climate polices and that they retain the level of public support needed to ensure climate ambitions are not compromised.

While regressive policy effects are likely concerning for policymakers, these impacts can be minimised or reversed by introducing measures that reduce or counteract the regressive element of the decarbonisation policy.[24] The purpose of Section 3, therefore, is to examine mitigating policy approaches from around the world and discuss key elements of effective climate policy design and measures that alleviate any disproportionate financial burden on low-income households. A deeper dive of these policies and their design elements are presented through five case studies, and the most effective measures are identified.

A comprehensive literature review and workshop consultations were undertaken to identify policy approaches that mitigate distributive effects of decarbonisation policies. The policy approaches broadly fall into two categories: 1) the redesign of an existing decarbonisation policy, or 2) a 'counter' policy. Counter policies are defined as additional policy measures that are introduced alongside climate policies that have the potential to lessen regressive effects, or even turn

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[24] Bruegel, 2018

regressive policies progressive. The effectiveness and limitations of some examples from each category are shown in more detail through the presentation of five case studies, which are used to inform the policy options presented in Section 4.

3.1 Overview of approach used to identify measures

Counter policy measures were primarily examined through the literature review conducted to identify the distributional impacts of the climate policies analysed in Section 2.3. An initial list of measures was compiled, and key indicators and potential case studies were catalogued for discussion at a workshop with Eurelectric members and external attendees. These key indicators were used to filter for the measures that would be most suitable for adoption within the EU (Figure 24), based on the findings of the research. In parallel, the results of the modelled impacts on distributional impacts was cross checked with the results of the literature review to identify cases where decarbonisation policies are expected to be progressive in theory but are regressive in practice, which in turn indicate potential to improve the design elements of the decarbonisation policy itself. In both cases, measures which would reduce the effectiveness of the climate policy in reducing emissions, were judged not compatible with reaching the emission reduction goal of the decarbonisation scenario and were excluded.

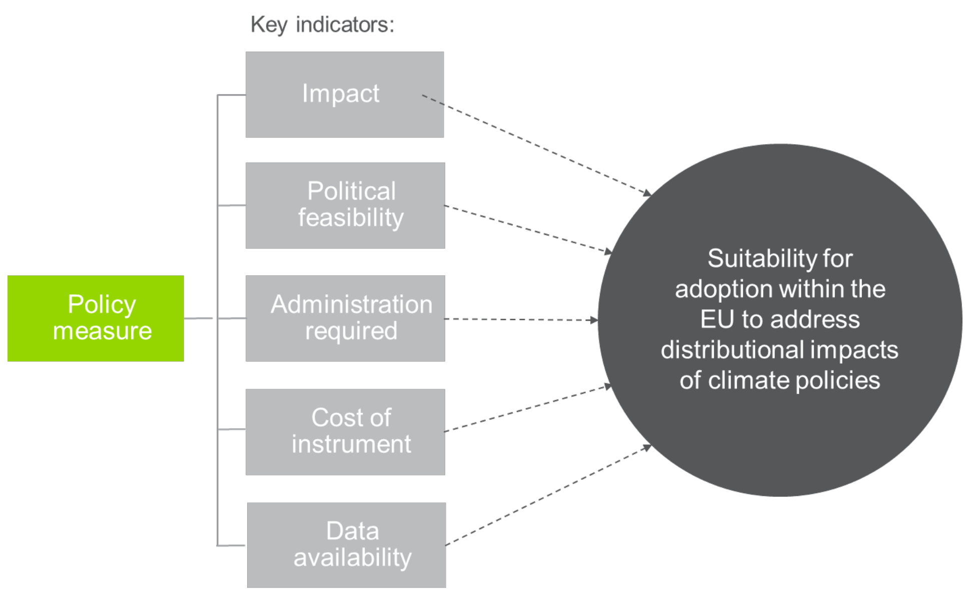

Figure 24: Process for selecting suitable policy measures to address regressive impacts

Based on the literature review, the policy indicators were scored using a traffic light system, whereby those thought to be most compatible with the goals of policy makers were scored green. The policy measures, along with their indicator scores are shown in Figure 25. The five most compatible policy measures were taken forward for case study presentation.

Policy Measure	Classification	Impact assessment	Political feasibility	Administration	Cost of instrument	Modelling feasibility	Recommended for the Case Study (Yes / No)
Lump-sum transfer on a per head basis	Financial						Yes
Reduction in income tax / VAT or electricity tax	Economic						Yes
Upfront grants and subsidies for the implementation low carbon technologies	Financial						Yes
Job retraining programme	Capacity Building						Yes
Legislation requiring revenue spending on low-income and disadvantaged communities	Regulatory						Yes
Mobility premium in form of a tax deduction per driven kilometer to work	Economic						No
Priority groups for energy efficiency grants	Regulatory						No
Revenue neutral implementation of RES support schemes	Regulatory						No

Key
High compatibility
Medium compatibility
Low compatibility
Unknown

Figure 25: Selection system for the case studies

3.2 Case study 1: Lump-sum transfers

Rebates in the form of lump-sum cash transfers can be used to target the regressive effects of certain climate policies, such as taxation on energy vectors and carbon pricing. The modelling in this study reveals that both policies can have a higher impact on low-income households, as they impose a higher cost of energy on individual households, as well as the overall economy. This finding is substantiated in the literature.[25,26] To counteract the regressive effects of carbon pricing, jurisdictions in North America and Europe offer rebates to households and firms. In addition to countering regressive effects of climate policies, the return of funds can help to improve public perception, and therefore the political feasibility of these policies.[27,28]

3.2.1 Canada

The Canadian Climate Action Incentive (CAI) is a prime example of a lump-sum transfer policy that has been used to counter regressive effects of carbon pricing. The policy presents an interesting case for learning, especially as carbon pricing has proved to be contentious in many of the Canadian provinces that are subject to the system, with four provinces challenging the imposition of the federal carbon price in court.[29]

On June 28, 2018, Canada established a federal carbon pricing system through the adoption of the Greenhouse Gas Pollution Pricing Act.[30] The system has both a carbon tax element, and a baseline-and-credit Emission Trading Scheme. The pricing initiative is considered a "backstop" system, whereby it is applied by default to provinces that do not voluntarily adopt it or implement their own federally approved carbon pricing scheme. The federal system is revenue-neutral and includes a rebate—the CAI—to households to counteract the extra financial burden associated with increased energy costs.[31] The Budget Implementation Act, 2018, No. 2[32] contains the legislative amendments to the Income Tax Act[33] that were required to implement the CAI payments.

The lump-sum transfer policy is designed so that the CAI payments will be returned to people in the provinces that pay them. Claims are made through income tax return forms, and the rebate is the same per household type, based on the total revenues collected in each province (with a

[25] Bruegel (2018)

[26] Enel

[27] Carbon Pricing Unlocked (2018). https://guidehouse.com/-/media/www/site/downloads/energy/2018/cpu2018carbonrevenuerecycling.pdf

[28] Agora Energiewende (2018)

[29] http://documents.worldbank.org/curated/en/191801559846379845/pdf/State-and-Trends-of-Carbon-Pricing-2019.pdf

[30] https://laws-lois.justice.gc.ca/eng/acts/G-11.55/index.html

[31] https://www.canada.ca/en/department-finance/news/2018/10/department-of-finance-announcing-climate-action-incentive-payments-and-launch-of-fuel-charge-consultations.html

[32] https://laws-lois.justice.gc.ca/eng/AnnualStatutes/2018_27/page-1.html?txthl=incentive+climate+action#5um

[33] https://laws-lois.justice.gc.ca/eng/acts/I-3.3/page-125.html#h-299820

10% bonus for rural Canadians and those living in small communities).[34] For tax year 2019, the maximum claimable amounts are shown in Table 5.[35]

Table 5: Maximum claim amounts for CAI payments[36]

Province	Basic Amount	Spouse or common-law partner amount	Qualified dependent amount	Single parent's qualified dependent amount
Alberta	$444	$222	$111	$222
Saskatchewan	$405	$202	$101	$202
Manitoba	$243	$121	$61	$121
Ontario	$224	$112	$56	$112

*

The "uniform" nature of the payments has previously been shown to be an important element in designing progressive policies.[37] Klenert and Mattauch (2016) show in their modelling that regressive effects can still be seen in carbon tax policies where rebates are in proportion to the households' productivities, however policies with uniform rebates are progressive. Indeed, the progressive nature of the CAI is demonstrated in two studies by the Canadian Parliamentary Budget Officer (PBO) and reveals that most Canadian households in provinces subjected to the carbon levy will be better off.[38,39] Figure 26, taken from the PBO 2020, update shows the economic effect for each income quintile in each province. According to the PBO, the analysis includes both direct costs from energy and indirect costs passed through for non-energy goods.

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[34] https://www.canada.ca/en/revenue-agency/services/tax/individuals/topics/about-your-tax-return/tax-return/completing-a-tax-return/deductions-credits-expenses/line-45110-climate-action-incentive.html

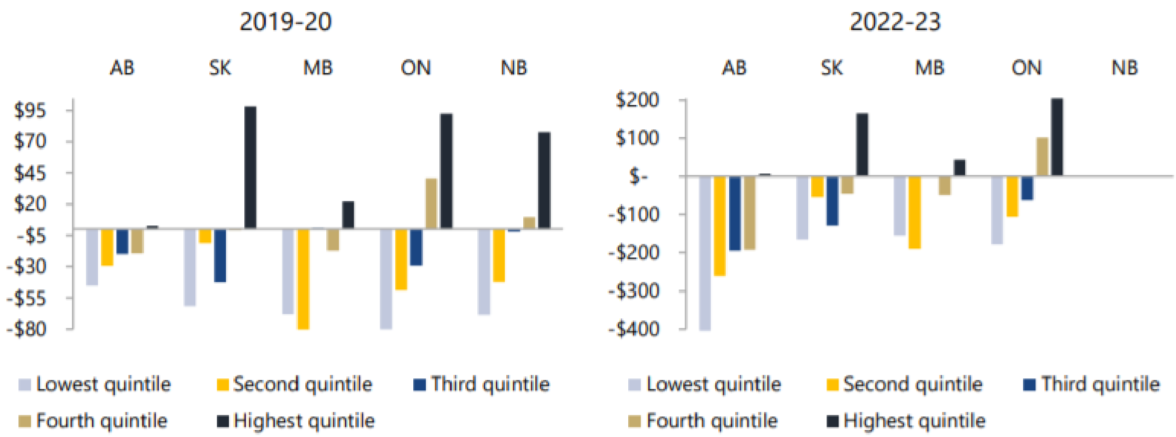
[35] Adapted from https://www.canada.ca/en/revenue-agency/services/tax/individuals/topics/about-your-tax-return/tax-return/completing-a-tax-return/deductions-credits-expenses/line-45110-climate-action-incentive.html

[36] These amounts do not include the supplement for residents of small and rural communities

[37] Klenert and Mattauch (2016) https://www.sciencedirect.com/science/article/abs/pii/S0165176515004759

[38] https://www.pbo-dpb.gc.ca/en/blog/news/Federal_carbon_pricing

[39] https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-1920-024-S/RP-1920-024-S_en.pdf



Source: PBO calculations.

Notes: Negative cost means rebates exceed the gross household carbon costs.

New Brunswick's proposed fuel charge would replace the federal fuel charge in 2020-2021.

Figure 26: Quintile distribution of household carbon cost net of rebate[40]

The results are likely welcome news for the Canadian Government who have been battling with the acceptability of the carbon tax in many provinces. Alberta, Manitoba, Ontario and Saskatchewan have all appealed to the Canadian Supreme Court to have the tax removed. While the results of the study have been published in many Canadian media outlets, the effects on public perception and political actions have yet to be seen.[41,42]

3.2.2 Other examples

Much of the design of the Canadian carbon price policy is borrowed from the carbon pricing mechanism that has been operating in British Columbia (BC) since 2008, and is often considered a well-established model for carbon pricing policy.[43] The BC Climate Action Tax Credit (BCCATC) is a similar lump-sum transfer paid to households and firms, however it differs from the federal system in that for household payments, it is linked to adjusted net family income. In other words, the maximum claimable amount goes down when net income goes up.[44] Switzerland and

[40] https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-1920-024-S/RP-1920-024-S_en.pdf

[41] https://www.theglobeandmail.com/politics/article-study-shows-carbon-tax-rebate-helps-lower-income-earners-the-most/

[42] https://business.financialpost.com/commodities/energy/canada-to-collect-c2-81-bln-in-direct-revenue-from-federal-carbon-price-in-2019-20

[43] https://www.theguardian.com/world/2018/dec/04/how-to-make-a-carbon-tax-popular-give-the-profits-to-the-people

[44] https://www2.gov.bc.ca/gov/content/taxes/income-taxes/personal/credits/climate-action

Denmark also feature lump-sum transfers as part of their carbon pricing policies; however, these countries also allocate funds for green infrastructure and/or general spending.[45]

Since 2007, Italy has had a social bonus for energy consumption of low-income families in the form of a financial transfer. The bonus, which is available upon request, covers up to 15% of the annual electricity and 20% of the gas expenditure of households. Eligible are families with an Equivalent Economic Situation Indicator[46] of less than EUR 8,265 or EUR 20,000 for a family with at least three dependent children or one family member of the household requires special medical treatment with the use of electrical energy-intensive machinery.[47] However, only around 30% of eligible families actually apply for the bonus. As response a national communications campaign was launched on radio and TV.[48] The example clearly shows the difficulties faced by non-automatic schemes that rely on applications by beneficiaries, and that automatic schemes are preferable.

3.2.3 Key lessons learnt

Imposing a carbon tax in a jurisdiction whose industry and households are heavily reliant on fossil fuels can be a tough sell. Evidence from the PBO reports show that lump-sum transfers to households are progressive in five Canadian provinces. This analysis finds that the two key features enhancing the policy's effectiveness are 1) the revenue-neutrality of the tax and 2) the uniform rebate to households. Additionally, using the existing income tax filing and return system to manage the claims and payments of the CAI helps keep the administrative burden to a minimum. Note that while the lump-sum transfers presented in this section are unconditional, it is also possible to introduce conditions to the design of this policy, e.g. make the financial support for energy efficiency investments, though this would introduce administrative challenges.

Actionable steps that can be taken by jurisdictions to design or adapt existing carbon pricing mechanisms to include lump-sum transfers:

1. Introduce or amend legislation to ensure lump-sum rebates.
2. Based on revenues, calculate each year how much the repayment will be to each claimant.
3. Put in place a system that allows households to claim the rebate.
4. Put in place a system that allows rebates to be paid to households.
5. Monitor economic effects on household income.

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[45] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/08/GRI_Global-lessons-in-carbon-taxes-for-the-UK_policy-brief.pdf

[46] The Equivalent Economic Situation Indicator is an Italian indicator to claim tax deductions, social bonus, university tuitions and other benefits.

[47] Lorenzoni, 2017, Energy poverty in Italy: Analysis and some proposals to reduce it, http://tesi.cab.unipd.it/59701/1/Betto_Frida_1129715.pdf

[48] Arera, 2014, Energy: social bonus, only 30% of needy families submit an application, https://www.arera.it/allegati/com_stampa/14/141015en.pdf

3.3 Case Study 2: Reduction in income tax / VAT or electricity tax

Redistributions through taxes can be done in several ways and are often highly specific to the local tax regime. Nevertheless, three common approaches can be differentiated. Lowering income taxes, decreasing value-added taxes (VAT) and decreasing electricity taxes. What all three approaches have in common is that they affect all types of households, high, medium and low-income, which tends to increase the cost of the measure when compared to a more targeted measure, such as the above mentioned climate action tax credits in BC, which are more easily restricted to a certain income class.

Low-income households receive a larger share of their income from labour and social transfers than high-income households, which might also receive income from capital, e.g. rental payments if they own property. This means that an income tax, is a tax on the primary source of income for many low-income households. They also spend a larger share of their income on VAT and electricity taxes, as these are indirect taxes that are uniformly applied across households. Recycling carbon taxes through lower income taxes compensates households directly and has the additional benefit of increasing their available income the incentive of perusing a formal work.[49] Lower VAT increases the purchasing power of the after tax-income. Lower electricity taxes make electricity cheaper and while alleviating the financial burden on low-income households it might increase the electricity consumption.

Offsetting carbon tax revenue through lowering other taxes also creates a “lock-in” effect of the carbon tax or emissions scheme, as future governments would have to raise potentially unpopular taxes again to get rid of the carbon tax.[50] This might be useful consideration in some countries.

3.3.1 Sweden

Sweden undertook a major tax reform in 1991 with the goal of lowering its marginal tax rates, reduce its labour tax and broaden its tax base. One measure to finance this tax reduction was the introduction of a carbon tax, which in turn prompted a 50% cut in other energy tax rates. There is no direct revenue recycling of the carbon tax revenue. The tax applies to carbon content of heating and motor fuels for both households and industry and thus affects households both directly and indirectly via second order effects.[51] This means, that Sweden at first did not want to

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[49] Parry et al. (2012) “How to Design a Carbon Tax”, Oxcarre, Department of Economics, University of Oxford

[50] Parry et al. (2012) “How to Design a Carbon Tax”, Oxcarre, Department of Economics, University of Oxford

[51] Sørensen (2010) “Swedish Tax Policy: Recent Trends and Future Challenges”, Expert Group on Public Economics.

mitigate the regressive effects of a carbon price but wanted to lower other regressive and distortive taxes and used a carbon price to pay for it.

Initially the carbon tax had two different levels for industry and households. Industry was exempt of most increases until 2010, from when on prices rose sharply and were finally aligned with the level of household tax in 2019. Since its introduction the carbon tax for households rose from €24 per ton of carbon in 1991 to €120 per ton of carbon in 2020. The initial tax reform lead to a lower marginal tax rate for low-income households from around 37% to 31%.[52] During the green tax shift from 2001 – 2006 the carbon price for households more than doubled from EUR40 per ton of carbon to EUR100 per ton of carbon. As a result, income taxes for low-incomes were reduced further. Other compensation measures included a temporary aid scheme for the conversion to renewable heating, additional welfare payments, reduced social security contributions and increase basic income tax deductions for low- and middle-income households.[53]

The initial tax reform is considered successful in reducing the general tax burden on households. Both, the carbon tax and the initial tax reform are marketed as successes by the Swedish Ministry of Finance.[54] The carbon tax is expected to reduce emissions from domestic transport by 70% in 2030 compared to 2010. The tax reform and any subsequent changes were administered by the Swedish Ministry of Finance. The initial tax reform took extensive planning and new legislation, as other options were considered as well, and the reform was estimated to concern budget in height of 7.1% of the 1991 GDP. The carbon tax was attached to the energy tax legislation. The administrative costs of the entire Swedish Tax administration are just 0.1% of the total revenues from the carbon and energy taxes.[55]

[52] Agell et al. (1995) "The Swedish Tax Reform: An Introduction", Swedish Economic Policy Preview.

[53] Raab (2017) "Carbon Tax – determining the tax rates", Swedish Energy Agency. Available at https://www.thepmr.org/system/files/documents/Sweden%20PMR%20Technical%20Workshop%20on%20Carbon%20Tax%2022%20March%202017.pdf

[54] Åkerfeldt, Waluszewski (2020) "Carbon Taxation in Sweden", Ministry of Finance Sweden. Available at https://www.government.se/492a01/contentassets/419eb2cafa93423c891c09cb9914801b/200224-carbon-tax-sweden---general-info.pdf

[55] Raab (2017) "Carbon Tax – determining the tax rates", Swedish Energy Agency. Available at https://www.thepmr.org/system/files/documents/Sweden%20PMR%20Technical%20Workshop%20on%20Carbon%20Tax%2022%20March%202017.pdf

3.3.2 Other examples

Portugal lowered its income tax in 2015 in response to a carbon tax.[56] In the Portuguese case a small portion of the revenue was earmarked for sustainable mobility and forestry, while the remainder was used to lower personal income tax for families with children.[57]

3.3.3 Key lessons learnt

Reductions in income tax, or VAT or electricity tax, offer an administratively cheap way to ensure that low-income households are not adversely financially affected by a rising carbon tax. While the initial tax reform might be offsetting for some governments, a reduced income, VAT or electricity tax has no ongoing administrative costs, as many subsidy schemes do and thus does not require the setup of an implementing agency. Depending on the height of the tax cut, the policy can be quite costly in terms of foregone budget. However, tax cuts are popular with voters, which can make a compelling case in national politics. Taxes offer the administratively cheapest way to reach all households levels but are over time less visible than a lump-sum transfer.

Changes in the tax code can be prepared and overseen by the Finance Ministry and usually require only amendments to existing legislature, as most countries already levy income tax, VAT and electricity taxes. No additional infrastructure is needed for the preparation or implementation of the policy.

Additional benefits arise from reducing other regressive or distortive taxes. Lower income taxes for example increase the incentive to pursue a formal employment, especially for low-income earners with salaries around the tax border.

3.4 Case study 3: Targeted energy efficiency measures

Support schemes for energy efficiency measures help people to reduce their energy consumption and can help to alleviate energy poverty. As such, targeted energy efficiency measures can be used to address regressive effects of phase out of subsidies for fossil fuels, e.g. in the case of oil and gas-based water heaters. In the modelling exercise such schemes are addressed through the subsidies for low-carbon technologies category.

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[56] Pereira et al. (2016) "A new carbon tax in Portugal: A missed opportunity to achieve the triple dividend?", Energy Policy, pp. 110-118.

[57]Ministerio do Ambiente, Ordenamento do Territorio e Energia: "Green Taxation Reform". Available at http://www.crescimentoverde.gov.pt/wp-content/uploads/2014/10/ReformaFiscalidadeVerde_GreenTaxReform_emagazine.pdf

3.4.1 USA: Weatherization assistance programme

The U.S. Department of Energy's (DOE) Weatherization Assistance Programme (WAP) has been in place since 1976. The programme was created to reduce energy costs for low-income households by increasing the energy efficiency of their homes, while ensuring the health and safety of households.[58] The programme comes at no additional costs for participants. While the WAP was not introduced to counteract the regressive effects of a climate policy, it is a prime example of such a policy. Many climate policies like a carbon tax or taxes on various energy vectors will, directly or indirectly, lead to higher energy prices for consumers, and the WAP is designed to reduce these costs for low-income households.

Households that meet the eligibility criteria of an income at or below 200% of the poverty level can apply through their local weatherization agency, which is responsible for the local implementation of the programme. Households that receive Supplemental Security Income or Aid to Families are automatically eligible. The application form takes around 20min to fill out and requires information about the energy costs of the household, a list of all household members and respective proof of income, proof of citizenship or legal residency. Once approved, the local weatherization agency will perform an energy audit to identify targeted measures. Once suitable measures are identified and agreed with the household, they are implemented by the weatherization agency.

Measures up to $6,500 are covered by the WAP, with the average costs per unit being $4,695.[59] Measures include mechanical measures such as cleaning, tuning, repairing or replacing heating or cooling systems incl. water heaters; building shell measures such as insulation or window replacements; electric and water measure such the installation of efficient light sources, showerheads or refrigerators; health and safety measures such as safety testing of the heating system and installation of indoor ventilation systems; and client education measures, which consist of demonstrations of any potential new appliances and the benefits of using energy-efficient products as well as educational material on potential household hazards.[60] The most common measures are the replacement of heaters and wall insulations.[61] All measures are audited by a certified quality control inspector. Eligible units include single family houses, small multi-family houses, mobile homes and large multi-family houses.

[58] Department of Energy (2019) "Weatherization Works!", Office of Energy Efficiency & Renewable Energy. Available at https://www.energy.gov/sites/prod/files/2019/07/f64/WAP-Fact-Sheet-2019.pdf

[59] Department of Energy (2020) "About the Weatherization Programme". Available at https://www.energy.gov/eere/wipo/about-weatherization-assistance-programme-0

[60] Department of Energy (2019) "Weatherization Works!", Office of Energy Efficiency & Renewable Energy. Available at https://www.energy.gov/sites/prod/files/2019/07/f64/WAP-Fact-Sheet-2019.pdf

[61] Fowlie et al. (2018) "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Programme", The Quarterly Journal of Economics, p. 1597-1644.

The WAP is estimated to save around 2.6TWh of electricity and 680ktoe of gas per year, which translates into an annual emissions reduction of 3.5 million tons of CO_2.[62] Actual achieved energy efficiency savings are often lower than possible savings, as suggested by the measures implemented.[63] This might be due to so called rebound effect, which describes a situation in which demand for energy end uses increases as a result of greater efficiency. Such an effect would highlight the need for additional educational measures.

The federal budget for 2020 is around $300 million but is usually supplemented by the Low-income Home Energy Assistance Programme (LIHEAP)[64], state-level funding and public utilities, which increases the total funding by a factor of two to three.[65] In 2016 the WAP leveraged an additional $350 million of non-federal funding, or $1.62 for every Dollar of DOE funds.[66] The state and federal budget stems from general taxation. Funding from public utilities is usually collected via rate increases or takes on the form of a bundling with a utility funded energy efficiency scheme.[67] As the programme is rather small in absolute terms, i.e. less than $1 per American citizen, no negative distributional effects are assumed from the programme. 10% of funding is used up for administrative purposes, 55% for programme operations costs, 15% for health and safety costs and 20% are spent on training and technical assistance costs.

As the WAP only targets low-income households, no population-wide distributional effects are assessed. Overall, the programme is considered to be successful both at reducing energy demand and creating co-benefits for households and society.[68] DOE estimates the average annual cost savings for energy at around US$283, an additional US$514 in saved out of pocket medical expenses and $583 savings due to fewer days of missed work. This translates to a return of US$4.5 for every US$1 invested into the programme. The programme is assumed to feature practically no free-riding, as all participants are low-income households and many feature

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[62] ACEEE (2018) "Savings from Weatherization Assistance Programme", American Council for an Energy-Efficient Economy. Available at https://www.aceee.org/sites/default/files/pdf/fact-sheet/weatherization-assistance-programme.pdf

[63] Fowlie et al. (2018) "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Programme", The Quarterly Journal of Economics, p. 1597-1644.

[64] LIHEAP provides ferally funded financial assistance for low-income and from energy-poverty afflicted households. More information can be found under https://www.acf.hhs.gov/ocs/programmes/liheap/about.

[65] Department of Energy (2020) "About the Weatherization Programme". Available at https://www.energy.gov/eere/wipo/about-weatherization-assistance-programme-0

[66] Community Action Partnership (2016) "The Weatherization Leveraged Partnerships Project". Available at https://communityactionpartnership.com/wp-content/uploads/2018/07/Joint-Report-on-Leveraged-Non-Federal-Funds-for-WAP-in-2016.pdf

[67] Community Action Partnership (2018) "Leveraging Your Weatherization Assistance Programme: Why & How". Available at https://communityactionpartnership.com/wp-content/uploads/2018/04/Leveraging-Your-WAP-Why-and-How.pdf

[68] Tonn et al. (2018) "Evaluation of the U.S. department of energy's weatherization assistance programme: Impact results", Energy Policy, Vol. 118, pp. 279-290.

documented problems of paying everyday bills.[69] Around 35,000 houses a year are weatherized under the programme.

The DOE which administers the programme on an ongoing basis, administers the funds to close to 800 local agencies, which in total support up to 8,500 jobs. The programme was set up in 1976 by Congress under Title IV of the Energy Conservation and Production Act.

3.4.2 Other examples

The WAP is an example of an energy efficiency scheme that targets only low-income households. However, many countries feature broader, less targeted energy efficiency schemes, which are available to more affluent parts of the population. These are often implemented in regressive ways. One particular interesting example is the "New Green Savings Programme" (NGS) of the Czech Republic.[70] The NGS, which was introduced as Green Savings Programme in 2009 and renewed and renamed in 2013 and 2014, finances a similar set of measures as the WAP, which aim to increase energy efficiency in single and multi-family houses.[71] The programme is implemented and administered by the State Environmental Fund (SEF). The main difference for low-income households is the financing structure of the programme. NGS projects need to be pre-financed by the applicant and the construction happens through a private but possibly licensed contractor, which reduced organisational burdens on the SEF.[72] However, an ex-ante energy audit by an energy specialist is mandatory. Up to 50% or EUR17,500 of the eligible costs reimbursed after an ex-post audit, leaving the household with the entire project risk. This kind of programme structure is almost per definition regressive as it precludes low-income households from participating in the programme, as these kinds of households are unlikely to have sufficient spare funds to pre-finance any such measures. Similar arguments can be made about other programmes, which subsidize renovations through tax credits.

However, the NGS in general is financed out of the proceeds of auctioned EU ETS certificates and topped up with general government funds. This kind of setup ensures, that while the programme per-se is not as accessible for low-income households as it could be, the funding of the programme does not burden low-income households further. Another difference to the WAP are the central application procedure through the programme website. The application

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[69] IEECP (2019) "Weatherization Assistance Programme", EPATEE. Available at https://epatee.eu/system/tdf/epatee_case_study_us_weatherization_assistance_programme_ok_0.pdf?file=1&type=node&id=85

[70]France has a similar energy efficiency programme which is financed through EU ETS auction revenue.

[71]Multi-family houses are actually only supported within the city of Prague. Multi-family buildings outside of Prague are eligible for another scheme. More information about the NGS and which measures are covered can be found at: https://www.novazelenausporam.cz/

[72] The programme website features a list of licensed specialists which can conduct the work. However, their use is not mandatory

procedure was simplified and streamlined since the original introduction of the programme to make applications easier. Publicising the programme on a local level played an important role to increase uptake of the programme and include a benefits calculator on the website, allowing households to estimate their reduced energy costs from participation.

Other, more targeted, energy efficiency schemes include the Latvian Baltic Energy Efficiency Facility (LABEEF), a private investment fund created to finance deep energy efficiency renovation measures in large multi-apartment buildings in Latvia. The renovation measures are paid for through an energy performance contract over a period of 20 years. The value of the contract is not or only slightly higher than the participants energy costs before the renovation measures, making it possible for low-income households to participate. The energy savings achieved, and thus lower energy costs, pay for the measures over the duration of the contract.[73]

3.4.3 Key lessons learnt

Most energy efficiency programmes are regressive, because of either the way participation is structured or the way they are financed. Low-income households lack the funds to participate in programmes that require significant contributions on the side of the applicant. Therefore, to be accessible for low-income households, any energy efficiency scheme should involve no or minimal costs for the worst off. This can take the form of a special programme, such as the WAP, a special income bracket for broader programmes, for which different rules apply or an energy performance contract. To ensure that funding of larger programmes themselves do not cause any regressive effects, revenue recycling from a carbon tax or EU ETS revenue are possible.

An easy and straightforward application procedure is another important aspect in making the participation hurdle as low as possible. Automatic qualification for the programme or special support if one already receives support from another social programme, as is done with the WAP, seems sensible. A central application procedure as provided by the NGS programme website seems to provide the highest visibility and clearest application route. Applications through local agencies is both more costly and administratively burdensome. If such a structure already exists, it can be leveraged to provide closer contact to the participants after the application procedure, e.g. in the energy audit.

The training of its own workforce as conducted by the WAP is likely more costly and administratively burdensome, too. A solution is to rely on licensing for quality assurance and communication of local contacts through the programme website, as done in the Czech Republic, which possibly allow for a more comprehensive local coverage, than educating a new workforce.

A clear and targeted communications strategy to get people involved into the programme is essential with any new programme. This should happen through several channels, e.g. online,

[73] Jörling & Schäfer (2018) “LABEEF in Latvia”, BEACON.

local communities, social services, etc. and focus on the benefits of the programme, e.g. reduced energy bills, better living conditions.

Some indications suggest that real savings often stay below ex-ante projected savings.[74] Early evaluations of the WAP showed that training households on the new appliances can help to reduce savings more permanently.[75] Educational measures can for example be implemented with the ex-post evaluation of the construction measures.

Actionable steps that can be taken by jurisdictions to implement similar subsidy scheme:

1. Pass legislation set up of a subsidy scheme for energy efficiency measures either specifically for low-income households or as part of a broader/ existing scheme.

2. Set up or identify a body for oversight and management of the scheme.

3. Define and set up a suitable application, implementation and evaluation procedure. Identification of low-income households can be done through leveraging other public programmes or databases.

4. Publicise the scheme broadly, e.g. online and in local communities.

5. Provide a measurable benefit for participants.

3.5 Case study 4: Job retraining programmes

Job retraining programmes are measures that can be implemented pre-emptively to counter redundancies resulting from the energy transition. Job retraining programmes address wage losses of workers, which could occur due to sectoral shifts in the economy, which in turn could be precipitated by decarbonisation policies. Programmes aim to reskill and upskill workers, enabling them to find employment in growth sectors. Job retraining programmes should consider the local labour market and be tailored at the regional level to specific groups or sectors. For example, Poland and Germany might need to reskill coal workers, but Germany might also need to reskill parts of its automobile supply chain, and Italy might need to reskill workers in thermal power plants. Examples of such programmes have already been implemented in the EU, in Scotland and Romania.

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[74] Fowlie et al. (2018) "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Programme", The Quarterly Journal of Economics, p. 1597-1644.

[75] Harrigan and Greogory (1994) "Do Savings from Energy Education Persist?". Available at https://www.aceee.org/files/proceedings/1994/data/papers/SS94_Panel1_Paper09.pdf

3.5.1 Scotland

In 2016, the Transition Training Fund (TTF) was set up in Scotland to support unemployed workers in the oil and gas sector.[76] The programme was developed in response to the shutting down of oil and gas operations in the North Sea that began in 2014. The Scottish Government allocated £12million of its general budget to the TTF, with the aim of redeploying 1,000 workers per year over the course of three years. No legislation was required to implement the policy, and the TTF was administered by an existing national skills agency—Skills Development Scotland. The fund made grants of up to £4,000 per person available for oil and gas workers who were either unemployed or at risk of redundancy, to assist them in accessing skills retraining.[77] Training was provided via two pathways: an individual route for an applicant's preferred training, or a procured route that provided training in target sectors. Skills Development Scotland engaged with industry to identify sectors in need of workers to ensure that those who selected the procured route had a high likelihood of finding a job once their training was complete. As shown in Figure 27, the TTF provided training for 4,272 people and 89% of trainees found employment post-training.[78]

[76] Skills Development Scotland (2019)

[77] https://ec.europa.eu/energy/sites/ener/files/documents/oil_gas_transition_training_fund_scotland_-_platform_for_coal_regions_in_transition.pdf

[78] https://transitiontrainingfund.co.uk/images/TTF_Review_Summary_Final.pdf

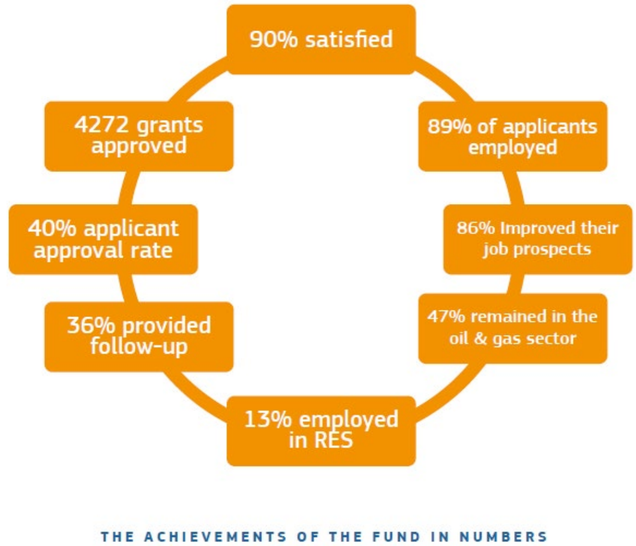

Figure 27: Key numbers relating to the Transition Training Fund

3.5.2 Key lessons learnt

Many lessons can be taken from the Scottish TTF. By implementing the programme through an existing skills agency, the fund was able to be rapidly deployed over a period of about six months.[79] This kept costs low—£178,000 over three years—as staff members were able to add TTF-related duties to their existing ones. Additionally, the dual pathway approach provided flexibility to workers in choosing retraining options. A post-programme review was key to identifying challenges and enabling effects, and it found that the fund could have been more beneficial to workers if it also covered the travel and accommodation costs associated with the training.

Actionable steps that can be taken by jurisdictions to implement similar job retraining programmes:

1. Identify need in sectors that are (or are likely to) experience significant unemployment.
2. Allocate funds to be administered by existing national skills agency (if one exists).
3. Identify sectors that need workers, e.g. those experiencing labour shortages or growth.
4. Design flexible retraining programmes, matching workers with sectors in need.
5. Market retraining programmes so that workers are aware of them and roll out applications.
6. Deliver retraining.

[79] https://transitiontrainingfund.co.uk/images/TTF_Review_Summary_Final.pdf

7. Monitor and report on spending and benefits delivered.

3.6 Case study 5: Compensation funds for low-income groups

Compensation funds can be used to target the regressive effects of certain climate policies, such as taxation on energy vectors and carbon pricing. The modelling in this study reveals that both policies can have a higher impact on low-income households, as they impose a higher cost of energy on individual households, as well as the overall economy. This finding is substantiated in the literature.[80,81] To counteract the well-known regressive effects, various jurisdictions in the US and Europe have targeted spending programmes for priority population groups, such as low-income households and disadvantaged communities.[82] Moneys raised through energy taxes and carbon pricing mechanisms can be used to implement improvements in social housing, public infrastructure, clean transport, residential energy efficiency, and other programmes to alleviate some of the financial burden caused by regressive policies.[83] In addition to countering regressive effects, the specific allocation of funds raised from energy taxes and carbon pricing mechanisms to these types of programmes can help to improve public perception of these policies.[84,85]

3.6.1 California

California offers a prime example of how funds from carbon pricing mechanisms can be used to address regressive effects. Due to the State's well-established cap-and-trade system, significant administrative capacity, and ardent environmental and social justice community, the experience in California serves as a key learning resource for other jurisdictions to extract best practices and gain insight into the ongoing challenges in establishing a policy framework for a just transition.

In 2006, the California legislature passed Assembly Bill 32, the Global Warming Solutions Act, which established the State's greenhouse gas reduction target.[86] As part of this bill, the State designed a cap-and-trade system to raise revenues that could be used to fund programmes that could expedite the shift to a low-carbon economy. The cap-and-trade programme was signed into law in 2012 and began holding auctions in 2013. Revenues raised from the cap-and-trade system are allocated to the Greenhouse Gas Reduction Fund (GGRF) and used to

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[80] Bruegel (2018)

[81] Enel

[82] ICAP (2019)

[83] ibid

[84] Carbon Pricing Unlocked (2018). https://guidehouse.com/-/media/www/site/downloads/energy/2018/cpu2018carbonrevenuerecycling.pdf

[85] Agora Energiewende (2018)

[86] AB32 (2006) https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200520060AB32

pay for greenhouse gas reduction projects—collectively known as California Climate Investments.[87] General spending allocations of the GGRF is shown in Figure 28. Two pieces of legislation—SB 535 and AB 1550—were since adopted, requiring that at least 35% of the GGRF funds are used to support projects for low-income and disadvantaged communities.[88],[89] The bills were drafted and approved in the context that 1) climate change will have disproportionate impacts on disadvantaged and low-income communities in California, and 2) efforts to reduce greenhouse gases through the Global Warming Solutions Act could have a detrimental effect on those communities.

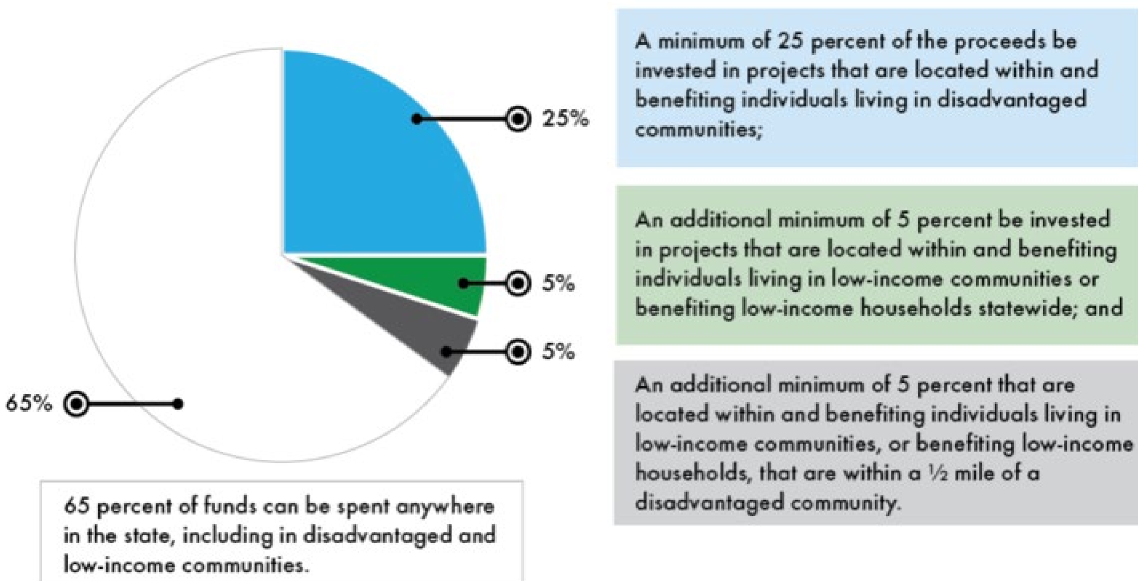

Figure 28: Spending allocations of the Greenhouse Gas Reduction Fund

California Environmental Protection Agency (CalEPA) undertook the task of identifying disadvantaged communities through public consultation and the California Communities Environmental Health Screening Tool 3.0 (CalEnviroScreen).[90] CalEnviroScreen is a tool that scores each census tract in California for pollution burden and population characteristics to identify areas disproportionately burdened by and vulnerable to multiple sources of pollution.[91] The output of the tool is a score for each locality and a map to be used for the purpose of allocating California Climate Investments according to the statute.

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[87] ICAP (2019)

[88] SB 535 (2012) https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB535

[89] AB 1550 (2016) https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1550

[90] https://calepa.ca.gov/envjustice/ghginvest/

[91] https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

Allocation of the funding to projects is overseen by California Air Resources Board (CARB). State agencies receiving appropriations develop and implement programmes within three priority areas: 1) Transportation and Sustainable Communities, 2) Clean Energy and Efficiency, and 3) Natural Resources and Waste Diversion. Projects must provide measurable benefits to disadvantaged communities, and there is extensive guidance on qualifying criteria on the CARB website.[92] All administrating agencies are required to track project progress and report to CARB, who is responsible for oversight and monitoring of programmes. Progress is reported in terms of measurable outcomes, including GHG reductions and co-benefits delivered, e.g. air pollution reduction, reduction in housing or energy costs, increase in numbers of quality jobs, etc., depending on the project type. Although the required administrative capacity for implementing and overseeing the California Climate Investment programme is significant, the costs are estimated to be 3.5% of the revenues generated by the cap-and-trade auctions.[93]

The policy and its oversight have so far been successful in ensuring disadvantaged communities are benefitting from funds raised by regressive carbon pricing mechanisms. The 2019 Annual Report of the Cap-and-Trade Auction Proceeds reveals that California is exceeding the 35% requirement of the statutes, and that $2 billion of the $3.3 billion in implemented investments—or 57% of the invested funds—are benefitting the State's most vulnerable communities.94 Project profiles for 2019 are reported by CARB[95] and provide valuable insight into the types of projects that can benefit low-income and disadvantaged communities. See Box 2 for examples.

92 CARB https://ww2.arb.ca.gov/resources/documents/cci-funding-guidelines-administering-agencies

93 Faber (2019) https://climate-xchange.org/2019/09/26/carbon-pricing-in-a-just-transition/

94 https://ww2.arb.ca.gov/news/report-cap-and-trade-spending-doubles-14-billion-2018

95 http://www.caclimateinvestments.ca.gov/2019-project-profiles

Box 2. Example California Climate Investment projects

The **Clean Mobility Options for Disadvantaged Communities** pilot projects address the barriers and transportation needs of low-income residents and those living in disadvantaged communities. The City of Los Angeles received a $1.7 million grant to start a zero-emission car share pilot project, BlueLA, to operate in four Los Angeles disadvantaged communities. This BlueLA project will ultimately deploy 100 electric vehicles (EV) and 200 EV chargers. BlueLA additionally offers reduced rates for low-income households earning less than US$35,000 per year. Other expected benefits include:

- 2,313 MTCO2e GHG reductions
- 3,519 pounds NO_X reductions
- 447 pounds PM2.5 reductions

CalVans has implemented US$6million in received funds to deploy 154 new, 15-passenger hybrid vans that provide near-zero emission transportation to agricultural job sites in disadvantaged agricultural areas of California. The vans reduce fuel consumption by 25 percent, resulting in immediate savings in fuel costs and emission reductions benefits, while also meeting a basic transportation need of agricultural workers. Other expected benefits include:

- 4,592 MTCO2e GHG reductions
- 576 pounds NO_X reductions
- 850 pounds PM2.5 reductions

Adapted from CARB (2019)

3.6.2 Other examples

Similar compensation funds have been developed elsewhere in the world, with France contributing almost all of its auction revenue to its National Housing Agency to retrofit social housing and enhance energy efficiency to support low-income households.[96] Members of the Regional Greenhouse Gas Initiative (RGGI) in the US use part of the RGGI proceeds to provide a direct energy bill assistance to households, with some states specifically targeting low-income households.[97] However, one of the advantages of the California system is that funding allocations are adaptable to deliver benefits to fit the specific needs of communities.

[96] ICAP (2019)

[97] Ibid.

3.6.3 Key lessons learnt

No evidence has been found to show that the statutory allocation of funds to disadvantaged communities has been poorly received, is too costly, or would otherwise not work effectively to counter regressive effects of climate policies.

Actionable steps that can be taken by jurisdictions to implement similar compensation funds:

1. Pass legislation requiring a minimum investment of compensation funds in low-income or disadvantaged communities.
2. Set up a body for oversight and management of funds.
3. Identify and define recipients using census data and other national statistics.
4. Identify a need within that community.
5. Provide a measurable benefit.
6. Monitor and report on spending and benefits delivered.

4. Key policy options with potential to reverse regressive effects

Key findings:

- Taking into consideration their simplicity, effectiveness, and transferability to the EU context, the four key policy options which have the potential to mitigate regressive impacts and which do not impact the EU's ability to achieve its climate goals are:
  - Recycling revenue through lump-sum transfers or lower VAT / electricity taxes to the general public
  - Implementation of targeted energy efficiency measures with no upfront costs, specifically targeting low-income households
  - Job retraining programmes focused on industrial sectors impacted by decarbonisation to prevent people from falling into poverty
  - Funding of low-carbon subsidies via general taxation or recycled carbon revenues to avoid uneven shouldering of the costs
- The policy options are not expected to have significant legislative or institutional barriers. Most measures can make use of existing institutional infrastructure and can be easily combined with existing EU and member state policies.

Taking learnings from the case studies and literature review, a selection of policy measures are identified that could be rolled out within the EU to counter regressive effects of climate policies. Policy measures are selected based on their effectiveness, simplicity and the transferability to the EU context. The policy options are:

- Lump-sum transfers (or a similar financial transfer consisting of lower VAT and electricity taxes)
- Targeted energy efficiency measures
- Job retraining programmes
- Funding for subsidies for low-carbon technologies

As part of the process for selecting the policy options for the combined modelling, potential measures were analysed for their ability to mitigate the regressive effects of the decarbonisation policies discussed in section 2. Based on the literature, case studies and expert knowledge, all potential measures were found to address regressive effects, either directly or indirectly, as shown in Table 6. Additional reasoning behind the selection of each measure is provided in the remainder of this section.

Table 6: Ability of measures to directly or indirectly address regressive impacts in the selected decarbonisation policies

	Lump-sum transfers	Tax cuts (income, VAT and electricity)	Inclusive energy efficiency measures	Compensation funds for low-income groups	Job-retraining programmes
Carbon pricing	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (orange)
Taxation of energy vectors	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (orange)
Subsidies for low carbon technologies	✓ (green)	✓ (green)	✓ (orange)	✓ (orange)	✓ (orange)
Emission performance standards	✓ (green)	✓ (green)	✓ (orange)	✓ (orange)	✓ (orange)
Phase out of FF subsidies	✓ (green)	✓ (green)	✓ (orange)	✓ (orange)	✓ (orange)
Energy efficiency solutions	✓ (green)	✓ (green)	✓ (green)	✓ (orange)	✓ (orange)

Key

✓ (green) Fully suitable counter measure

✓ (orange) Suitable counter measure, while only partially addressing the causal elements of the distributional effects.

As can be gleaned from Table 6 and the case studies presented in section 3, there is overlap between policy measures where two measures are able to address distributional impacts in a similar way and only one is necessary. For example, both lump-sum transfers and tax reductions can be used to directly mitigate any negative income effects from all climate policies. However, lump-sum transfers offer broader coverage than income tax reductions and can be targeted more specifically to the lowest earners—those earning less than the tax threshold. Additionally, lump-sum transfers have a higher signalling effect than tax reduction throughout their lifetime. For these reasons, lump-sum transfers may be the more effective policy option, although a policy offering a reduction in electricity tax or VAT could be a viable alternative. A reduction in electricity tax can be applied to all EU households in addition, including those not targeted by an income tax reduction. Lower electricity prices due to a lower electricity tax also favour the electrification of for example heating and cooling in households.

Targeted energy efficiency measures are also identified as a policy option for the combined modelling, as energy efficiency obligation and energy efficiency schemes are already part of the general mix of climate policies in most European countries and can easily be tweaked. Existing energy efficiency schemes can be re-designed to specifically target low-income households, which will help make them more progressive. This can be a relatively cheap policy to implement, as administration is already in place.

As an additional measure—one that cannot be modelled using E3ME—job retraining programmes can be implemented to avoid increases in long term unemployment and help redundant or at-risk workers gain employment. They can be used as a pre-emptive policy measure, or rapidly deployed following an unexpected spike in unemployment. Their focus can be highly country-specific to take into account local economic conditions and sectors. By shifting skills to the low-carbon economy, decarbonisation and climate policies are likely to be received more favourably by the public.

Whilst not part of the case studies, the wider research has revealed that subsidies for low-carbon technologies and, in particular renewable energy, are found to have regressive impacts if not designed properly, despite the initial modelling results. The research found that while commonplace throughout the member states, subsidies for renewable energy is generally funded through a surcharge, which is levied on the electricity tariffs for households. This is the case for example in Germany, Italy and the Netherlands. The literature review also showed that it is this kind of tariff design that tends to have a negative distributional impact, because the surcharge system is uniform and thus often burdens low-income households relatively more than other income groups.[98] On the other hand, the E3ME modelling assumes the funding of renewable energy support schemes would be through general taxation, thus indicating that a simple switch of the way this climate policy is funded would be an easy solution for avoiding this regressive impact.

The compensation fund policy was not taken forward in the combined modelling, as the model would not be able to account for all assumptions, and the other policy options would be sufficient to mitigate regressive effects.

Additional information about each suggested measure is presented in the following sections.

4.1 Lump-sum transfers

- **Target group:** A lump-sum transfer should target the entire population. Targeting the entire population creates acceptance throughout all income levels.
- **Key design elements:** Lump-sum transfer should be large enough to fully compensate lower incomes and partially compensate middle and high incomes. A uniform lump-sum

[98] Source: Bruegel, 2018 and McInnes, 2017, Understanding the Distributional and Household Effects of the Low-carbon Transition in G20 Countries.

transfer on a per head basis will ensure that families with children receive more support than single households. The use of existing infrastructure for the transfer such as the tax or health care system can offer low administrative costs. Paying the transfer at the beginning of a year can additionally increase transparency and acceptance of the policy. Lump-sum transfers can be unconditional or can be designed to introduce conditions, e.g. the financial support can only be used for energy efficiency investments, though this would introduce implementation challenges and normally if part of a wider climate policy package, decarbonisation policies such as emission performance standards could help to curtail any potential rebound effects.

- **Funding mechanism:** A lump-sum transfer should be funded directly from money from a revenue-generating decarbonisation policy, such as a carbon price. In this way, public acceptance of the decarbonisation policy is increased, and the funding for the lump-sum transfers is in place.

- **Cost:** Dependent on the level of revenue raised through carbon and energy taxes.

- **Key implementation body:** Ideally the transfer is either done through the tax authority or the social welfare system to avoid the need to set up an additional agency. Oversight from the member state's Ministry of Finance (for example) would be required for budgetary planning.

- **Legislative vehicles:** None at an EU level, as taxation is decided on MS level. To establish a carbon pricing mechanism in addition to the EU ETS, many member states (e.g., France, Poland, Portugal) have already adopted additional legislation to enact a carbon price. Depending on the member state, this can require amendments of existing legislation relating to taxation.

- **Duration:** Lump-sum transfers would need to stay in place as long as the carbon pricing mechanism stays in place.

- **Policy interactions:** No immediate interactions, depending implementation. Eventually, even other social welfare policies could be shifted to the lump-sum transfers offering the possibility to simplify welfare payments.

4.1.1 Reduction of VAT or electricity tax (alternative to lump sum transfers)

- **Target group:** A reduction in VAT or electricity tax would target the entire population. Lower electricity tax can be targeted specifically at households, as business usually have pay special tariff.

- **Key design elements:** A reduction to the VAT or electricity tax can be

- **Target group:** A reduction in VAT or electricity would automatically target the entire population. As electricity tax is separate for business and non-business customers, households can be targeted directly.

- **Key design elements:** The reduction of VAT or electricity tax, or any combination thereof should be large enough to fully compensate the negative distributional effects of the carbon pricing mechanism for low-income households. This requires subsequent decreases in the relevant tax until 2050, but no implementation body. If rates are limited by the lower bounds defined by EU legislation.[99]

- **Funding mechanism:** A reduction in VAT or electricity tax should be funded directly from money from a revenue-generating decarbonisation policy. In this way, public acceptance of the decarbonisation policy is increased.

- **Cost:** Dependent on the level of revenue raised through carbon and other non-electricity energy taxes.

- **Key implementation body:** Any structural changes in VAT or electricity tax need to be agreed upon by the respective national parliaments, as existing legislation needs to be amended. No continuous implementation and oversight are needed, beyond a continuous decrease of the tax to fully compensate lower income households for a rising carbon price.

- **Legislative vehicles:** Taxation is decided on MS level. However, the Energy Taxation Directive 2003/96/EC and the VAT Directive 2006/112/EC set lower bounds for both electricity tax rates and VAT. Lowering these can provide MS with more leeway in reducing their own tax rates.

- **Duration:** A reduction in VAT and electricity tax would need to stay in place as long as the carbon pricing mechanism stays in place.

- **Policy interactions:** Existing national legislation needs to be changed. Policy interaction is possible with European-level legislation if VAT or electric taxes are to be reduced beyond the current mandated minimum.

4.2 Targeted energy efficiency measures

- **Target group:** Energy efficiency measures are already widely used, but generally target the entire population. Existing or new schemes could be modified to include a bracket to direct more funds to low-income households. Special conditions in this bracket could

[99] EU Energy Tax Directive 2003/96/EC and EU VAT Tax Directive 2006/112/EC

ensure participation of low-income households and thus mitigate regressive effects of rising energy prices.

- **Key Design Elements:** Energy efficiency measures should specifically be targeted at low-income households. To this end they should feature some form of auto-identification with other social welfare programmes or a certain income-level. This setup will keep transaction costs for identification of the target group to a minimum. Support should be paid in the form of an upfront subsidy for a certain measure, as to not burden low-income households and increase uptake in the target group.

- **Funding mechanism:** Targeted energy efficiency measures can be funded from recycled revenue from a carbon pricing mechanism such as a carbon tax or the EU ETS. However, as the budget of such schemes are considerably smaller than those of a lump-sum transfer they can also be financed out of the general government revenue directly.[100]

- **Cost:** €1-3bn (equivalent to around 10% of annual total energy efficiency investment cost in households)

- **Key implementation body:** Targeted energy efficiency measures require an agency to process applications and distribute subsidies. This implementing agency is usually a government-related institution—or for an obligation scheme, a utility. Depending on the exact setup of the scheme, parts of the scheme, such as distribution of financial support, monitoring and evaluation can be delegated to private sector parties.

- **Legislative vehicles:** At a European level, the "Clean energy for all Europeans package"[101] and more specifically the Energy performance of buildings directive[102] offer the possibility to nudge member states into special consideration of low-income households. For example, member states could be required to reflect a special consideration of low-income households in their long term renovation strategies.

- **Duration:** Lump-sum transfers are most likely needed throughout the transition to a decarbonised economy, which means they would possibly stay in place even beyond 2050.

- **Policy interactions:** A special bracket or a separate scheme for targeted energy efficiency measures for low-income households, with higher subsidies than in the main bracket will create an incentive for applicants to be considered as low-income to take advantage of the higher subsidies. The auto-identification with other social welfare

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[100] Within the E3ME model policy is modelled with recycled revenue.

[101] Clean Energy for all Europeans package (EU) 2018/2002. Available at https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive_en

[102] Energy Performance in Buildings Directive (2018/844/EU). Available at https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

schemes can help minimise such effects and expensive identification measures. While the effect is negative from a budgetary perspective it is not immediately evident that it would have any negative effects on the climate target contribution of the energy efficiency measure.

4.3 Job retraining programmes

- **Target group:** Job retraining programmes can target workers who have been made redundant or are at risk of redundancy in sectors that have suffered negative economic impacts as the result of the energy transition.

- **Key Design Elements:** Job retraining programmes should be set up early and pre-emptively reskill and upskill workers. Programmes should reflect the impacts on the local labour market conditions, for example Poland and Germany might need to both reskill workers from coal-dependent industries, but Germany and Italy might also need to reskill parts of its automobile supply chain. Programme administrators should work with industry to identify labour shortages and reskill workers to fill gaps in these sectors.

- **Funding mechanism:** Job retraining programmes can be funded through carbon pricing mechanisms or from general tax revenue.

- **Cost:** Cost would vary by member state and would be largely dependent on the costs of sector-specific training.

- **Key implementation body:** Existing national skills agencies would be best placed to administer the programmes.

- **Legislative vehicles:** None are required.

- **Duration:** The programmes could run as frequently as needed, for as long as needed, to avoid large-scale unemployment resulting from the energy transition.

- **Policy interactions:** Job re-training programmes are stand-alone policies which can boost other programmes and provide a double dividend effect when combined with other progressive measures by targeting and treating job losses associated with the energy transition.

4.4 Fund low-carbon technology subsidies via general taxation

- **Key design elements:** Funding existing subsidies for low-carbon technologies such as renewable energy support schemes not through a surcharge on electricity consumption but through another less regressive way, such as rising income tax rates for high incomes or business tax.

- **Cost:** Costs vary by member state and size and type of the support measure.

- **Key implementation body:** Changing the funding of existing schemes will most likely require changes in existing legislation, hence national legislature is the implementing body.

- **Legislative vehicles:** On a European level the revised Renewable Energy Directive (RED II). At a national level it is each member state's respective renewable energy framework. Other support for low-carbon technologies is also regulated on a national level.

- **Duration:** As long as large scale subsidies for renewable energy generation or other low-carbon technologies are in place.

- **Policy interactions:** Depending on the alternative funding measure various policy interactions are possible. Renewable energy support schemes and other subsidies are subject to the EU State Aid guidelines and thus need to be approved by the European Commission.

4.5 Other alternative measures: reduction in income tax

The only other measure, which could address the distributional effects on a large enough scale are targeted tax cuts. Their effect is similar to the lump-sum transfer, as they increase the available income of households. Depending on conditions of existing legal and tax infrastructure in member states, they might be a suitable alternative for a lump-sum transfer.

Tax cuts to decrease the distributional effects of climate policies exist and are successfully implemented in some countries. The most prominent example is certainly Sweden, as discussed in the case study in section 3.3.1 , which reduced its income tax rate in response to the introduction of a carbon tax in 1991

The main issue with income tax cuts is, that it is difficult to reach the lowest incomes. To have a maximal effect on low-income households, a decrease in income tax should take on the form of an increase of tax-free income. A higher tax-free income would benefit everyone equally in absolute terms, but the effect is relatively higher for low-income households, who receive more or all of their income from labour. The only issue is, that the very lowest incomes, who do not pay any income tax or receive welfare will not be affected by an increase in tax-free income. They would need to be targeted specifically with an additional transfer, e.g. increased welfare payments or reduced social security payments., which depending on the exact implementation could look very much like a targeted lump-sum transfer for the lowest-incomes.

The revenue raised by a carbon tax will fluctuate significantly over the period of 2025–2050. Recycling the raised revenue through lower income tax would therefore require subsequent increases of tax-free income throughout 2050. Tax measures are also less visible over time when compared to a lump-sum transfer, which can be more easily attributed to the revenue raised by a carbon tax as done in Switzerland.[103]

4.6 Implementation in EU context

While the EU can and does already actively engage with member states on energy efficiency measures and job retraining programmes, it does so less on the issue of revenue recycling for mitigating regressive effects.

The main issue regarding implementation efforts of the EU towards a lump-sum transfer or a reduction in VAT or electricity tax, is that tax related issues are under national jurisdiction of each member state. In the absence of a single European-wide solution the EC can provide guidance and best practices for member states to implement. Such guidance could take on the form of case studies and suggestions for each member state of how a lump-sum transfer on national level could be implemented. Both VAT and electricity taxes face mandated minimum levels through their respective European legislation, the VAT Tax Directive and the Energy Taxation Directive. Lowering these might provide member states with more leeway in reducing their rates. The Energy Taxation Directive is currently being revised by the European Commission as part of the Green Deal.[104] The revised EU ETS Directive provides that at least 50% of auctioning revenues of the EU ETS should be used by member states for climate and energy related purposes.[105] One proposition is to spend this money on energy efficiency measures for low and middle income households.[106] Another example of revenue recycling is the Modernisation Fund, which recycles up to 2% of EU ETS revenue between 2021 – 2030 to support the 10 lower income member states in their transition to a low-carbon economy. As such it can be noted, that the EU ETS already has a re-distributive element, but that targeting in member states on low-income households needs to be increased.

The situation is different for targeted energy efficiency measures. Energy efficiency obligation schemes or comparative schemes are mandated directly on a European level through the EED article 7. Through a revision of the EED article 7 or through a delegate act further specifying the modes of implementation, the EU could stipulate a minimum of savings that needs to be achieved

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[103] Edenhofer et al., 2019, Optionen für eine CO_2-Preis Reform

[104] EC (2020) „EU Green Deal – Revision of the Energy Taxation Directive". Website. Visited on 8 June. Available at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12227-Revision-of-the-Energy-Tax-Directive

[105] EC (2020) "Auctioning". Website. Visited on 5 May: Available at https://ec.europa.eu/clima/policies/ets/auctioning_en

[106] EC (2018) "EU Directive 2018/410 Article 10". Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0410&from=EN

or support to be paid for low-income households. Further could the special consideration of low-income households be reflected in each member states long term renovation strategies.

The EU already supports job retraining programmes in member states through one of its structural funds and its social transition agenda, which is part of the Clean Planet for All package. The European Social Fund Plus, which will be part of the Just Transition Mechanism in the forthcoming multiannual financial framework, aims at spending at least 25% of its €100 billion budget on measures fostering social inclusion and targeting those most in need. The European Globalisation Adjustment Fund provides financial assistance for job losses due to the transition to a low-carbon economy and helps with the necessary reskilling for the new jobs.[107] Both funds can be used to help member states to finance long term operational programmes that provide necessary financial assistance and reskilling of workers in carbon intensive industries. This support can be kept up as long as needed and even greatly expanded, if enough budget in the multiannual financial framework is made available. The Modernisation Fund also has a special bracket for a just transition in carbon dependent regions, which could provide targeted support and retraining for affected lower income member states and regions.[108]

[107] EC (2018) "Our Vision for A Clean Planet for All: Social Transition". Available at https://ec.europa.eu/clima/sites/clima/files/docs/pages/vision_3_social.pdf

[108] EC (2020) "Modernisation Fund". Website. Visited on 5 May: https://ec.europa.eu/clima/policies/budget/modernisation-fund_en

5. Impact assessment results of the combined policy options

Key findings:

- The modelling shows that the combined policy measures can effectively address the regressive effects of the key climate policies and result in positive distributional and macroeconomic impacts across Europe.
- Recycling revenue through lump-sum transfers or lower VAT / electricity taxes to the general public provides direct financial assistance to help offset increased costs. Key decarbonisation policies including carbon pricing and fossil fuel taxes would see an average sum of €260 going to households across the EU every year. This amount represents a 4.2% increase in household disposable income for the lowest income households while only 0.8% increase for the highest income households.
- Implementation of energy efficiency measures with no upfront costs, specifically targeting low-income households overcomes the key challenge of initial financing. Financing can come from carbon revenues and only 1 – 3 billion EUR per annum would be needed to fund this option for the EU as a whole.
- Funding of low-carbon subsidies via general taxation or recycled carbon revenues would be an administratively simple way to avoid uneven shouldering of the costs.
- The modelling suggest that all regions of Europe will benefit from the combined policies. Southern Europe and Central and Eastern Europe are expected to see the most benefits in terms of tackling inequality, with Western Europe expected to see a large share of the employment benefits in terms of increased jobs

Having established the key design elements of the policy options the next step is to rerun the macroeconomic model with the combined policy options to see if the regressive impacts identified in section 2 are effectively addressed. The combined policy options are modelled with the same scenario inputs as those for the six individual policy scenarios. However, net government revenues are reallocated to finance two mitigation measures:

1. Full subsidy for household energy efficiency investment for the lowest three income deciles
2. Lump-sum transfers of any remaining net government revenues from the policy costs.

The policy options include two additional measures that are not explicitly covered here:

3. **Fund subsidies through low-carbon technologies** – This is already built into the assumptions around subsidies for low-carbon technologies being funded through government revenues and so is included in the policy costs.

4. **Job retraining programmes** – In the modelling, the issue of skills requirements and retraining needs before workers can switch employment is not captured. While we focus on the aggregate employment impact, we see that the winners and losers from the transitions especially for those in fossil fuel sector jobs.

As shown in the Table 7 below, at the EU28 level, the combined policy options generate substantial net revenues that can be allocated to the lump-sum transfers even after accounting for other policy costs and the energy efficiency subsidies for low-income households. The net revenue for the lump-sum payment is converted to a per capita basis and multiplied by the average household size to determine the lump-sum payment per household. This payment is then allocated to the average disposable income for each income decile.

Table 7: Expected annual policy revenues and costs

	2025	2030	2035	2040	2045	2050
Decarbonisation Policy Revenues* (€2010bn)	135	186	204	200	175	155
Decarbonisation Policy Costs** (€2010bn)	45	60	31	17	8	0
Energy efficiency subsidies for low-income households (€2010bn)	1	2	2	2	2	3
Net revenue available for Lump-sum measure (€2010bn)	89	124	171	181	164	152
EU Population (millions)	517	520	522	525	526	527
Lump-sum per capita (€)	172	239	328	344	313	288

* Includes carbon tax revenue and fossil fuel taxes for heating and transport and phased out fossil fuel subsidies
** Includes Subsidies for low-carbon technologies and redistribution RES support

While the level of the subsidy may not seem particularly large in absolute terms, this lump-sum transfer can represent a relatively large increase in income for the lowest income deciles. To demonstrate the relative impact of the lump-sum transfer, in Figure 29 below, the income distribution across the EU28 to the average lump-sum transfer of €260 (from Table 7 above) are compared. For the first income decile the transfer represents 4.2% increase in household disposable income, while for the tenth income decile the transfer represents a 0.8% increase in income.

With respect to potential rebound effects where the direct rebate is spent on emission intensive activities, it is already highlighted as option that conditions on the use of the direct rebate could be introduced by policy makers if this is significant concern. However, in the context of a decarbonising economy, the macroeconomic model results showed economic activity in the combined policy option scenario as increasing by up to 2.5% relative to baseline. Even if all the growth went to carbon intensive activities, it would not be enough to undermine the overall reduction in emissions brought on by the suite of decarbonisation policies

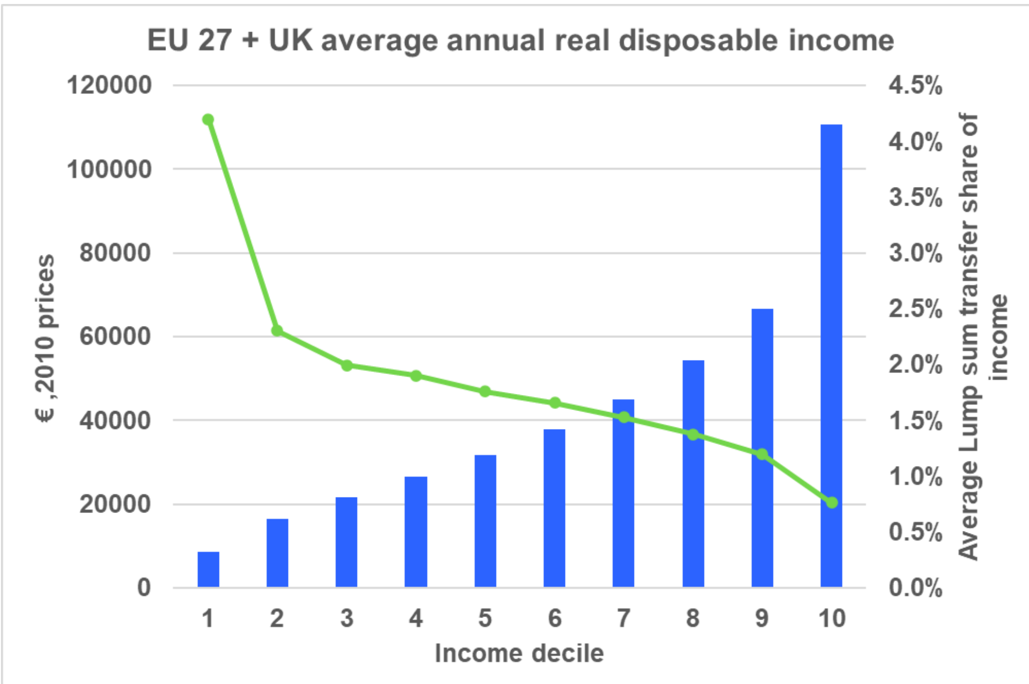


Figure 29: EU average annual real disposable income

5.1 EU distributional impacts

Figure 30 below illustrates the distributional impacts of the combined policy options, relative to the baseline scenario. This shows that the lump-sum transfer leads to a strong progressive impact as it has a proportionally large impact on the incomes of the lowest income deciles. In the short term, the lump-sum transfer is sufficient to make sure that the lowest income deciles are compensated for any upfront costs from higher energy prices or investments in household heating and energy efficiency. Over the longer term, the progressive impact of the energy efficiency measures, and emissions performance standards also help to increase the overall progressive impacts of the combined policy options.

The subsidy for energy efficiency in the lowest income deciles provides a small progressive benefit but the impact of this is much smaller than the lump-sum transfer. The relative scale of the progressive impact between the two measures reflects the scale of the transfer as the lump-sum transfer represents a large transfer of revenues.

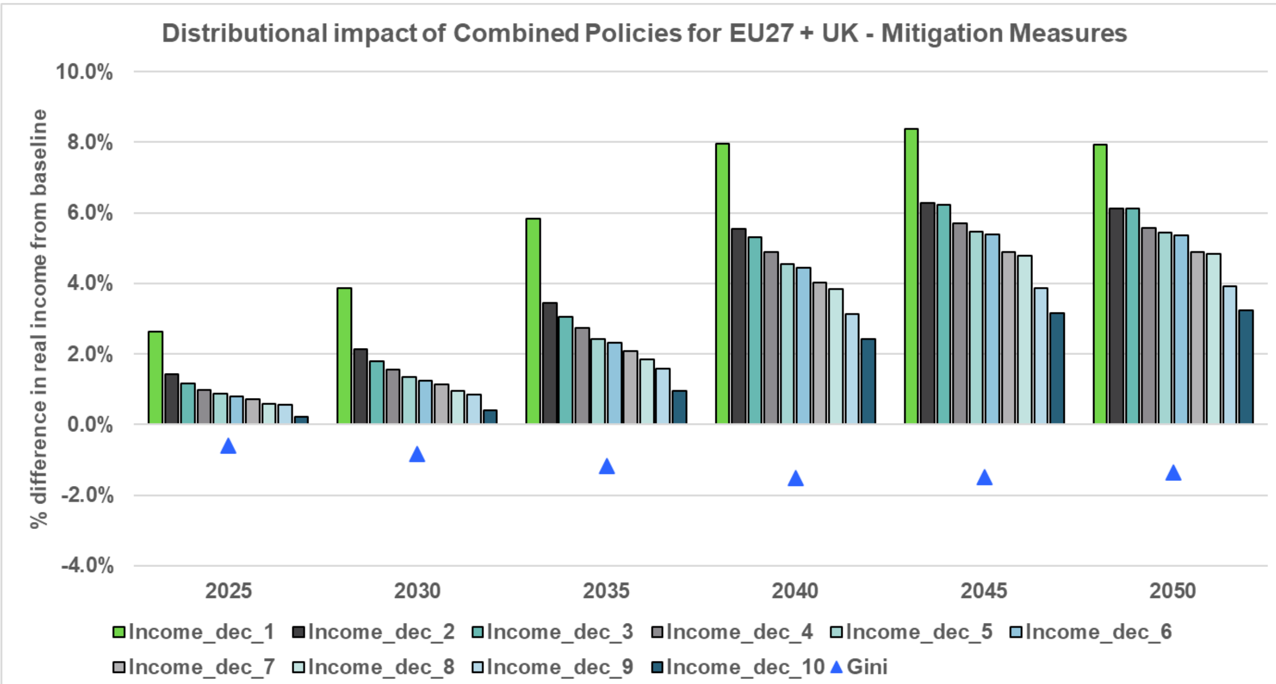


Figure 30: Modelled distributional effects of the combined policy options

5.1.1 Sensitivity on scale of the lump-sum transfer

Three sensitivities on the share of the net revenues allocated to the lump-sum transfer are tested:

1. A scenario run of the combined policy options with only 50% of the net revenues allocated to the lump-sum transfer. The remaining revenue is recycled to reduce general taxation using the central assumption of allocating to income tax, employers' contributions and VAT.
2. A scenario run of the combined policy options in which all net revenues are recycled through general taxation as implemented for the individual policy scenarios.
3. A scenario run of the combined policy options in which all net revenue are recycled through VAT as implemented in the individual policy scenarios

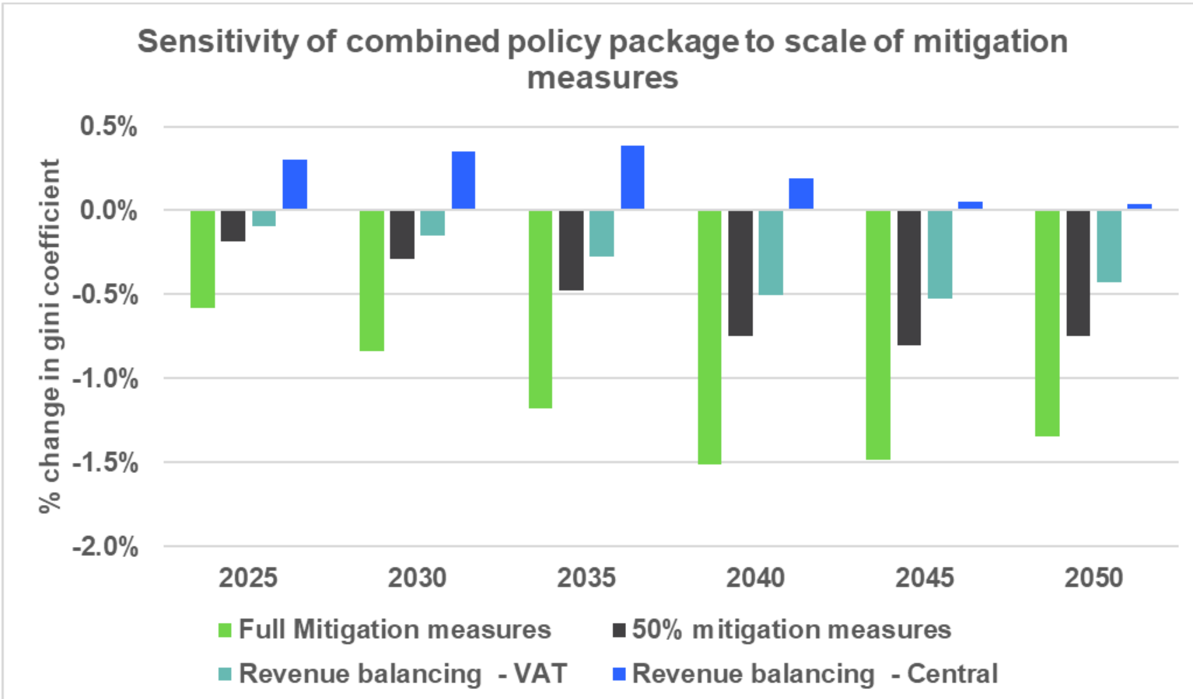


Figure 31: Sensitivity of the combined policy options to scale of mitigation measures

In Figure 31 above, the change in the Gini coefficient relative to baseline is presented for all scenario variants. This illustrates that even with only half the net revenues allocated to the lump-sum transfer, the combined policy options show consistently progressive impacts. Even in the 50% mitigation measures sensitivity, regressive impacts generated by the climate policies and changes in general taxation are offset by the lump-sum transfer.

In contrast, without the mitigation measures, the impact of the combined policy options would be regressive as a larger share of the revenue recycled goes to the higher income deciles who pay a larger share of direct taxes. Over the longer term, the regressive effect diminishes as the savings in household energy expenditure in transport and heating benefit lower income households proportionally more. If the government were to balance all net climate revenues through reductions in VAT, this also results in a progressive impact though not as strong as the mitigation measures.

5.1.2 Regional difference in distributional impacts

The general trend in the distributional effects of the combined policy options with mitigation measures is broadly consistent across all regions, i.e. a progressive effect in all regions (Figure 32).

The smallest progressive impact from the combined policy options is observed in NE. This largely reflects the relatively high levels of decarbonisation in the region and lower levels of income inequality already present in the baseline . The further decarbonisation induced by the combined policy options reduces the amount of carbon tax revenue available to redistribute through taxation.

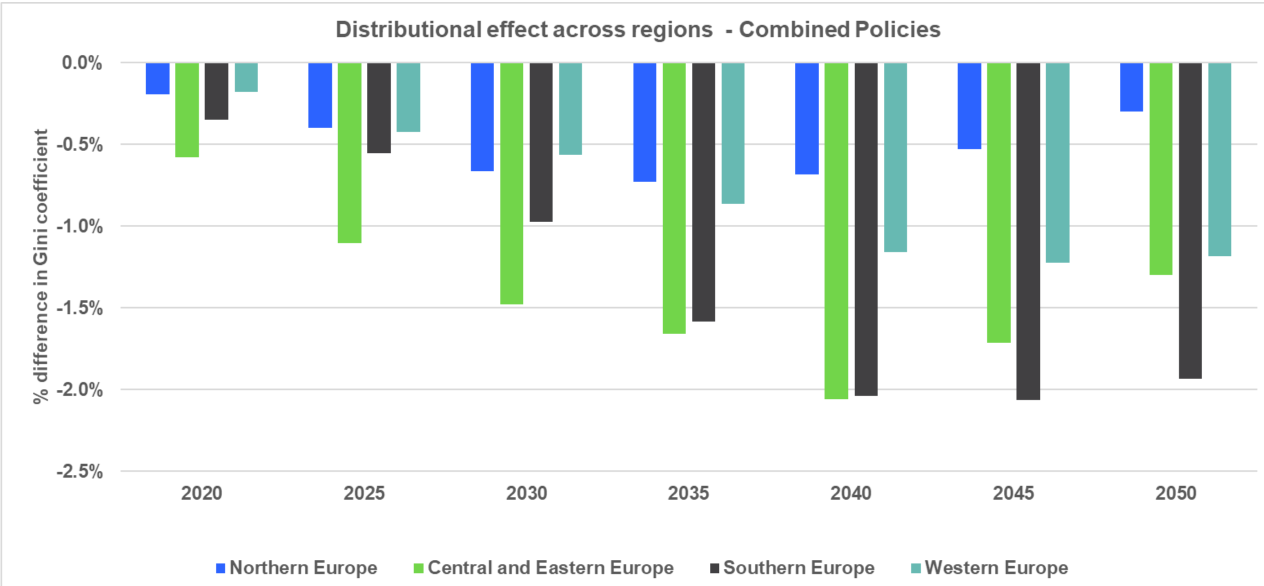


Figure 32: Regional differences in the modelled distributional effects of the combined policy options

5.2 EU macroeconomic impacts

Over the whole time period, the combined policy options with mitigation measures shows positive economic impacts for the EU27+UK (Figure 33). In the short term, the GDP impact is mostly driven by investments in energy efficiency measures. In the longer term, the positive change in GDP increases as the emissions performance standards come into effect, reducing consumer prices through energy savings in industry, and a reduction of fossil fuel imports as road transport is electrified from 2035 to 2050. Comparing with the combined policy options without any recycling of climate policy revenue, highlights the importance for government to redistribute any revenue generated from climate policies back into the economy in some form. Especially in the short term where the upfront costs of climate policies are outweighed by the economic benefits.

For employment, over the period to 2035, employment growth is dominated by an increase in construction and manufacturing jobs to meet the energy efficiency investment. Over the longer term, the growth in employment is concentrated in service sectors and the electricity generation and supply sector. The positive employment effect in the service sectors is driven by an increase in consumer demand from higher real incomes. The positive employment effect in the electricity generation and supply sector is driven by the need to meet the additional electricity demand for the electrification.

However, jobs associated with fossil fuels production and distribution fall over time due to decarbonisation. This highlights that even beyond the distributional impact in terms of average incomes or net employment effects, the path to decarbonisation is a transition that will not be smooth for everyone. Where job losses are concentrated, effective social, labour market and retraining policies will be required to mitigate the impact for those negatively affected.

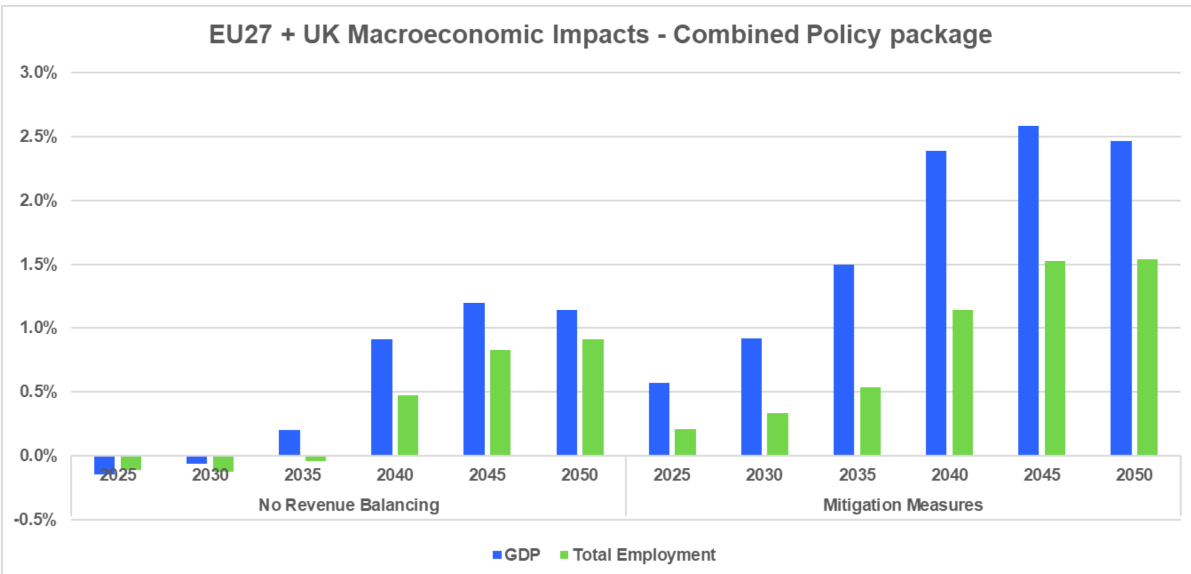


Figure 33: Modelled macroeconomic impacts of the combined policy options

5.2.1 Regional difference in macroeconomic impacts

From a macroeconomic perspective, the overall trend across the regions is broadly similar (Figure 34). The largest economic impact in terms of change in GDP between the baseline and scenario is observed in CEE. This is driven by the scale of the revenues generated, which represent a higher proportion of GDP than in other regions.

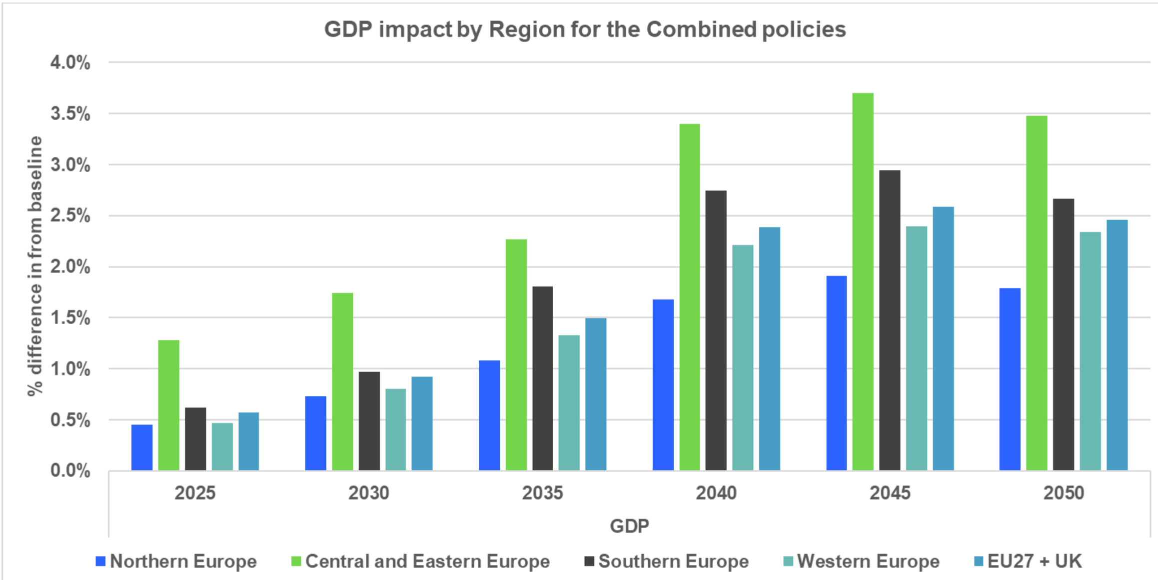


Figure 34: Regional differences in the modelled macroeconomic impacts of the combined policy options

However, as can be seen in Figure 35, in terms of employment, the impact in CEE is smaller relative to the other regions due to the greater importance of the loss of fossil fuel sector jobs and the knock-on effect this has on wages. The smallest economic impact is observed in NE, reflecting the smaller net revenues from the climate policies.

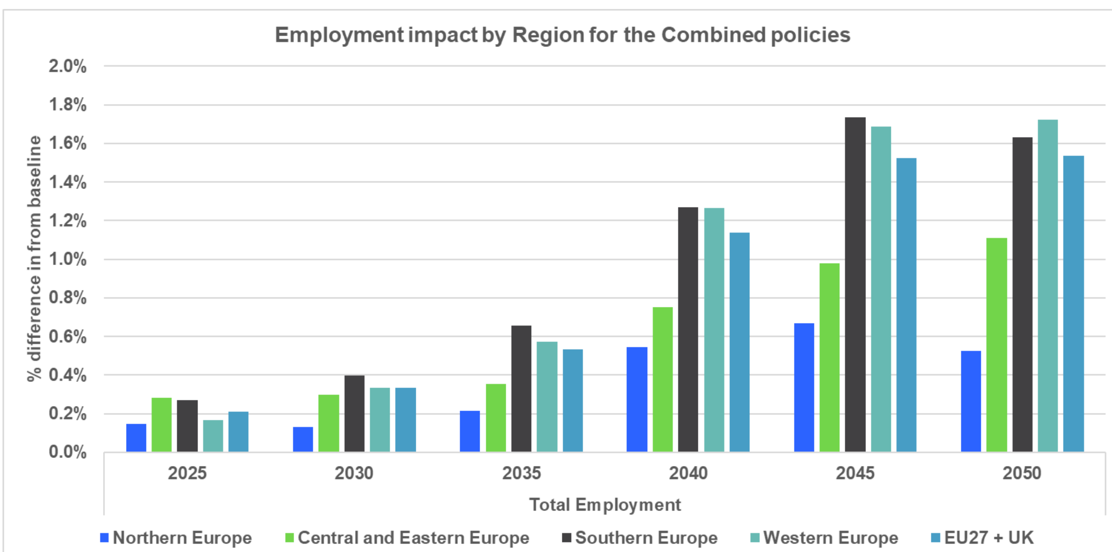


Figure 35: Regional differences in the modelled employment impacts of the combined policy options

5.3 Sensitivity due to the Covid-19 pandemic

The effects of the Covid-19 pandemic and the measures that were taken to limit its spread are having major impacts on the economy and on society. However, in the main modelling of the climate policy scenarios, the E3ME baseline does not factor in the immediate impacts of the Covid-19 in 2020 or any lasting impacts on the economy. As such the question is, does the economic shock of Covid-19 affect the relative impact of the combined policy scenario?

This sensitivity analysis seeks to address this question by developing an alternative baseline which aims to capture the impact Covid-19 has had on the global economy. The assumptions are based on the emerging literature on the impacts that Covid-19 and lockdown response has had on the global economy. Please see Appendix E for addition information relating to the assumptions and approach used for this sensitivity analysis.

The alternative baseline assumptions are then applied to both the E3ME baseline and the combined policy options scenario to assess if Covid-19 impacts the distributional and economic impacts from the combined policy options. It is important to keep in mind though that the Covid-19 shock is introduced to the baseline as well as the scenario. As such, as in the original analysis, the results presented here capture the distributional effect of the policy measures contained in the combined policy options and NOT the distributional effect of the Covid-19 shock.

5.3.1 Distributional impacts of the combined policy options with Covid-19 shock

Overall, it was found that the impact of the Covid-19 shock does not impact the magnitude or direction of the distributional impacts of the combined policy scenario relative to baseline. While Covid-19 does present a substantial negative shock to the European economy (see discussion above), it does not fundamentally change the pathways through which the combined policy scenario leads to positive economic and distributional impacts.

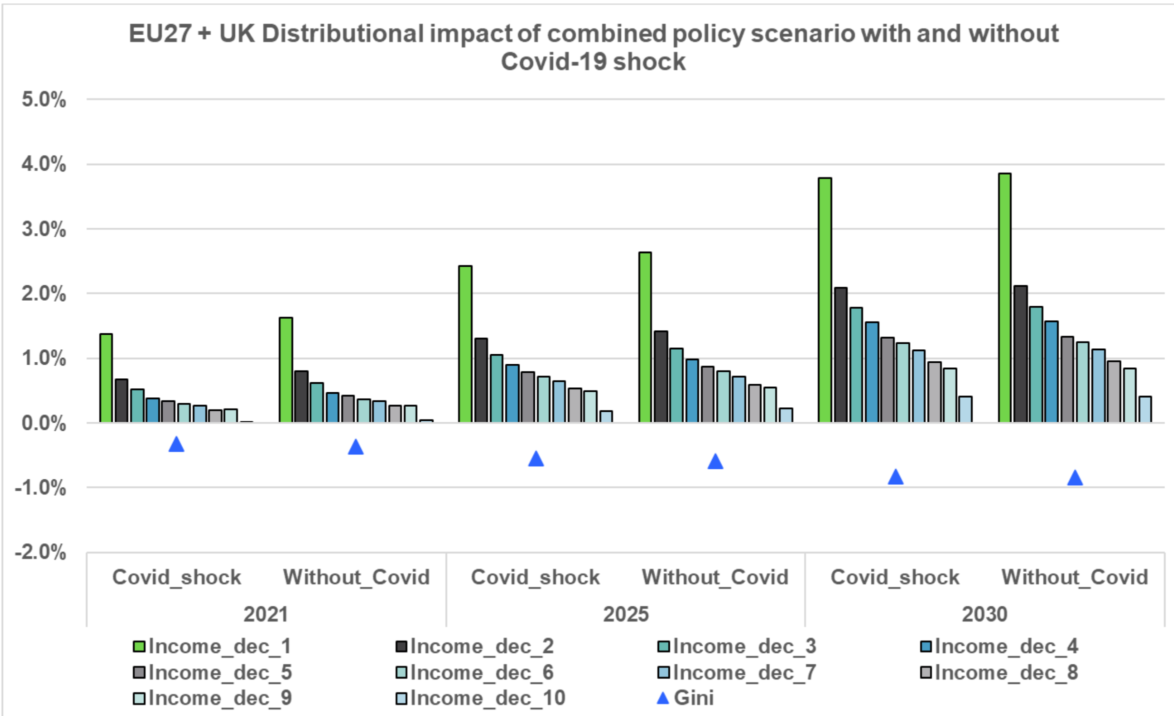


Figure 36: Distributional impacts of the combined counter distributional effects policy options

Overall, the addition of the Covid-19 shock to the baseline and the combined scenario does not have a substantial impact on the distributional effects of the decarbonisation policies (note that no changes to the policy ambition and design are made).

There is a small reduction in the progressive impact throughout the period as the scale of the change in real income under the Covid-19 shock is slightly reduced. The main driver of the smaller progressive impact is the reduction in climate policy revenues that are allocated to the lump-sum transfer which are lower with the Covid-19 shock in 2021. This reflects both reductions in road transport demand from weaker economic activity overall and the reduction in emissions. Over the longer term, the trend in road transport demand and CO2 emissions does partially recover and so the revenues from the decarbonisation policies are only slightly lower by 2030.

Beyond the lump-sum transfer, the impacts on other individual policy elements are less definitive. The net effect on prices faced by households is only slightly smaller by the Covid-19 shock. Price effects from subsidies in low-carbon technologies have a proportional impact on electricity prices and taxation on energy vectors has a proportional impact on fossil fuel for household heating. The exception is the taxation on road transport fuel, which has a slightly larger impact under Covid-19 due to lower oil prices in the short term, but this is then offset by lower demand for road transport.

5.3.2 Macroeconomic impacts of combined policy options with Covid-19 shock

When the combined policy scenario with the Covid-19 shock is compared to the baseline with the Covid-19 shock, the direction of macroeconomic impact of the combined policy scenario is the same as the macroeconomic impact in the original analysis; an increase in GDP and employment relative-to-baseline. However, the macroeconomic benefits from the combined policy scenario are smaller in magnitude when the Covid-19 shock is included in the analysis. The smaller macroeconomic benefits are mainly explained by a smaller increase in consumption relative to baseline as the level of the recycled revenues are lower due to lower emissions and road transport fuel demand caused by the Covid-19 shock.

For the combined policy options, in the short term the energy efficiency investment is an important driver of the macroeconomic impacts. As this investment is defined in absolute terms, when the Covid-19 shock is applied the investment stimulus is larger in proportion to lower baseline GDP due to Covid-19. This does not offset lower consumption increase in terms of driving GDP however it does offset the impact on employment in 2021 as the employment impact is driven by additional construction jobs to deliver the energy efficiency investment.

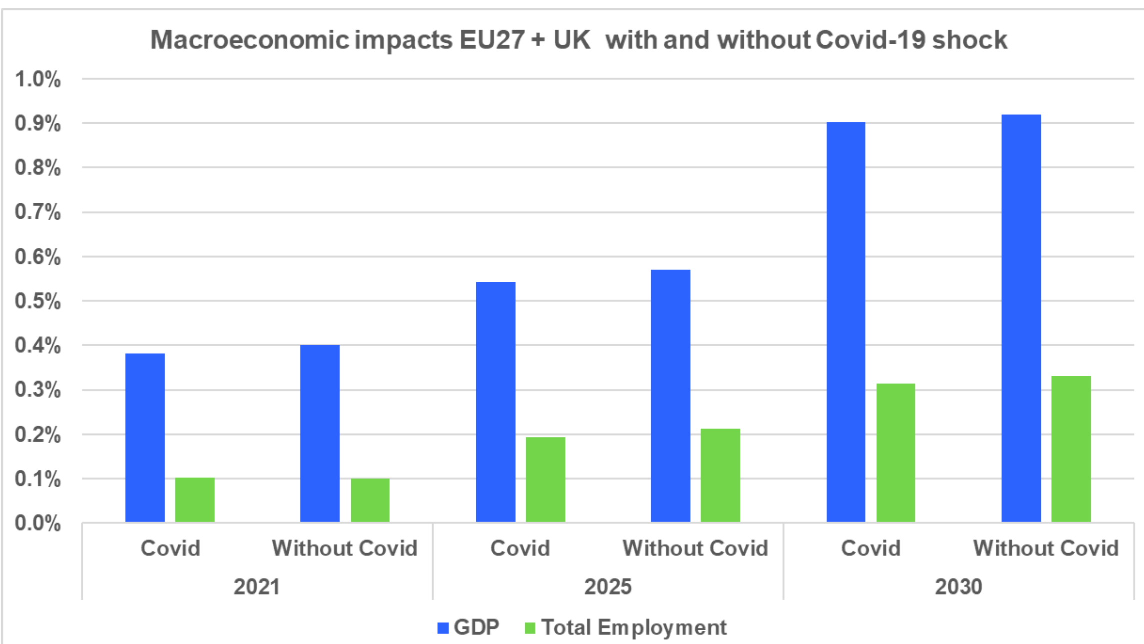


Figure 37: Macroeconomic impacts of the combined policy options

5.3.3 Covid-19 sensitivity conclusions

It is clear that Covid-19 and the countermeasures imposed have already had a substantial impact on the global economy and those effects are likely to impact the economy for years to come. Given the unprecedented nature of this crisis, it is important to reiterate the wide degree of uncertainty at this stage around the full impacts that Covid-19 will have on our economies. In particular, the potential behavioural shifts around digitalisation and remote working which may be permanent or may be reverted as lockdown measures are eased.

While our modelling shows sustained negative economic impacts from the Covid-19 shock throughout the projected time period, our modelling also shows that these impacts of Covid-19 does not drastically alter the impact decarbonisation policies can have both for the distributional impacts and the macroeconomic impacts, especially in the longer term. The impacts from combined policy scenario with Covid-19 shock are still positive when compared to the baseline with Covid-19 shock, although the impacts are slightly smaller in magnitude. The latter is primarily driven by the effect of the covid-19 shock on economic activity in the baseline and the tax base for taxation policies, resulting net revenues and thus governments ability to finance other policies or counterbalance regressive effects.

In our modelling, Covid-19 is not assumed to put a political constraint on the decarbonisation policies in terms of ambition. In other words, what is not captured in the modelling is how the impact of Covid-19 changes the political will to implement decarbonisation policies. Recent policy debates have nonetheless shown that there is a clear need to help the European economy recover and climate policies can play a role to not only stimulate the economy but help accelerate the decarbonisation dubbed a “green recovery”[109]. In this context it further emphasises the need to ensure that the benefits from any additional climate policies are distributed in a progressive manner.

5.4 Summary of findings for combined policy options

The modelling results for the combined policy options illustrate that when net revenues are reallocated to counterbalance the regressive effects of climate policies, this can lead to net positive economic impacts for all regions as well as more progressive outcomes:

- The positive net economic impacts in the long term are driven by the continued investment in energy efficiency, a reduction in fossil fuel imports and lower industry and consumer prices from energy efficiency and a shift away from rising fossil fuel prices increasing real incomes and consumer expenditure. .

- Several of the climate policies generate revenues for government, which can be used to ensure that not only are the costs of climate policies paid for, but also help to ensure that the long term benefits of a low-carbon transition are distributed progressively across households. The scale of these measures depends on the levels of revenues that can be raised from climate policies.

[109] Proposals by European commission to include **Supporting the green transition to a climate-neutral economy via funds from Next Generation EU recovery mechanism** https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response/recovery-plan-europe_en

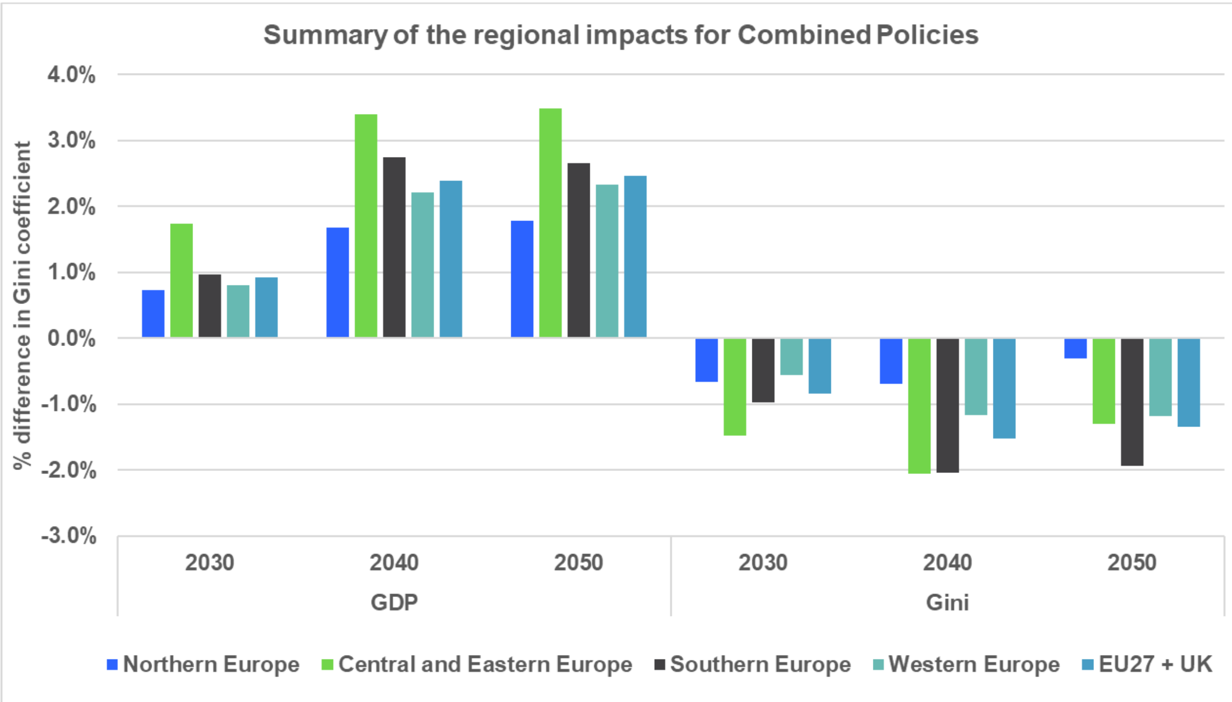


Figure 38: Modelled macroeconomic and distributional effects of the combined policy options

6. Conclusion

If implemented without measures to curtail their distributional effects, some EU cornerstone climate policies such as carbon pricing, phase out of fossil fuels and subsidies for renewable energy are likely to have regressive effects — either immediately or in the future—until full decarbonisation is reached in 2050. To avoid these negative distributional effects, counter measures are needed. Such counter measures can either be additional counter policies, such as a lump-sum transfer or a redesign of the original decarbonisation policy.

Given the existing and planned decarbonisation polices in place, the policy options described in section 4 enables the mitigation of all regressive effects. They would provide a level of financial assistance that counterbalances the financial burden the climate policies place on low-income households. Ultimately—through implementation of a straightforward set of counter measures—regressive effects of decarbonization policies are not only reduced, but low-income households financially benefit.

The key counter measures options identified are:

- lump-sum transfer of carbon pricing revenue (or, a reduction of VAT and/or electricity tax)
- energy efficiency measures targeted specifically to low-income households
- job retraining programmes for workers in industries affected by decarbonisation
- funding for renewable energy subsidies through general taxation

The policy options are not expected to have significant legislative or institutional barriers. In fact, most measures can make use of existing institutional infrastructure and can be easily combined with existing EU and member state policies. The European Commission can actively support energy efficiency (obligation) schemes and job retraining programmes through future amendments and consideration in the EED and its structural funds and social transition agenda, respectively. A policy for lump-sum transfer for revenue-recycling of a carbon pricing mechanism must be implemented at the member state level, as tax-related issues remain within national jurisdiction. The European Commission, however, could assist on a case by case basis with country-specific guidance for implementation of such a transfer scheme. It could also strengthen the EU ETS directive, to mandate that an increasing percentage of ETS revenue needs to be used to mitigate regressive effects of decarbonisation policies.

The findings of this study reveal that solutions to address the regressive impacts of climate policies are unlikely to be technically challenging and are likely to be highly socially acceptable. Taking into consideration the need to increase climate ambition in order to achieve Paris Agreement aligned climate goals, and the short time remaining to achieve them, it is imperative that EU policymakers explore a coordinated response to address the regressive effects of climate policies and in doing so ensure their effectiveness and longevity.

Appendix A. The E3ME model

E3ME is one of the most advanced models of its type today. Its main strengths are:

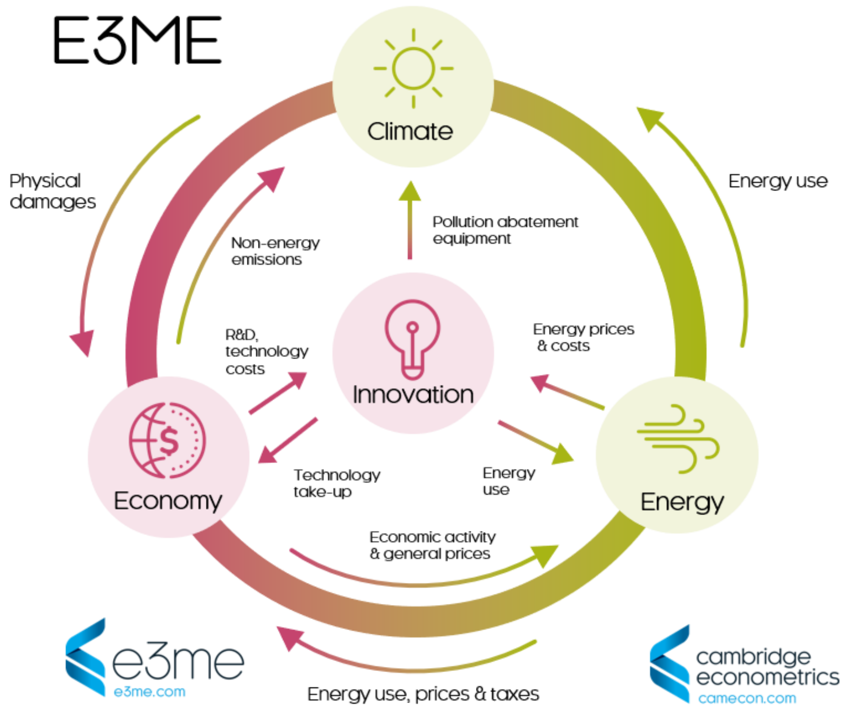
- A high level of disaggregation, enabling detailed analysis of sectoral and country level effects from a wide range of scenarios. Social impacts (including unemployment levels and distributional effects across income groups, e.g. changes in consumer spending per income decile) are important model outcomes.

- An econometric specification that addresses concerns about conventional macroeconomic models and provides a strong empirical basis for analysis.

- Integrated treatment of the world's economies, energy systems, emissions and material demand. This enables E3ME to capture two-way linkages and feedbacks between each of these components.

Figure 39 shows how the three components (modules) of the model - energy, environment and economy - fit together. The linkages between the components of the model are shown explicitly by the arrows that indicate which values are transmitted between components. For example, the economy module provides measures of economic activity and general price levels to the energy module and the energy module provides detailed price levels for energy carriers, the overall price of energy and energy use in the economy.

Figure 39: E3ME modules and linkages



E3ME is defined at member state level and extends the economic analysis to include physical environmental impacts (energy consumption, emissions and material consumption). The current version of the model has the following dimensions:

- 61 regions – all major world economies (i.e. G20), the EU28 and candidate countries plus other countries' economies grouped
- 70 (Europe)/43 industry sectors, based on standard international classifications
- 43(Europe)/28 categories of household expenditure
- 22 different users of 12 different fuel types
- 14 types of airborne emissions (where data are available) including the six greenhouse gases monitored under the Kyoto protocol1

The model is widely used for policy impact assessment (e.g. 'In-depth Analysis in Support of the Commission Communication COM(2018) 773'[110]) and has been used to assess the effects of

[110] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

climate policies, as well as to capture the socioeconomic impacts of circular economy, collaborative economy and resource efficiency policies.

The structure of E3ME is based on the system of national accounts, with further two-way linkages to energy demand and environmental emissions. The labour market is also covered in detail, including both voluntary and involuntary unemployment. In total there are 33 sets of econometrically estimated equations, including the components of GDP (consumption, investment, international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector. E3ME's historical database covers the period 1970-2016 and the model projects forward annually to 2050. The main data sources are Eurostat, the OECD (both the National Accounts section and STAN), World Bank, United Nations, International Monetary Fund (IMF) and ILO, supplemented by data from national sources. Energy and emissions data are sourced from the IEA and EDGAR. Gaps in the data are estimated using customised software algorithms.

It should be noted that E3ME is a simulation model and not an optimisation model. More specifically, it is an econometrically estimated model, which provides a strong empirical basis and means it is not reliant on some of the restrictive assumptions common to CGE models. Behavioural relationships are given by econometric equations for which the parameters are derived from historical time-series data (e.g. price elasticities used in the model are based on how sectors or consumers responded to price changes in the past, ceteris paribus). As a result, E3ME predicts the response to policy changes based on historically observed relations between data, without imposing assumptions about household and firm behaviour (e.g. that agents have perfect knowledge and behave in an optimal manner).

For further details about the E3ME model, the full model manual (Cambridge Econometrics, 2019) is available online from www.e3me.com.

Appendix B. Modelled macroeconomic impacts of the selected key decarbonisation policies

B.1 EU macroeconomic impacts

Key findings:

- Largest economic benefits accrue from the emissions performance standards policy grouping which is driven by reduction in fossil fuel imports and investment in the electricity sector.
- For policies imposing costs on industry and households (Carbon pricing, Taxation on Energy vectors), there is a net negative impact on GDP and Jobs due to the increase in prices impacting competitiveness and household spending. However, if government recycles those additional revenues, this can produce net economic benefits.
- Energy efficiency measures produce a net economic benefit as increase in investment in the European economy to deliver energy efficiency in industry and over the long term also reduces industry prices due to lower energy bills even after factoring in the cost of energy efficiency investment.
- Despite net increases in jobs in many of the policy scenarios, the path to decarbonisation is a transition that will not be smooth for everyone. Where job losses are concentrated, effective social, labour market and retraining policies will be required to mitigate the impact for those negatively affected.

Alongside the distributional effects, the macroeconomic impacts in terms of GDP and employment are presented. As with the distributional effects, the direct impact of the policy without revenue balancing as well as the impact of the policy with revenue balancing are assessed to capture the reallocation of revenues and costs associated with the policy.

B.1.1 Carbon pricing

As illustrated by Figure 40 without revenue balancing, in the short term, there is a small increase in GDP as the carbon price stimulates investment in the power generation sector. However, in the longer term, the carbon price raises costs for EU firms both directly in ETS sectors, but also indirectly through rising costs down the supply chain. These higher prices affect international competitiveness and feed into end consumer prices, squeezing real incomes and reducing aggregate consumer expenditure. Employment follows in line with GDP, with lower employment in the fossil fuel sectors and carbon intensive sectors.

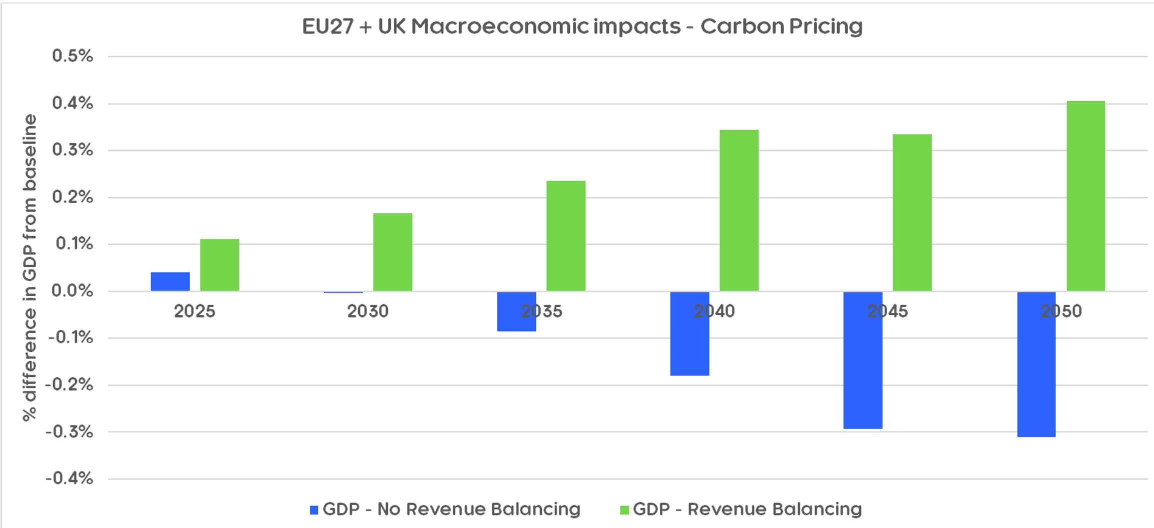


Figure 40: Modelled macroeconomic impacts of carbon pricing

However, as there is a net increase in revenue generated from the carbon pricing, how these revenues are used by government is an important driver of economic results. When revenues are used to reduce taxes and employers' contributions in the revenue balancing scenario, the tax reductions offset the increase in costs predominantly through increasing consumer expenditure. This leads to a double dividend effect, whereby the policy generates both economic benefits of decarbonising the economy (such as the reducing import dependency of fossil fuels reducing leakage from the EU economy) and environmental benefits. Employment (Figure 41) follows in line with GDP, with increases in electricity, construction and retail services, whilst there are jobs losses in the fossil fuel sectors.

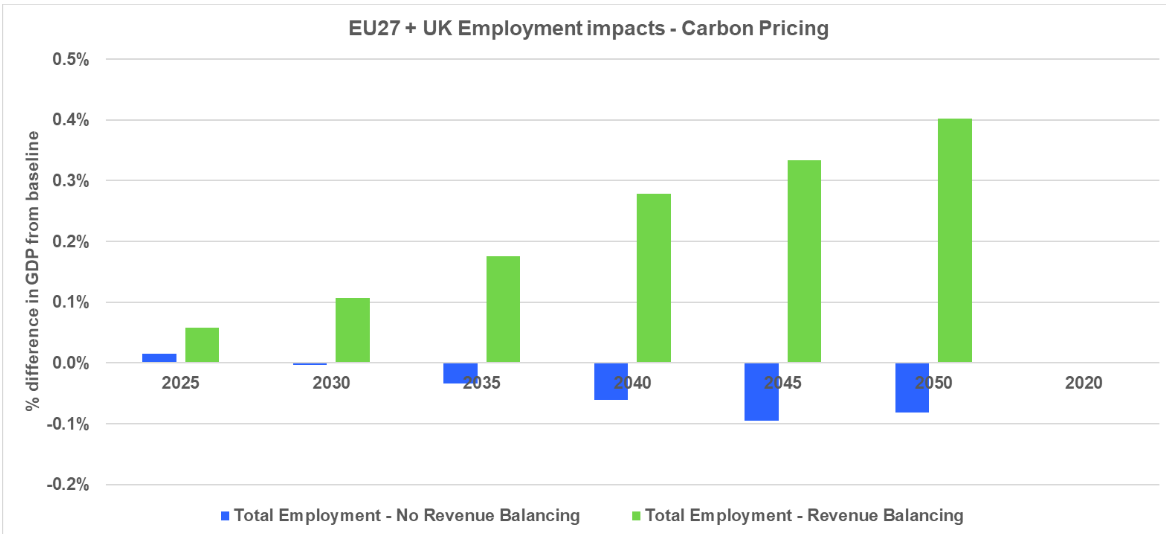


Figure 41: Modelled employment impacts of carbon pricing

B.1.2 Taxation on energy vectors

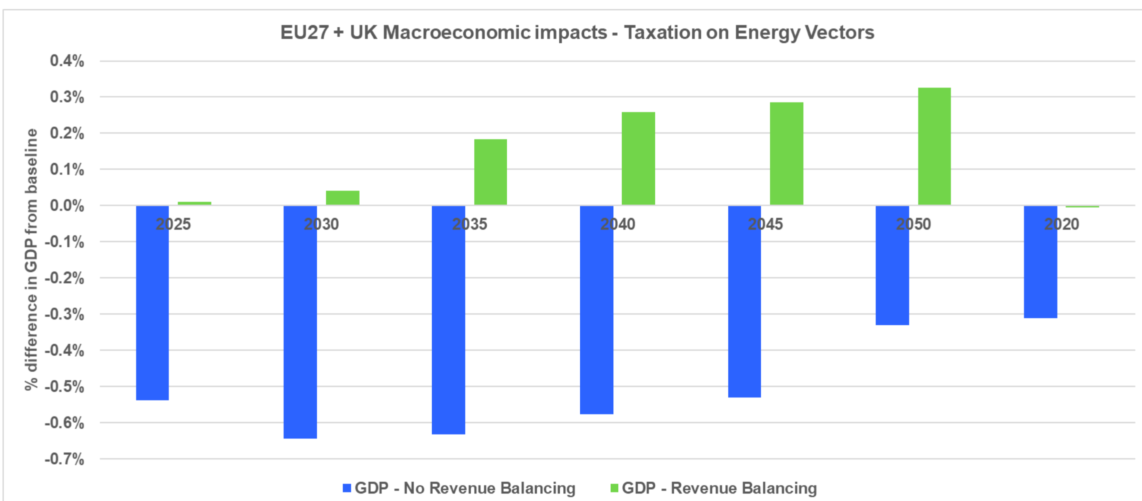


Figure 42: Modelled macroeconomic impacts of taxation on energy vectors

Without revenue balancing, the taxation on energy vectors raises costs significantly for households over the whole time period (Figure 42). In the short to medium term, the additional taxation imposes higher cost on consumers who are unable to respond immediately, but over time the higher costs related to fossil fuel heating and transport technologies incentivise households to switch to low-carbon technologies. Thus, the economic burden of the taxation starts to reduce post 2035 despite the increased taxation rates.

Furthermore, the reduction of electricity levies for current RES support helps offset some of the increase in energy costs from the fossil fuel taxation. However, if those costs are redistributed to higher taxation, the net impact of this from a macroeconomic perspective is minimal relative to the fossil fuel taxation.

As with carbon pricing, the taxation of energy vectors generates substantial revenues for government which can be recycled. When revenue balancing is applied in the form of reduced general taxation, real incomes are increased, which can offset the negative effects of the direct fuel taxes. Coupled with the benefits of reducing fossil fuel use in the EU, leads to a small increase in GDP and employment (Figure 43).

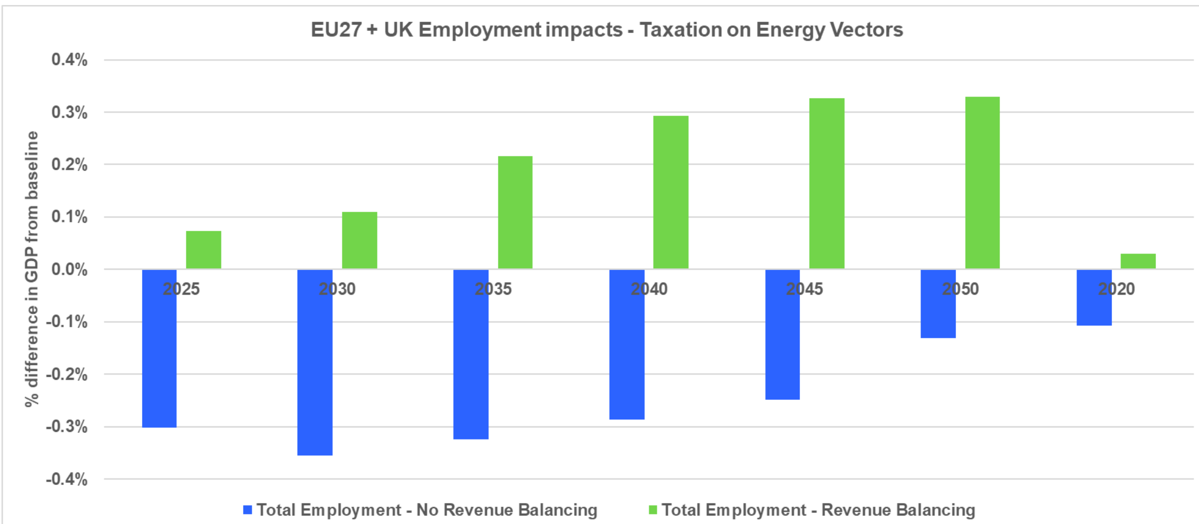


Figure 43: Modelled employment impacts of taxation on energy vectors

B.1.3 Subsidies for low-carbon technologies

For subsidies to low-carbon technologies, Figure 44 shows that the economic effects are most substantial in the period up to 2035, which is when most of the subsidies are in place before they get phased out by 2050. Overall, though it is important to note that relative to the other policy groupings, the economic impacts of subsidies are very small.

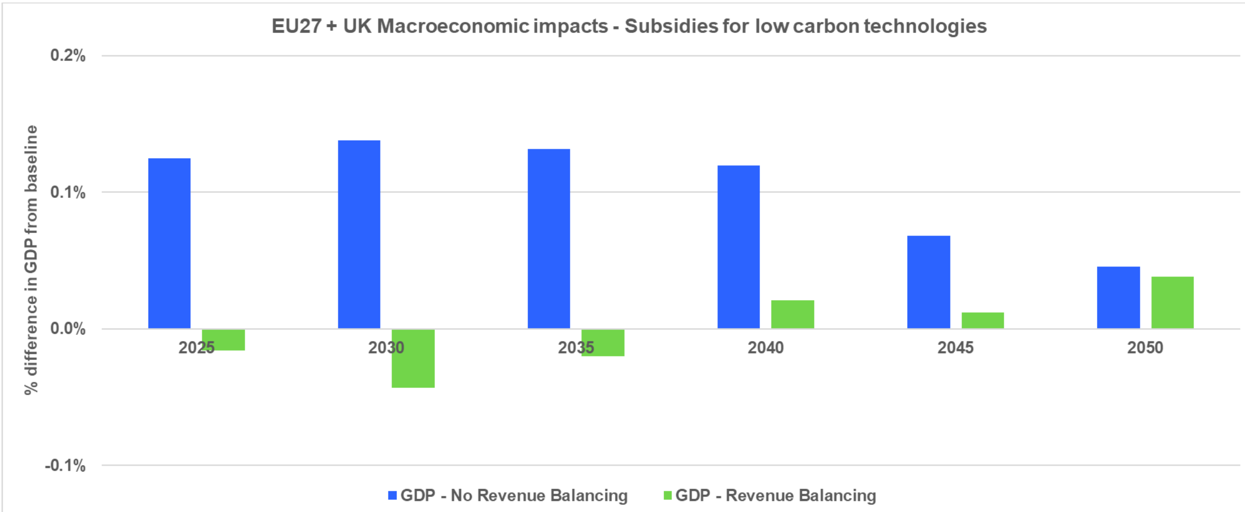


Figure 44: Modelled macroeconomic impacts of subsidies for low-carbon technologies

Without revenue balancing, the subsidies for low-carbon technologies, allow for a reduction in costs for low-carbon power generation and household heating technologies. As well as stimulating the uptake of low-carbon technologies, they also reduce energy costs. This leads to an increase in real incomes, increasing consumer expenditure in aggregate. The increase in employment (Figure 45) is predominantly in the services sectors meeting the additional consumer expenditure along with construction and electricity sectors from the investment in low-carbon technologies.

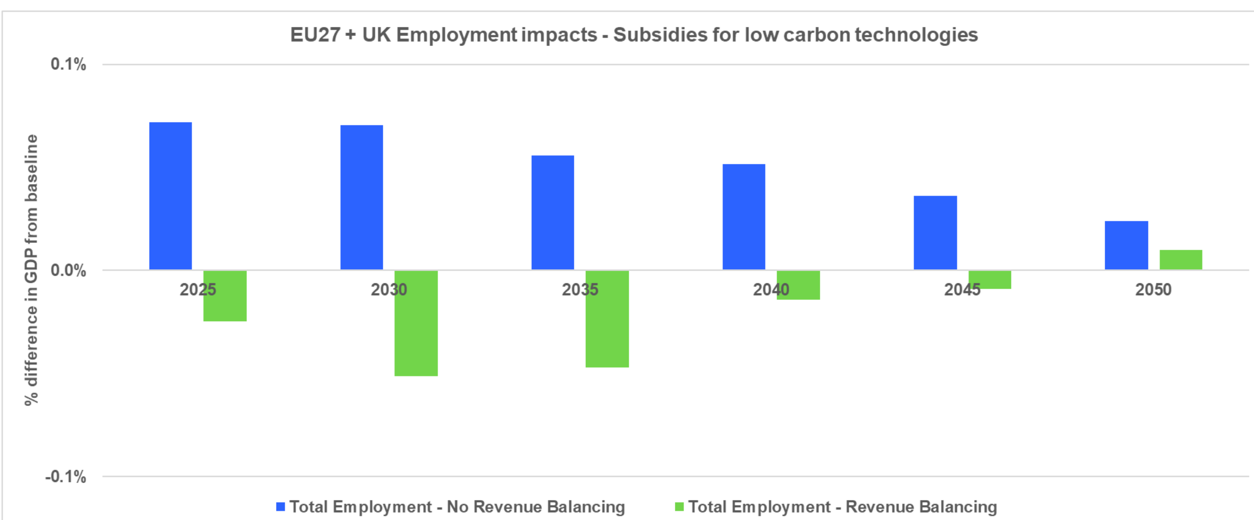


Figure 45: Modelled employment impacts of subsidies for low-carbon technologies

With revenue balancing, the cost of the subsidies is recouped by government through increasing taxation. In the short to medium term, the negative effect from the increase in the cost of the subsidies more than offsets the economic benefits from the reduction in energy costs. Over the longer term, the subsidies are phased out and thus the relative impact of the revenue balancing diminishes until 2050, where the subsidies are themselves fully phased out.

B.1.4 Phase out of fossil fuel support

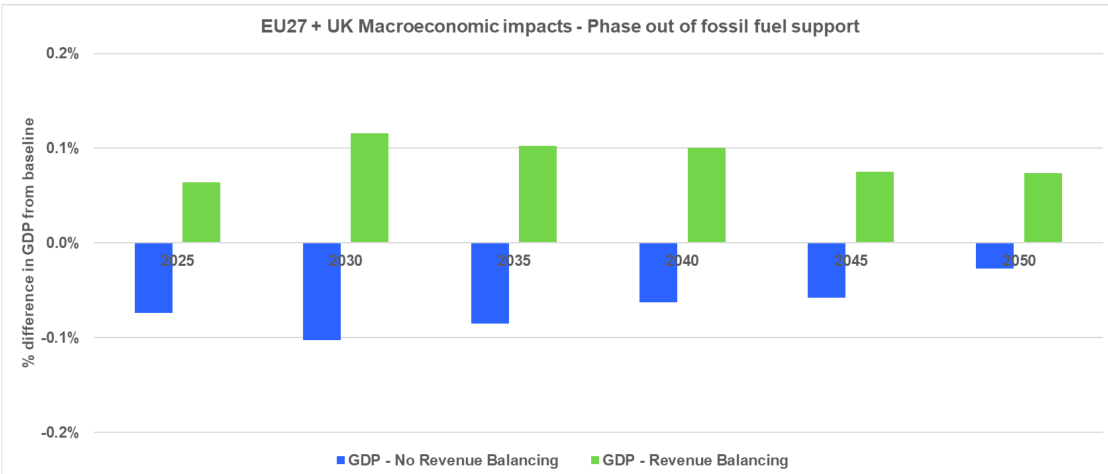


Figure 46: Modelled macroeconomic impacts of phase out of fossil fuel support

Without revenue balancing, the phase out of current fossil fuel support leads to an increase in prices for fossil fuel use across all fuel users in the economy, for both household and industry use of fossil fuels. The net impact of this is a small increase in overall consumer prices reducing real incomes and consumer expenditure which then accounts for almost all the reduction in GDP (Figure 46). In terms of employment, while the increase in fossil fuel prices does lead to a small reduction in fossil fuel sectors, most of the reduction is in services sectors result from the reduction in consumer expenditure (Figure 47).

In the scenario with revenue balancing, the government expenditure freed up by removing the fossil fuel support is reallocated to reduce general taxation. The reduction of VAT and employer's contributions offset most of the price effect of higher fossil fuel prices. The reduction in income taxes provides and additional increase in real incomes leading to a net increase in GDP driven by consumer expenditure. The employment results mirror the economic results, with an increase in employment in retail and other service sectors benefitting most from increased consumer spending overall.

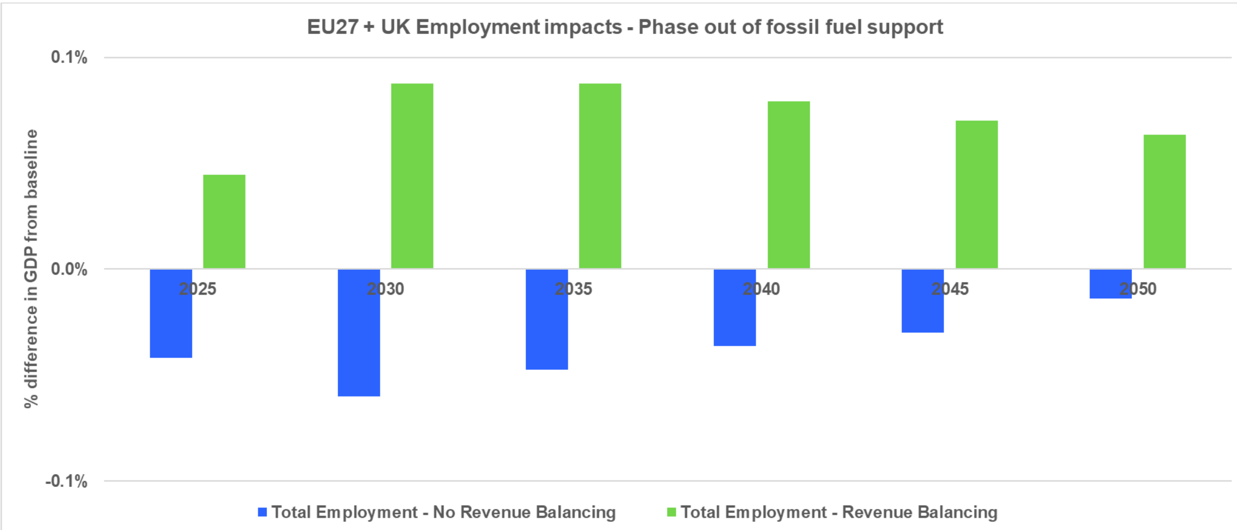


Figure 47: Modelled employment impacts of phase out of fossil fuel support

B.1.5 Emission performance standards

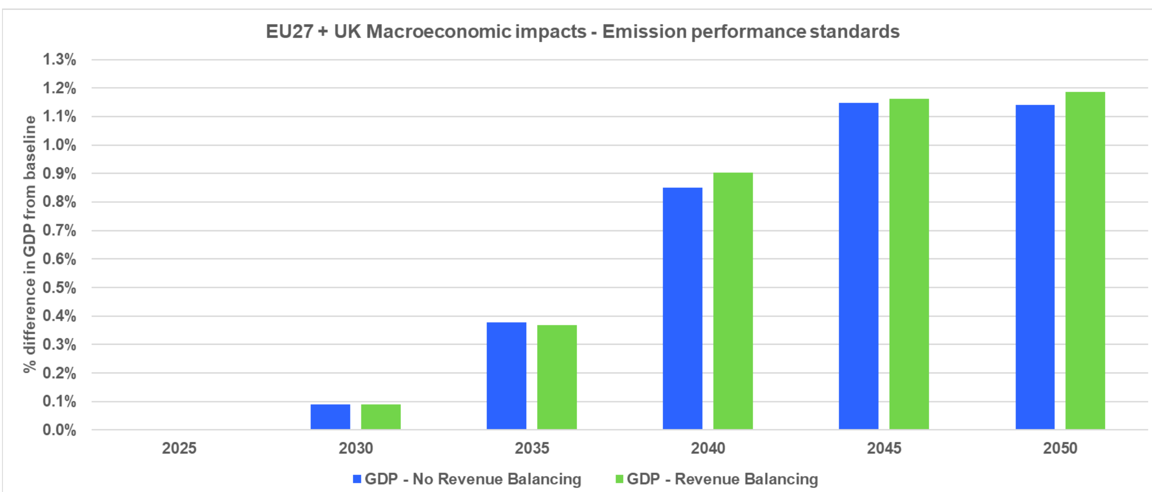


Figure 48: Modelled macroeconomic impacts of emission performance standards

For emissions performance standards, the regulation forces a steady phase out of fossil fuel heating technologies from 2025. This drives an increase in electrification and a shift away from fossil fuels, resulting in an increase in investment in the electricity sector to meet additional electricity demand. This investment leads to a modest increase in GDP (Figure 48). After 2035, the ban of ICE vehicles from new sales starts driving a shift in electrification in road transport. In addition to the additional investment in the electricity sector to meet the demand of electrifying the passenger car fleet, the shift away from petroleum reduces EU's overall dependency on oil imports and reallocates consumer spending to goods and services with a higher domestic content. This feeds into higher employment (Figure 49) and real incomes leading to an increase in consumer expenditure and hence GDP.

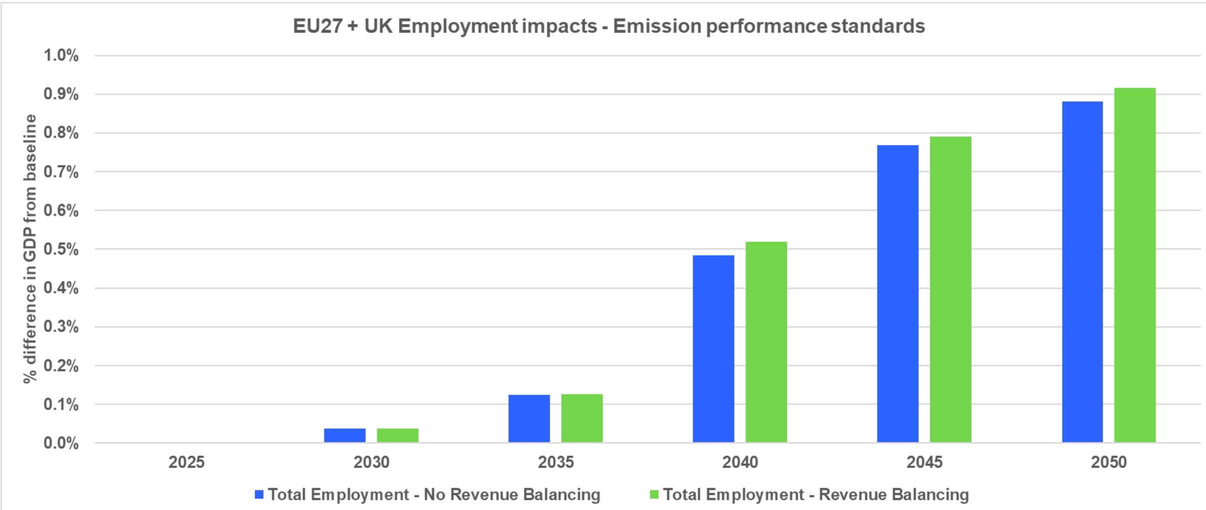


Figure 49: Modelled employment impacts of emission performance standards

B.1.6 Energy efficiency measures

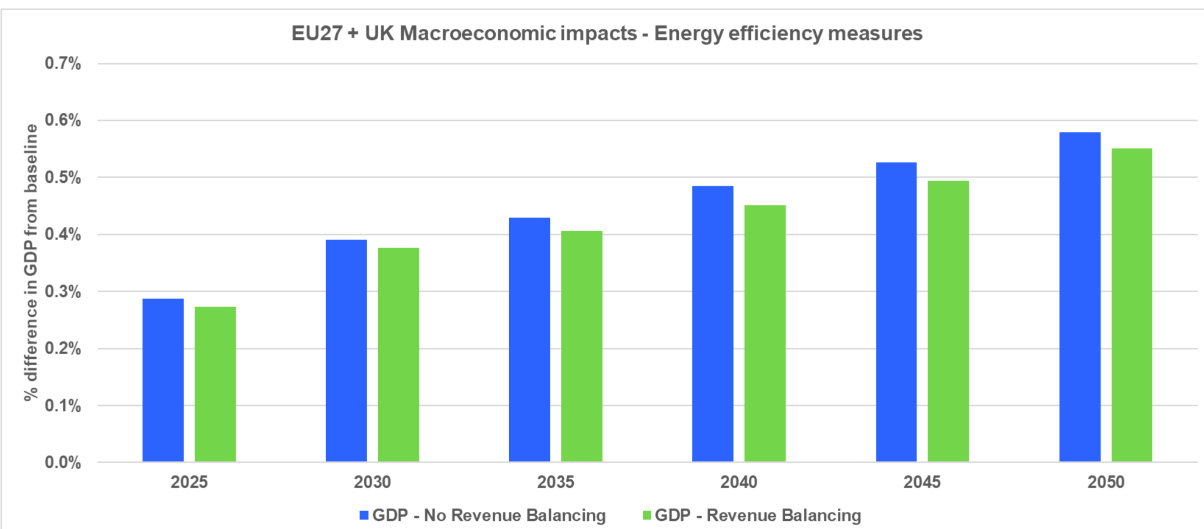


Figure 50: Modelled macroeconomic impacts of energy efficiency measures

Energy efficiency measures lead to a modest increase in GDP over time (Figure 50). This GDP increase is driven by a number of key drivers, including an increase in investment in the European economy to deliver energy efficiency in industry which also reduces industry prices due to lower energy bills. The reduction in energy use lowers demand for fossil fuels import dependency in the EU, reducing imports relative to baseline. Over the longer term, consumers benefit from the lower prices from increased energy efficiency in industry boosting real incomes. In terms of employment, the increase in jobs (Figure 51) is driven by construction and services but is offset by a reduction in the energy supply sectors as energy demand falls.

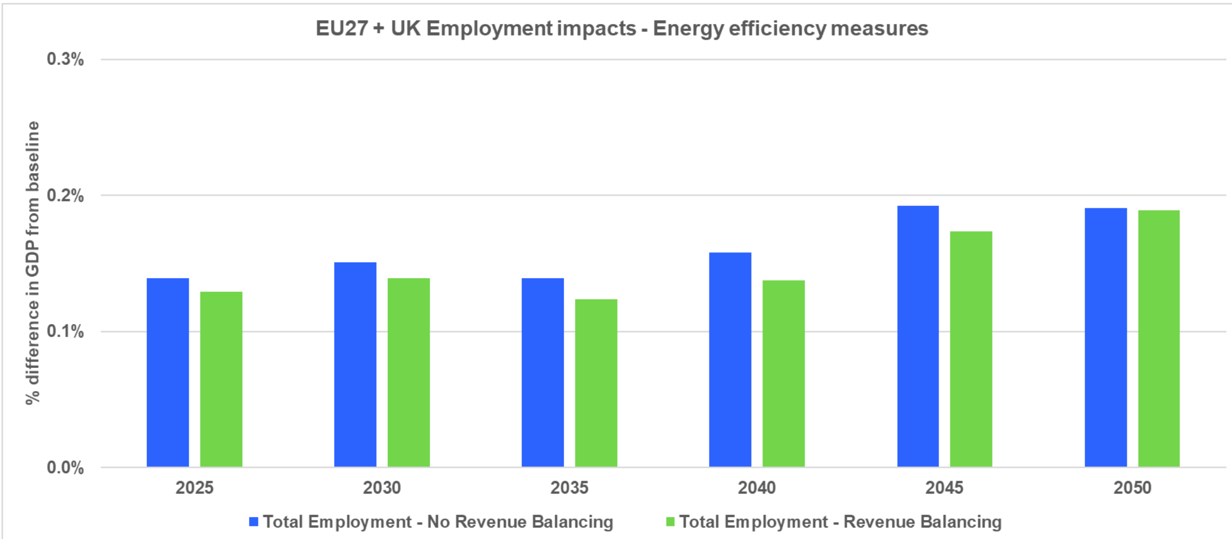


Figure 51: Modelled employment impacts of energy efficiency measures

B.2 Regional differences

Key findings:

- Overall, the direction of the economic impacts for each climate policy is the same for each region of the EU though the magnitude of the impact does vary slightly
- Northern Europe shows the smallest economic impact from the various climate policies, reflecting a higher level of decarbonisation already achieved in the baseline compared to the rest of the EU.

In this section, we go through the regional impacts of the climate policy groupings. Overall, as the policy groupings are defined at a European level, the general finding is that impacts are consistent across the regions, but there are some differences between regions which are highlighted here.

B.2.1 Carbon pricing

Overall, the trend in GDP between regions is broadly consistent over time (Figure 52). Without revenue balancing, the small negative effect on GDP of the carbon price increases across all regions. NE is the clear outlier across the period reflecting the lower carbon intensity.

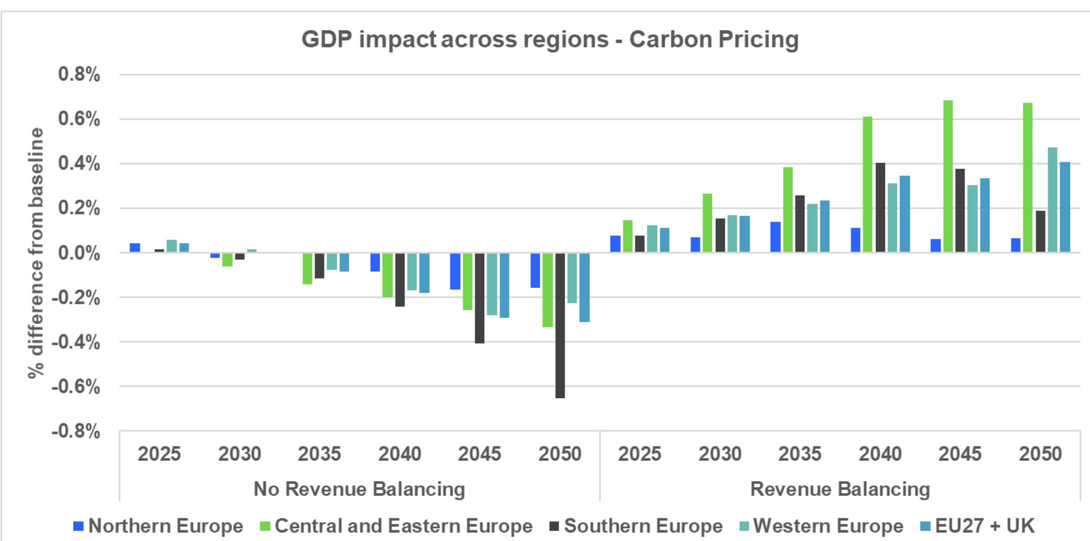


Figure 52: Regional differences in the modelled macroeconomic impacts of carbon pricing

The employment results are more mixed. In CEE, the impact on employment is smaller than for GDP (Figure 53). This reflects a transition in employment as jobs are lost in the fossil fuel sectors but is offset by an uptake in jobs in the electricity sector reflecting that low-carbon power generation technologies are more labour intensive.

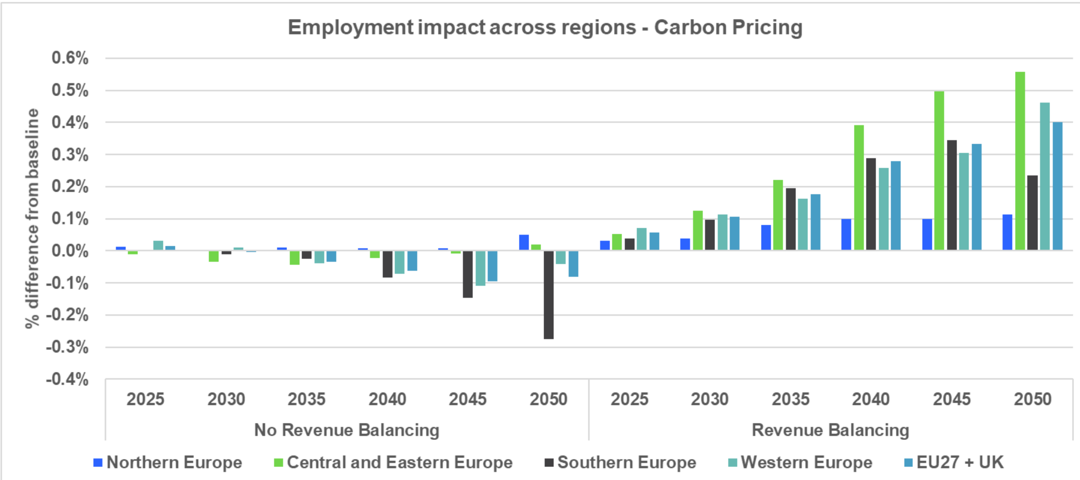


Figure 53: Regional differences in the modelled employment impacts of carbon pricing

With revenue balancing, NE remains the least impacted by the carbon pricing. However, the largest impact of the balancing of carbon revenues is observed in CEE, reflecting a higher carbon revenue relative to GDP, compared to the other regions. Employment broadly follows GDP as the recycled revenues lead to increases in real incomes and consumer expenditure which supports additional jobs in service sectors.

B.2.2 Taxation on energy vectors

Without revenue balancing, the GDP and employment impacts are similar across regions. This reflects the proportional increase in prices from taxes on household heating and on transport reducing real incomes and household expenditure.

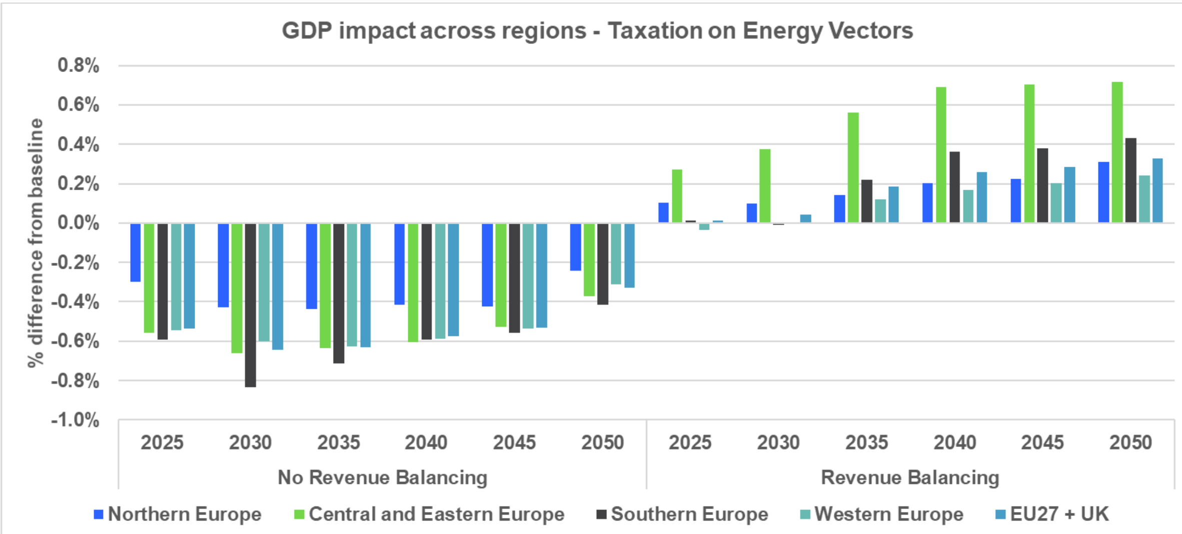


Figure 54: Regional differences in the modelled macroeconomic impacts of taxation on energy vectors

With revenue balancing, the impact is more diverse across regions (Figure 54). Out to 2030 CEE sees a stronger impact from balancing the revenues through general taxation as the revenue from fuel taxes for heating and transport are larger as a share of GDP.

The employment results largely mirror the GDP effects (Figure 55), but at smaller magnitudes.

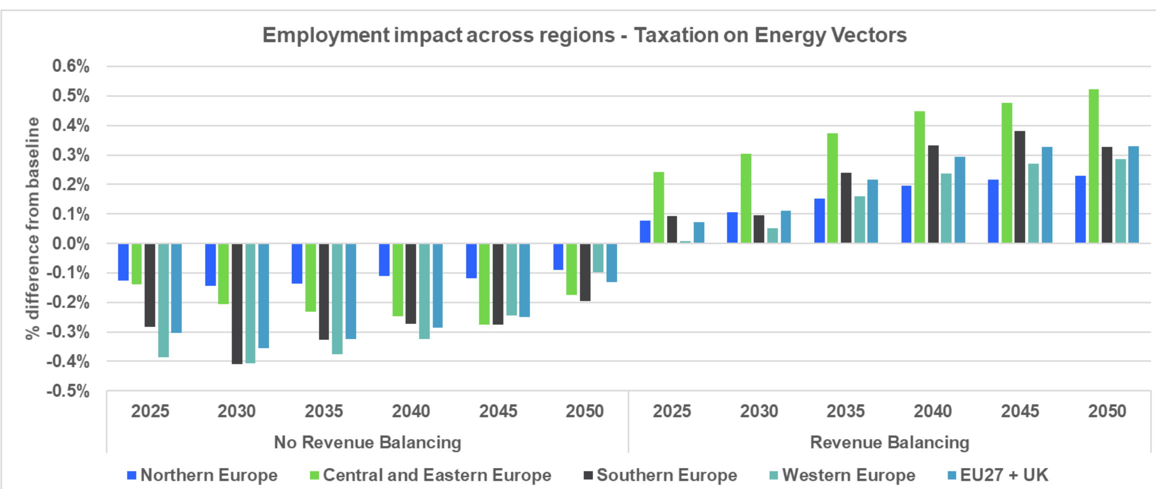


Figure 55: Regional differences in the modelled employment impacts of taxation on energy vectors

B.2.3 Subsidies for low-carbon technologies

Without revenue balancing, the GDP impact of the subsidies for low-carbon technologies is broadly similar (Figure 56). However, when revenue balancing is introduced such that the subsidies are paid for through general taxation, the results are more varied across regions. In CEE, the additional financing requirements for the feed in tariffs are higher and expected to be needed through to 2035, considering there are assumed to be no tariffs in the baseline. In most of NE, SE and WE, feed in tariffs exist in the baseline and are expected to be needed through to 2030 instead of 2035.

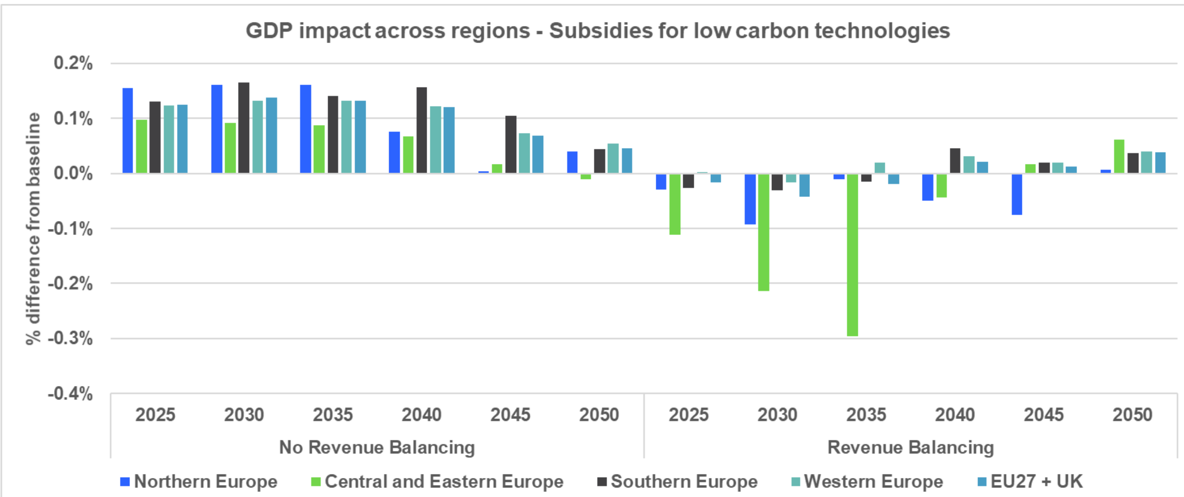


Figure 56: Regional differences in the modelled macroeconomic impacts of subsidies for low-carbon technologies

For employment, in the scenario without revenue balancing most regions follow the same trend (Figure 57), except for CEE. In CEE, the negative employment effect in the coal and gas sectors is proportionally larger than for the rest of Europe. This is also observed in the scenario with revenue balancing.

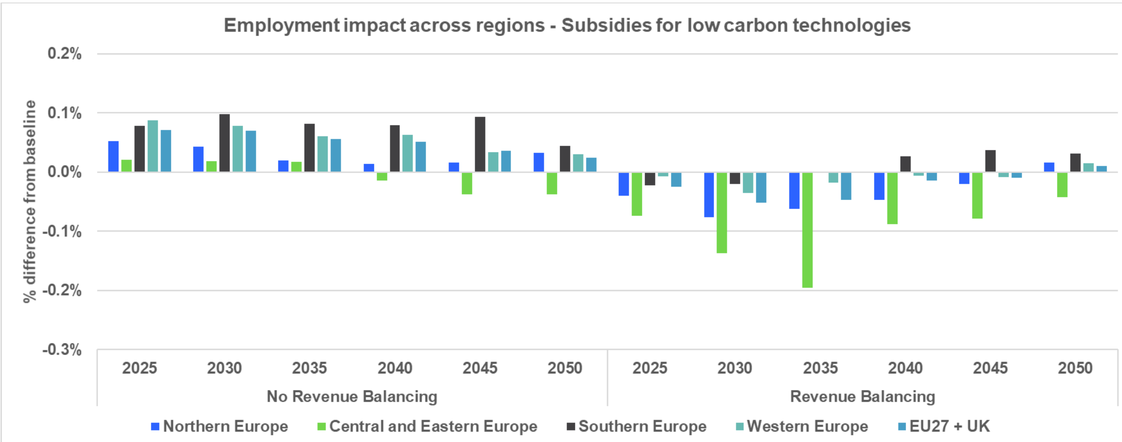


Figure 57: Regional differences in the modelled employment impacts of subsidies for low-carbon technologies

B.2.4 Phase out of fossil fuel support

Across regions, the economic impact is similar across (Figure 58) as the level of fossil fuel support is shared out proportional to fossil fuel use. However, when the saved expenditure is recycled to reduce general taxation, CEE sees a stronger response to consumer expenditure as the fossil fuel support saved represents a relatively larger share of GDP than in other regions.

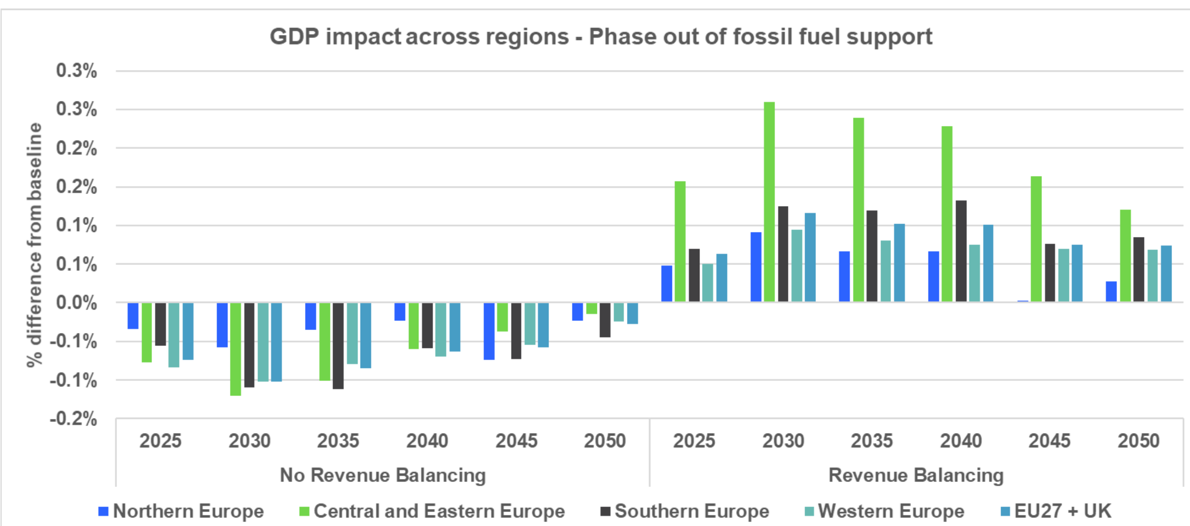


Figure 58: Regional differences in the modelled macroeconomic impacts of phase out of fossil fuel support

As can be seen in Figure 59, the employment results mirror the GDP results.

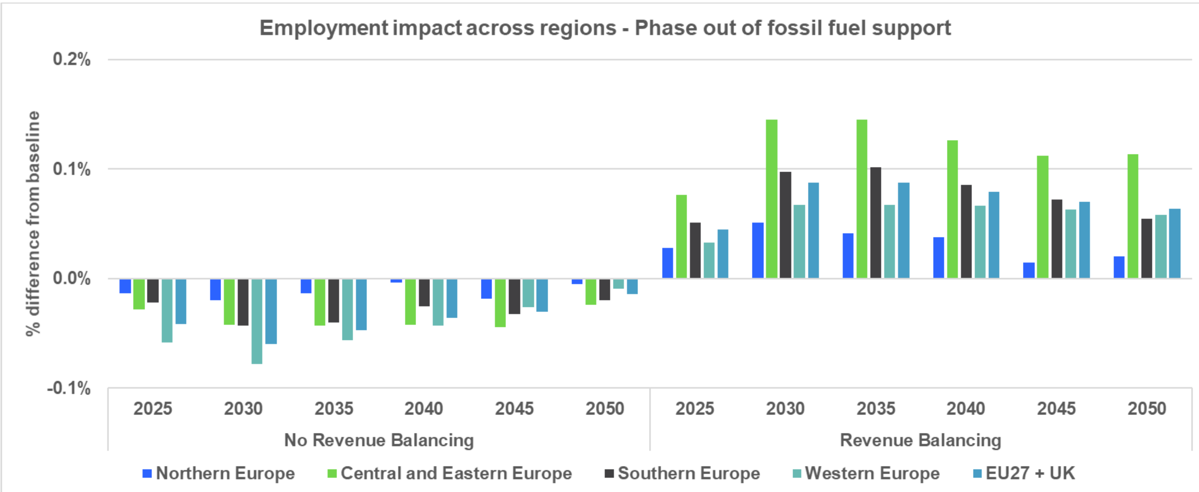


Figure 59: Regional differences in the modelled employment impacts of phase out of fossil fuel support

B.2.5 Emissions performance standards

In terms of GDP, the impact is broadly similar across regions (Figure 60), as all regions benefit from a) the reduction in fossil fuel expenditure in heating and transport and b) additional investment in electricity sector.

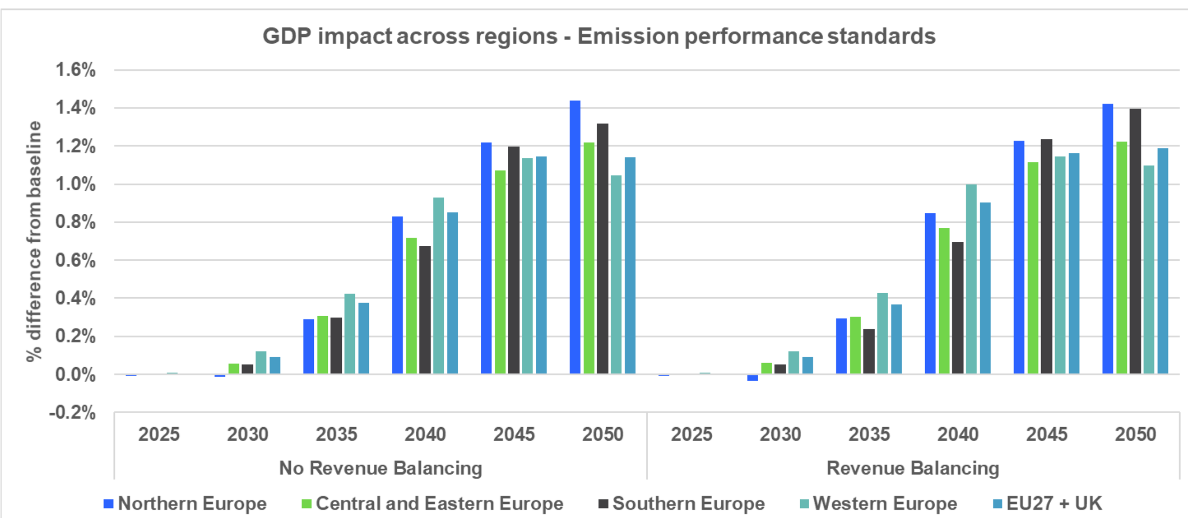


Figure 60: Regional differences in the modelled macroeconomic impacts of emission performance standards

In terms of employment, the positive effects are stronger in SE and WE relative to the other regions (Figure 61). This is explained by the relatively strong fall in consumer prices driving consumer expenditure through higher real incomes and leading to an increase in labour intensive service sectors.

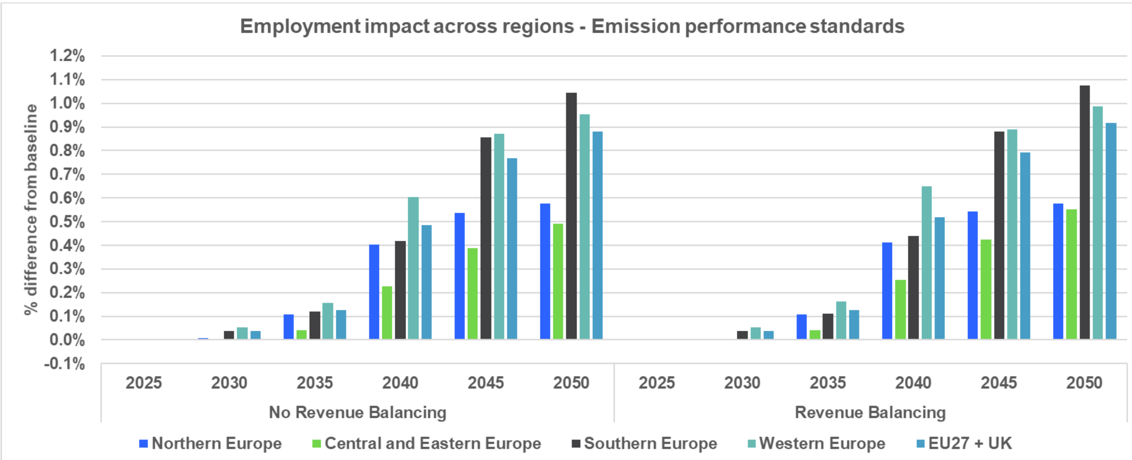


Figure 61: Regional differences in the modelled employment impacts of emission performance standards

B.2.6 Energy efficiency measures

All regions see a positive benefit from energy efficiency measures in terms of GDP (Figure 62). However, the magnitude of the benefit varies between regions as well as its key driver. For CEE, the strong GDP impact is mostly driven by the scale of the investment in additional energy efficiency in industry. Conversely, for SE, the strong GDP impact is driven by a strong reduction in consumer prices due to the reduction in energy expenditure by industry.

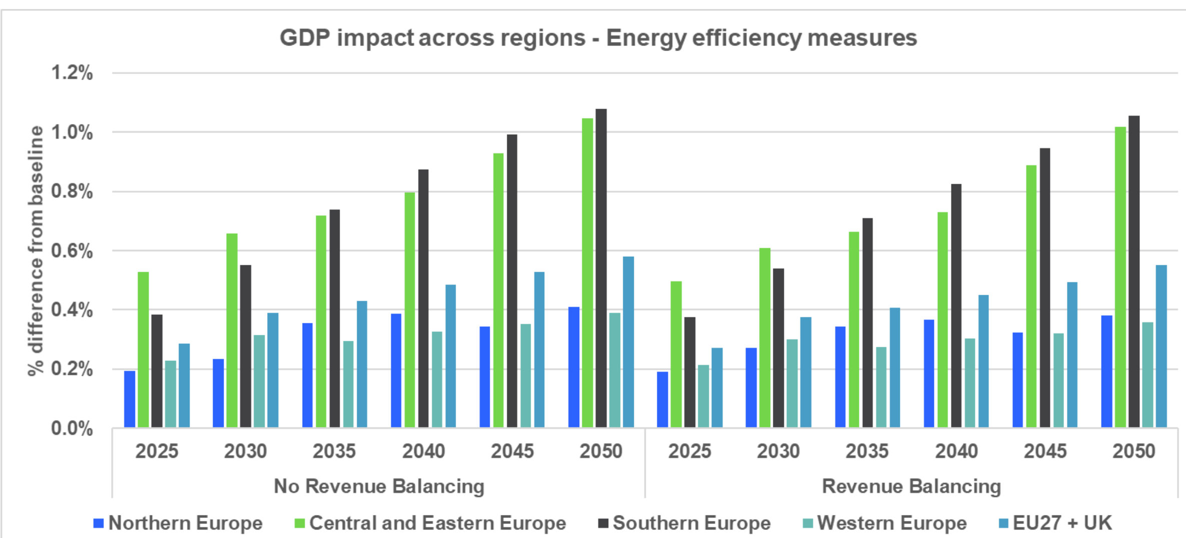


Figure 62: Regional differences in the modelled macroeconomic impacts of energy efficiency measures

For employment, the impact is more mixed (Figure 63). CEE sees a smaller increase in employment relative to other regions in the scenario. This downwards pressure on jobs is driven by the relative importance of fossil fuel sectors for employment and income in the region, which can only partly offset by the positive employment effect in construction as a result of the energy efficiency investments.

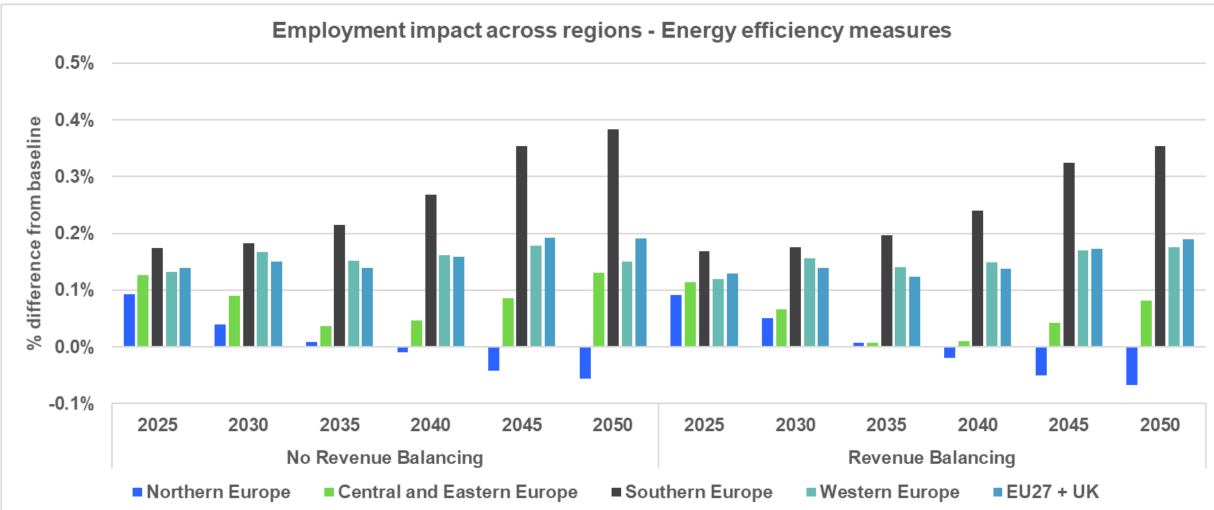


Figure 63: Regional differences in the modelled employment impacts of energy efficiency measures

Appendix C. Estonia specific results and considerations

C.1 Region specific results

For the combined policy options, GDP increases broadly in line with the rest of the EU. This is driven in the short term by the investment in energy efficiency with a pickup in consumer expenditure in the long term. Employment growth is driven by higher employment relative to baseline in services and construction.

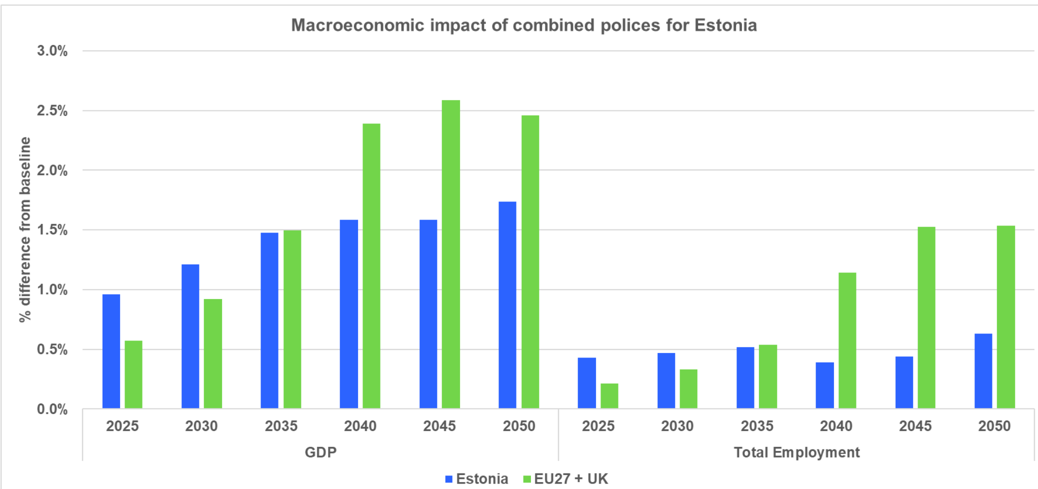


Figure 64: Modelled macroeconomic impacts of the combined policy options for Estonia

As with the EU wide results, a clear progressive impact from the combined policy options is projected, due to the mitigation measures in place.

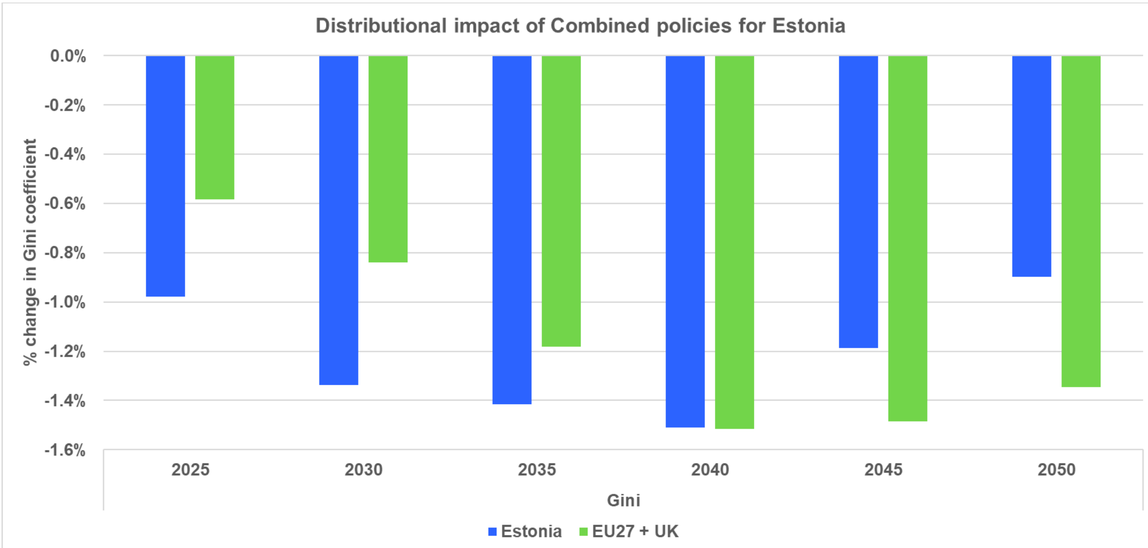


Figure 65: Modelled distributional impacts of the combined policy options for Estonia

C.2 Region specific implementation considerations

Estonia's national climate policies are directed by its "General Principles of Climate Policy until 2050" and detailed by its "Climate Change Adaptation Development Plan until 2030".[111] Larger Estonian firms are subject to the EU ETS requirements. However, most thermal energy producers are not subject to the EU ETS, but are covered by a national carbon tax of EUR 2 per ton of CO_2, with the exception of biofuel emissions and an excise tax on solid fuels.[112] As part of the Energy Management Organisation Act an energy efficiency obligation scheme was put in place in 2016 to achieve its EU mandated GHG reduction targets in the building sector.[113]

With respect to implementation considerations of the policy options, in the context of Estonia, many of the needed existing policy experience and legislative framework is already in place.[114] In many ways with the exception of the lump-sum transfer policy, Estonia already has a basic version

[111] Available at https://www.envir.ee/en/news-goals-activities/climate/general-principles-climate-policy

[112] Source: OECD, **Taxing Energy Use 2019: Country Note – Estonia**, 2019, https://www.oecd.org/tax/tax-policy/taxing-energy-use-estonia.pdf and https://www.emta.ee/eng/business-client/excise-duties-assets-gambling/about-excise-duties/rates-excise-duty#liquid-fuels-and-electricity

[113] Source: Riigi Teataja, **Energy Management Organisation Act,** www.riigiteataja.ee/akt/112112019005#para16lg2

[114] For achieving carbon neutrality by 2050, Estonian Government commissioned a study in 2019, the results and implications of which are currently still being discussed. A summary of the study is available at https://www.sei.org/wp-content/uploads/2020/03/reaching-climate-neutrality-in-estonia.pdf

of the measures in place. Therefore, there are considerable potential efficiencies to be explored with these existing schemes and policies.

Targeted Energy Efficiency Obligation Schemes

Estonian households consume just over 40% of the final energy consumption, which is mainly due to old inefficient apartment blocks and soviet-era district heating infrastructure.[115] In light of this it is not surprising that energy efficiency in the buildings sector is already an area covered by existing climate policy in the form of the Energy Management Organisation Act. The energy obligation scheme under the act does not have special provisions targeting low-income households, as Estonia distinguishes between its energy and its social policy.[116] The existing scheme and the Energy Management Organisation Act offers potential opportunities to integrate the policy options relating to targeting energy obligation schemes to possible negative distributional effects from energy efficiency policies.

Several options are available to the Estonian government in doing this:

- They could mandate in the Energy Management Organisation Act that part of the energy savings need to be achieved at low-income households. Identification of applicable households would function through the Estonian e-government portal e-Estonia, which is also used to implement various social policies.

- The KredEx Revolving Fund currently provides grants and loan guarantees for energy efficiency renovations based on expected savings that will be achieved. Grants for low-income households could be increased to beyond the current maximum of 40% and possibly changed to subsidies for income levels that cannot afford loans.

- Loan guarantees can be provided to energy service companies or financial institutions that provide or back low-income friendly EPC financed energy efficiency renovations of apartment buildings.

All features would contribute to the inclusion of low-income households in existing support schemes for energy efficiency renovations in line with the policy options.

Lump-sum Transfers

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[115] Source: MKM, Energy Efficiency ,05.05.2020, https://www.mkm.ee/et/tegevused-eesmargid/energeetika/energiasaast

[116] The issue of energy poverty is seen a social issue and is hence covered through social policy. If energy costs are too high families are eligible to an electronically, via e-Estonia, managed subsistence cost subsidy. More information is available under https://www.sm.ee/en/subsistence-benefit-0

At its current rate of EUR 2/tCO2 it is not currently clear if the Estonia carbon tax would generate sufficient revenues to fund a lump-sum transfer system. However, if, in achievement of its long term climate strategy, the current carbon tax is raised, and broadened, the additional revenue could be recycled through a lump-sum transfer as suggested by the combined policy options. Alternatively, additional taxes such as the excise tax on solid fuels and EU ETS auction revenues could be used to fund a lump-sum transfer. This rebate could take place through e-government portal e-Estonia, which offers a range of digital government services to all Estonians, thus leveraging the existing systems and infrastructure.

Job Retraining Programmes

Estonia has an existing Employment Programme (Tööhõiveprogramm), which provides financial benefits and retraining opportunities to Estonians and this could form the basis upon which the job retraining programme policy could be built upon. [117] The current Tööhõiveprogramm scheme already focuses on growth sectors and cooperation of the programme with employers should be further intensified to retrain part of Estonian shale oil workforce and other potentially affected industries in the fossil fuel and energy sectors. Long term funding can potentially be secured through sources such as the European Globalisation adjustment fund, which provides support to people losing their jobs as a result of major structural changes in world trade patterns due to globalisation.[118]

Funding for Subsidies for Low-carbon Technologies

Like most of Europe, the support for renewable energy generation is currently also levied on household electricity bills in Estonia, through the renewable energy charge. The charge which was introduced with the Electricity Market Act is calculated by the transmission system operator. To allow the renewable energy charge to be financed from general taxation or from recycled revenue such as EU ETS auction revenue or from the carbon or excise tax an amendment to the Electricity Market Act would likely be required. While such a change would require cross ministry consensus, there does not appear to be any immediate legislative barriers to doing this. Other support for renewable energy such as investment support provided through KedEx or the environmental investment centre KIK.

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[117] Source: Eurofound, *Estonia: New training schemes aim to counter unemployment*, 2017, https://www.eurofound.europa.eu/publications/article/2017/estonia-new-training-schemes-aim-to-counter-unemployment

[118] https://ec.europa.eu/social/main.jsp?catId=326

Appendix D. Methodological appendix

D.1 Model feedbacks by policy grouping

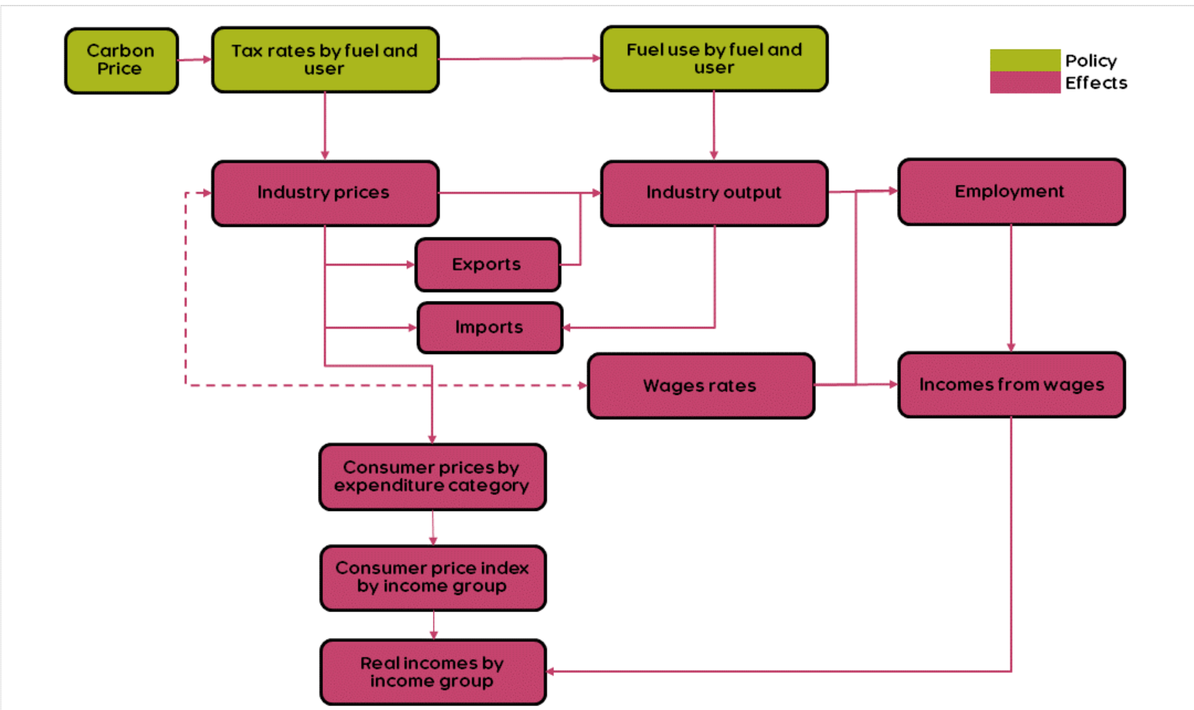
D.1.1 Carbon pricing

The carbon price policy imposes additional costs on industry and power generation based on the carbon intensiveness of the sector.

In Figure 66, the E3ME model response to the changes to the carbon price is shown. First, the carbon price directly impacts industry prices based on the carbon intensity of that industry. This then feeds through into final consumer prices for each expenditure category which feeds through into the calculation of real incomes by decile.

The carbon price impacts industry output directly through changes in energy inputs, but also indirectly through the changes in domestic demand and also international competitiveness (impact on imports and exports) as a result of a carbon price. This change in output leads to changes in employment demand which in turn impacts real incomes. Moreover, real income can also be affected if wages do not move in line with inflation.

Figure 66: Model pathway for carbon price impact on industry prices



D.1.2 Taxation of energy vectors

The taxation of fossil fuels in both heating and transport impose additional costs on conventional fossil fuel-based heating systems and ICE vehicles for road transport. This imposes a direct cost on the consumer as it raises fossil fuel prices for consumers. However, the taxation also encourages fuel switching encouraging the uptake of low-carbon technologies shifting demand from fossil fuels to electricity. This switching to low-carbon technologies also factors in additional capital expenditure for new heating systems which are more expensive, leading to a net increase in expenditure on household appliances.

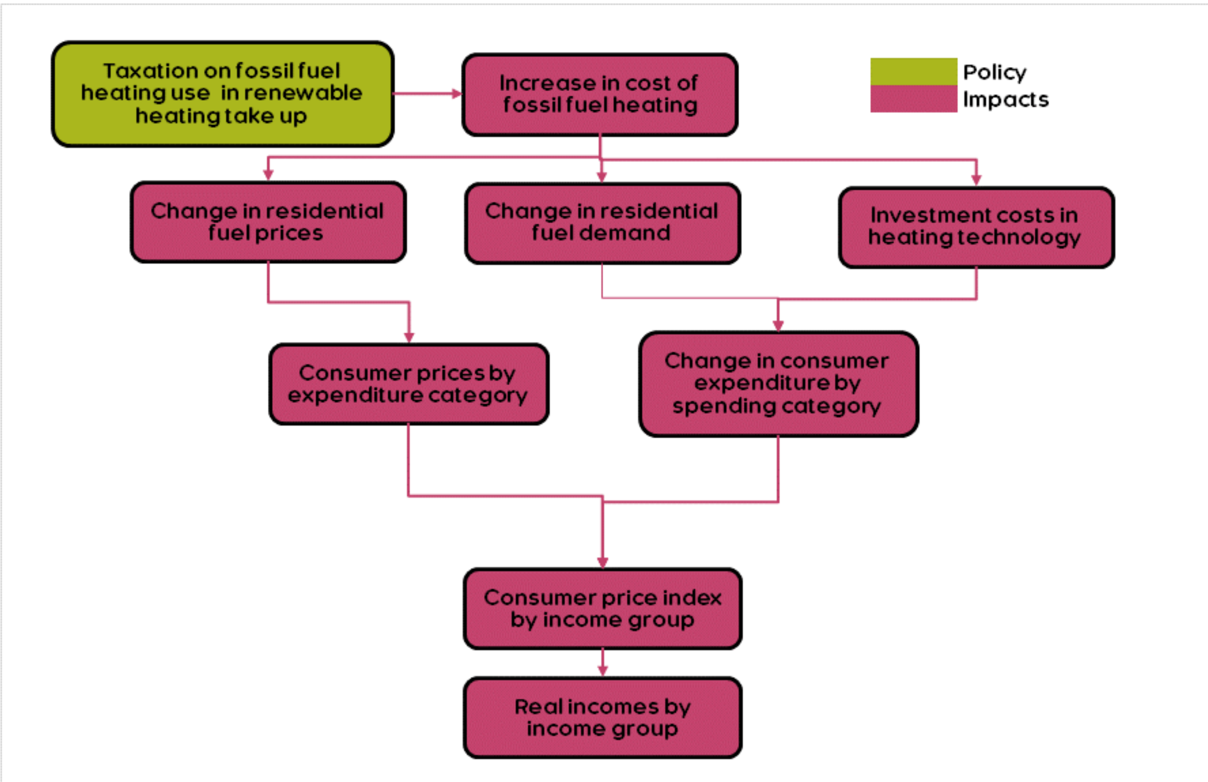


Figure 67, shows the main pathway for the taxation of fossil fuel heating through to impacting consumer prices and real incomes. The pathway for road transport is broadly similar.

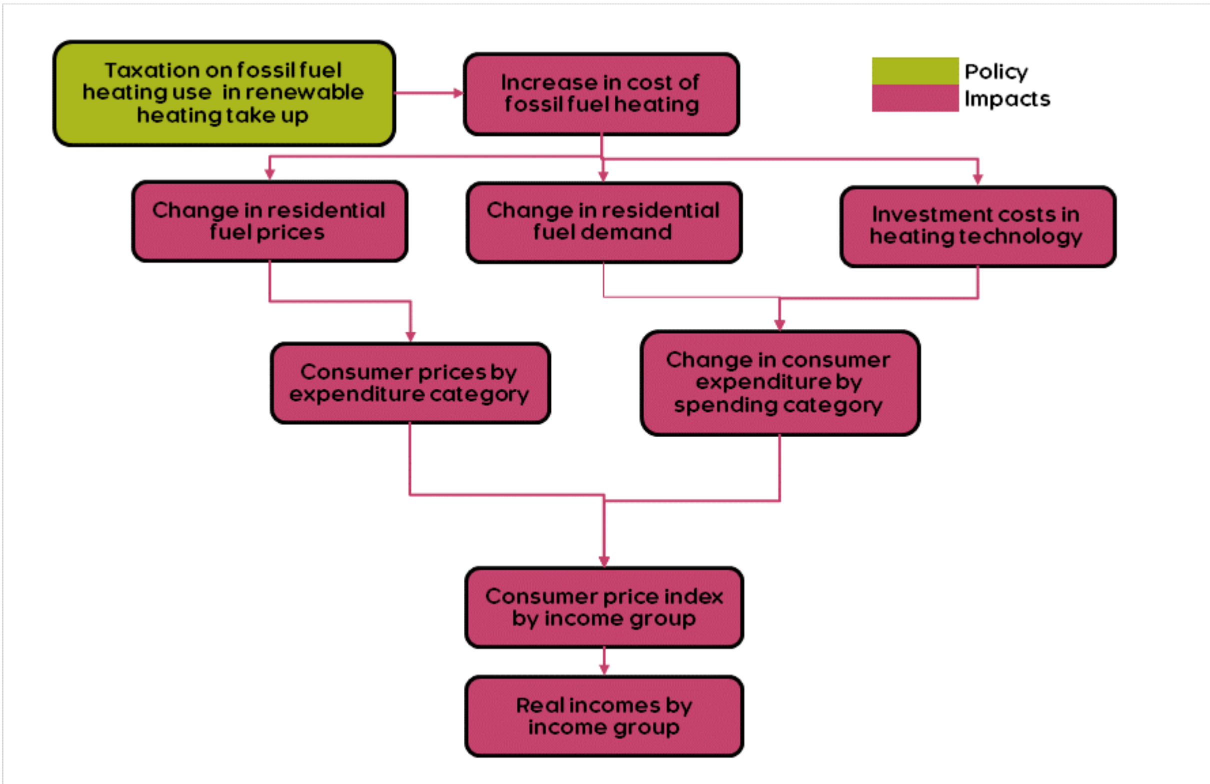


Figure 67 : Model pathway of applying taxation on fossil fuel heating

The reduction of levies for RES support on electricity prices leads to a reduction in end user prices, impacting prices for both consumers and industrial users. It also incentivises some fuel switching as lower electricity prices encouraged switching from other fuels as the relative prices have fallen. The reduction in the levy is then reallocated to general taxation which then reduces average real incomes.

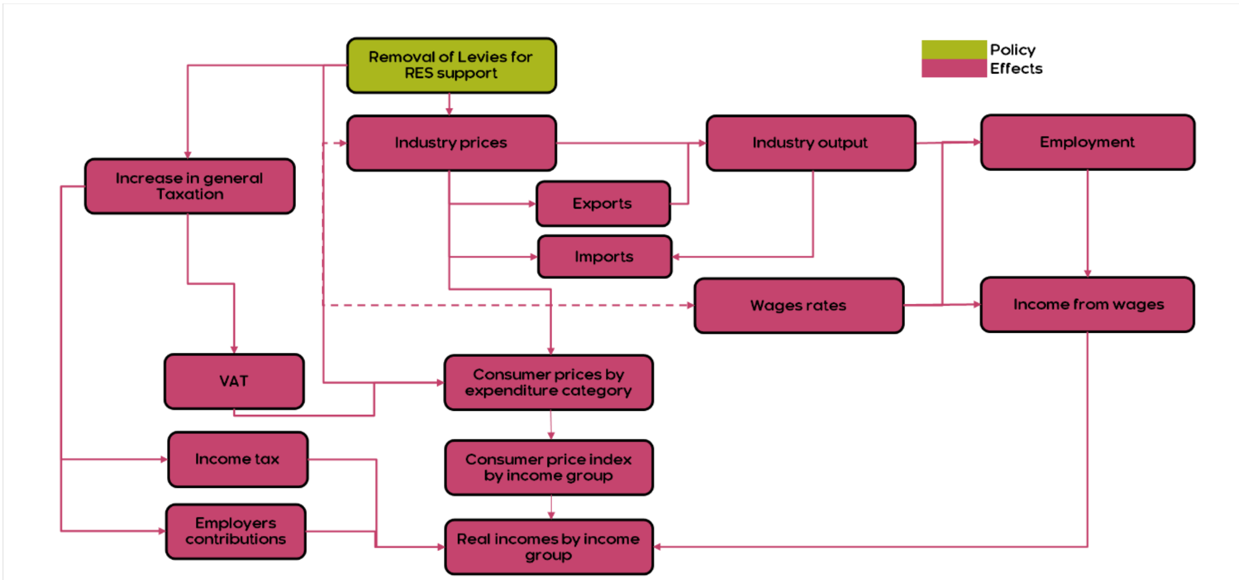


Figure 68: Model pathway of redistributing levies on electricity to fund RES support

D.1.3 Subsidies for low-carbon technologies

The subsidies for low-carbon technologies reduces the cost to investors in deploying renewable technologies on power generation and households investing in residential heating. This leads to an increase in take up of renewable technologies both in power and heating.

For heating, this leads to a change in residential fuel demand substituting fossil fuel use for electricity and biomass and also leads to a net change in household spending in heating technologies. Both of these changes affect the composition of consumer expenditure which in turn impact the consumer price index by income decile and real incomes.

For power generation, the subsidies for low-carbon technologies lower the investment cost for these technologies, encouraging renewable uptake and reducing end user electricity prices. This change in electricity prices feeds through household electricity prices and in turn reduces average consumer prices. The extent of this price effect depends on share of electricity spending in consumer expenditure for each income decile.

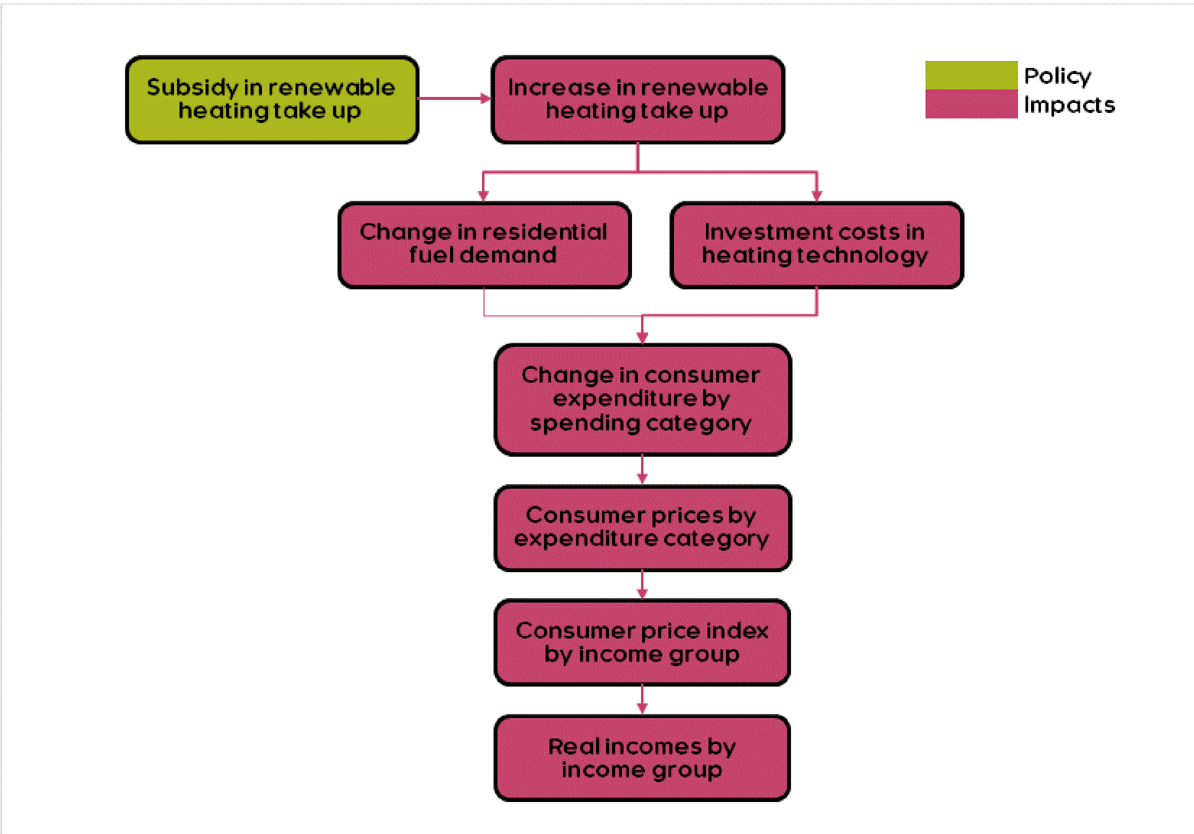


Figure 69: Model pathway of subsidies in renewable heating technologies

D.1.4 Phase out of fossil fuel subsidies

The removal of fossil fuel subsidies is modelled as a direct increase in fossil fuel prices, imposing a cost on all end users. This leads to an increase in industry and household prices for fossil fuel use leading to a net increase in consumer prices and a fall in real incomes. A second order effect of the price increases is that an increase in industry prices leads to lower industry output which in turn impacts on employment demand. This in turn leads to reduction in total incomes from wages which feeds into loss of real incomes.

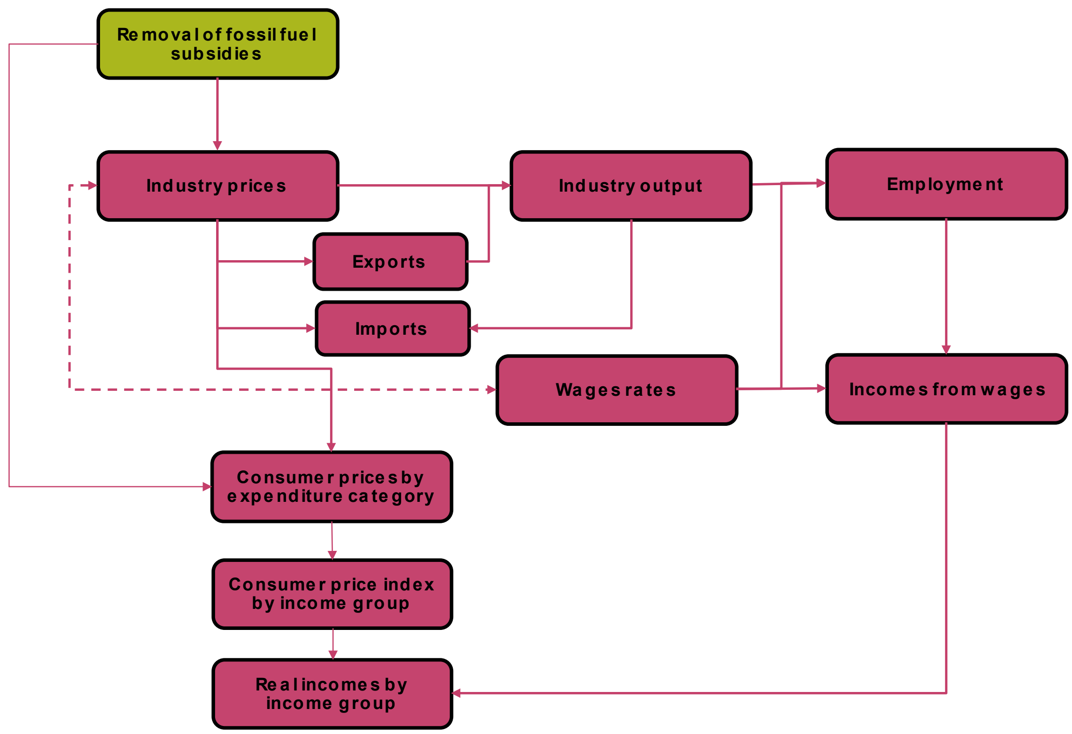


Figure 70: Model pathway of removing fossil fuel subsidies

D.1.5 Emission performance standards

The phase out of fossil fuel heating technologies leads to a shift to renewable heating technologies. This leads to an initial increase in expenditure in new heating technologies which are more expensive and a shift in expenditure on fossil fuels towards electricity (Figure 71).

For phase out of ICE vehicles, we get a shift towards electric vehicles. From this, we capture the change in fuel expenditure and that feeds back into the rest of the economy. It is important to note we are not looking at the supporting investment required to make the phase out feasible and we are assuming that the cost of vehicles have reached parity by 2035 when the phase out begins so we are not evaluating the impact of changes in vehicle costs relative to baseline before that.

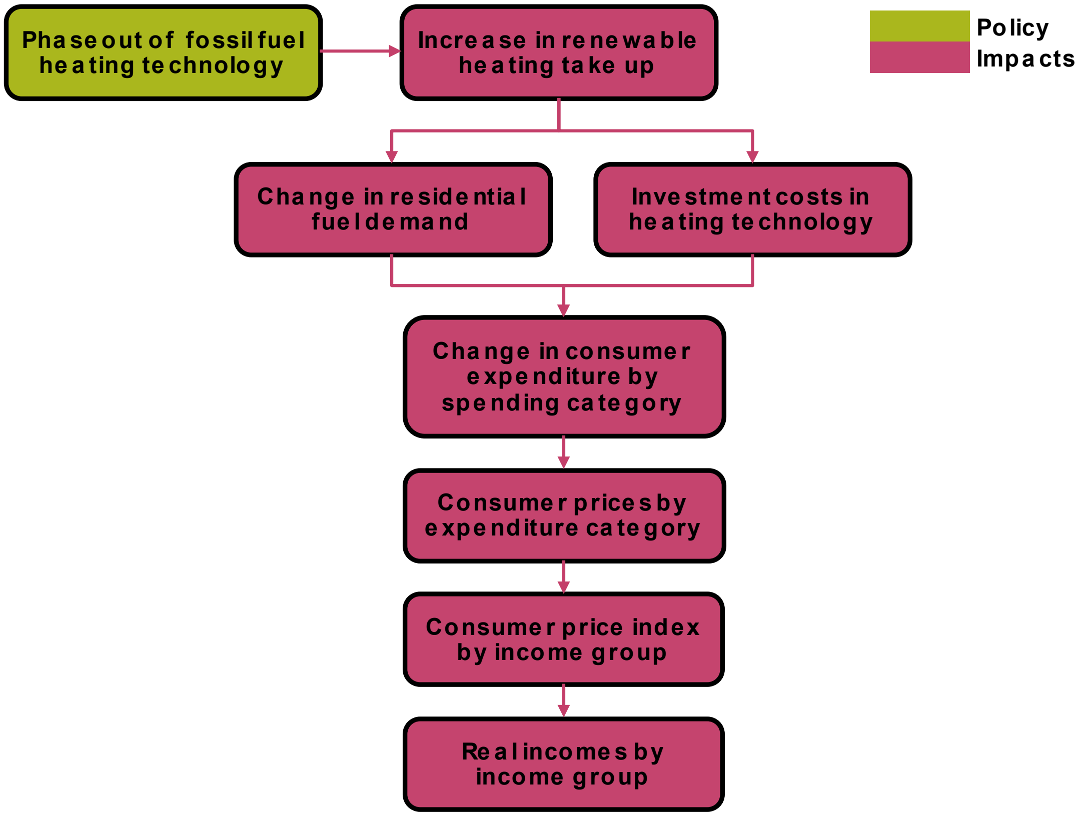


Figure 71: Model pathway of phasing out fossil fuel heating technologies

D.1.6 Energy efficiency measures

For households, the additional energy efficiency measures impose costs directly on consumers through household maintenance but also bring about cost savings from the reduction in fuel demand brought about by energy efficiency (Figure 72).

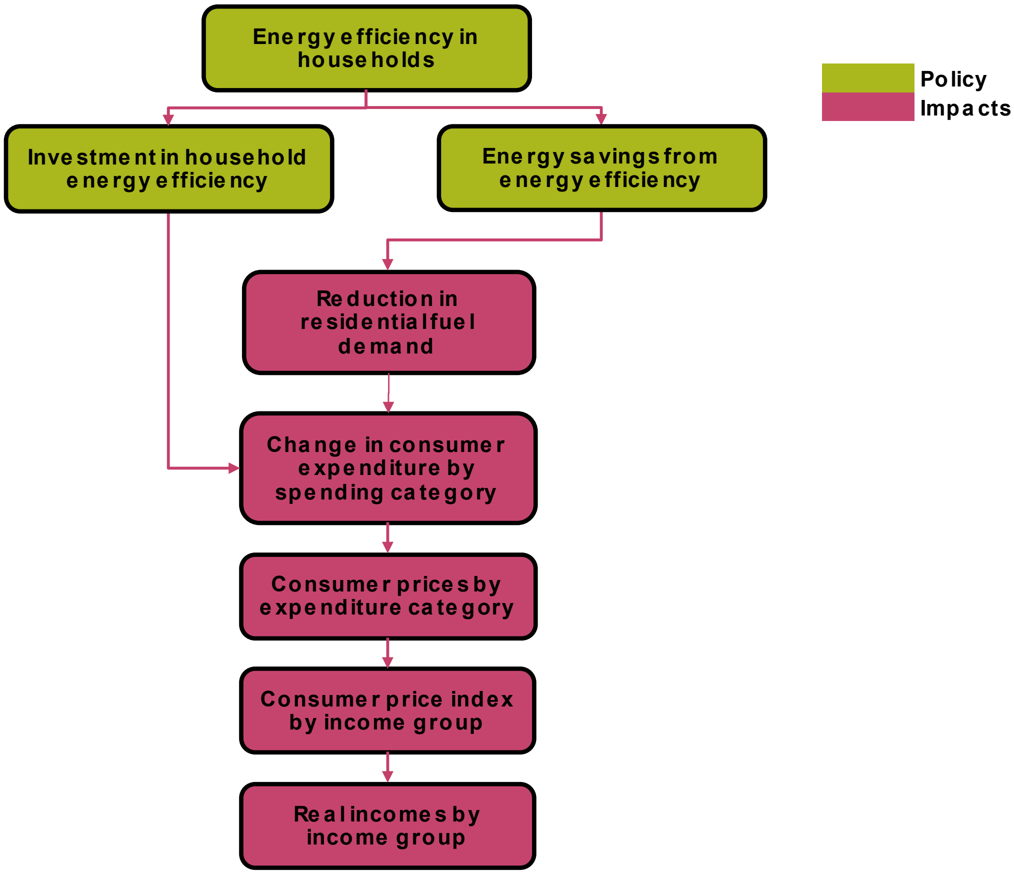


Figure 72: Model pathway of applying energy efficiency measures to households

For energy efficiency from industry, the investment in energy efficiency leads to a change in industry prices through the reduction in fuel demand. This leads to a net reduction in industry prices. This reduction in industry prices then feeds through directly into consumer prices leading to an increase in real incomes. The change in industry prices also feeds through into the calculation of industry output and employment which then feeds into real incomes (Figure 73).

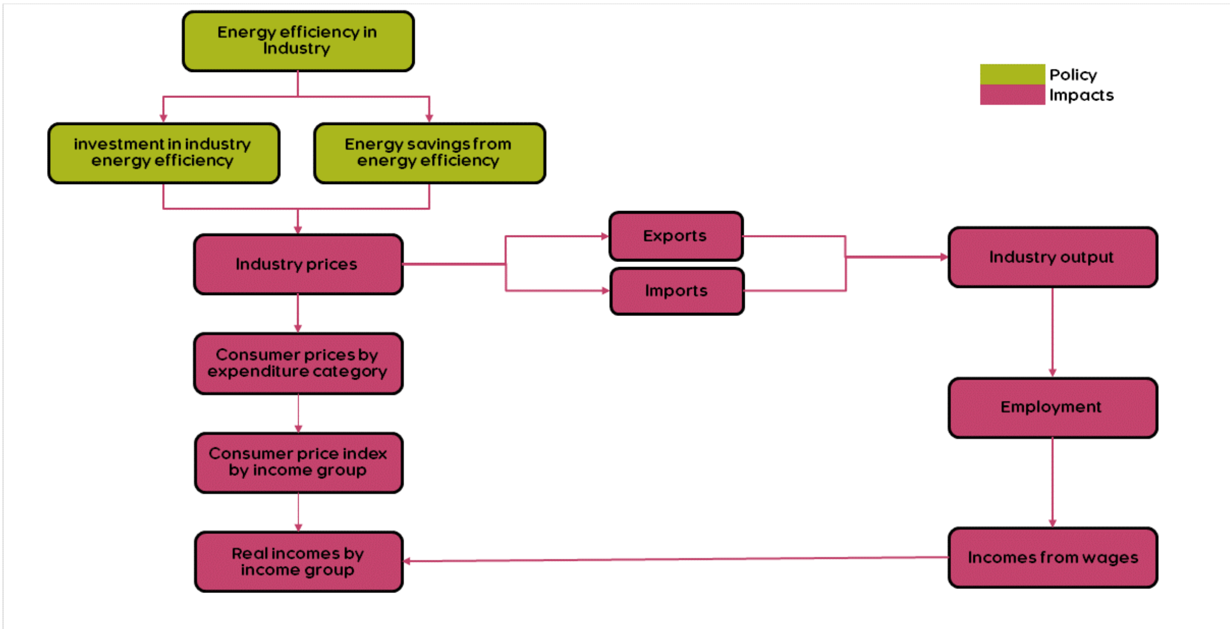


Figure 73: Model pathway of applying energy efficiency measures to industry

D.2 Calculating real income by decile

Real income by decile is used to evaluate the distributional impact of each policy scenario. The calculation of real income takes results from the E3ME scenario runs and combines this with inputs assumptions by income decile for incomes and consumer expenditure by category sourced from the Household Budget Survey[119] and European union statistics on income and living conditions (EU-SILC) datasets[120]. The process of calculating real incomes by decile is shown in

The calculation of real income by deciles can be split into two parts, nominal income and average consumer price (based on consumer spending).

First, nominal incomes by deciles are calculated by taking the historical data on income by decile by member state and projecting this forward by the growth rate in nominal income from E3ME results for each scenario.

For prices, historical shares of consumer expenditure by category for each decile were used to project forward by the change in shares of total consumer expenditure from the E3ME results. These projected shares of consumer expenditure for each decile are then multiplied by the consumer prices by category series from the E3ME results to obtain the weighted average consumer price index for each income decile.

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[119] https://ec.europa.eu/eurostat/web/microdata/household-budget-survey

[120] https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

Real income by decile is calculated from deflating nominal income by the weighted average consumer price index for each decile. To obtain real disposable income, propensity to consume for each income decile has also been taken into account. Lower income deciles on average tend to spend more of their disposable income than higher income deciles which save more and receive fewer benefits in kind.

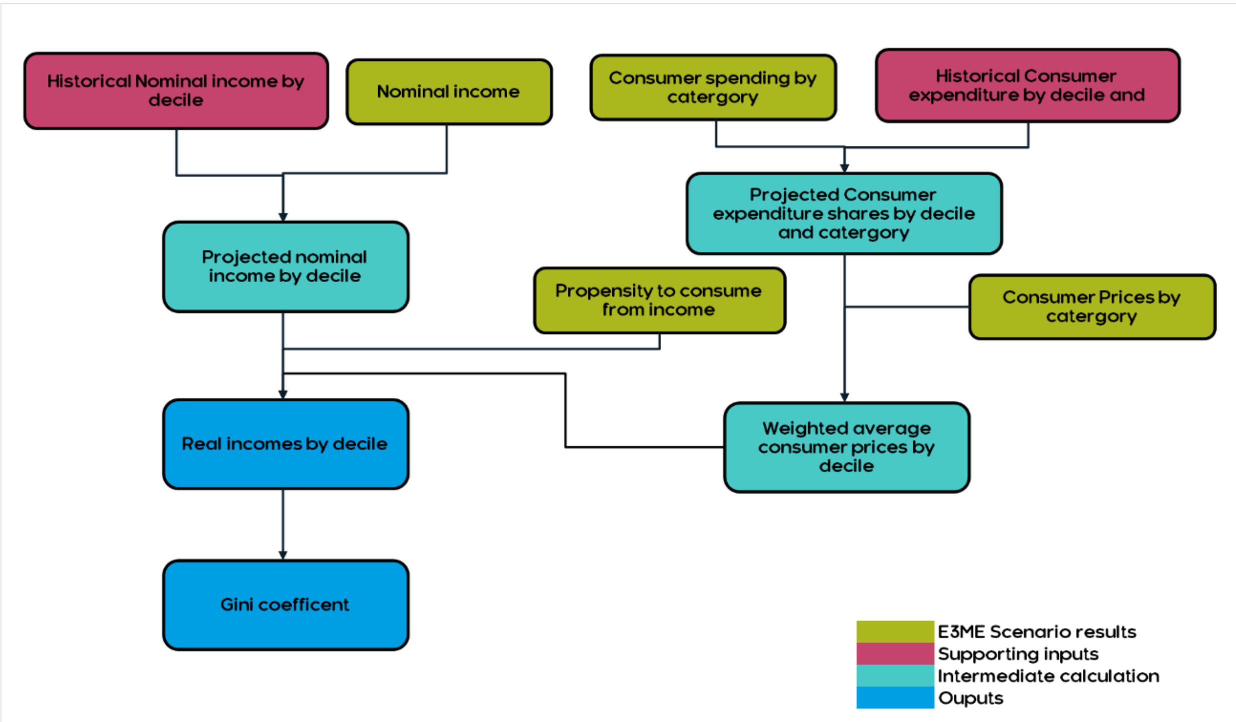


Figure 74: Process for calculating real income by decile

D.2.1 Accounting for changes in energy expenditure

The final adjustment is to adjust the disposable income measure to account for changes in energy expenditure and policy costs. From a strict analysis, the change in energy expenditure does not directly affect total disposable income (income after direct taxes) beyond the sensitivity of income groups to energy prices. However, from a welfare perspective, it is quite clear that if energy efficiency reduces total energy expenditure for a household such that they spend less of their income on energy for the same level of utility (such as heating a home or travel the same distance by car), that household is better off by freeing up disposable income to spend on other goods and services.

To account for the expenditure effects, we take out the share of expenditure on energy and any direct policy costs (such as energy efficiency and heating technology investment) that are in volume terms (in contrast to price effects such as taxation applied to fossil fuel prices).

This revised income measure has a significant impact on the distributional impact for policies which impact household energy consumption (e.g. energy efficiency) rather than consumer prices (e.g. carbon tax). In particular, emissions performance standards and energy efficiency measures scenarios demonstrate this effect as there is further progressive impact in the long run as household energy savings benefit low-income households proportionally more.

D.3 Calculation of the Gini coefficient

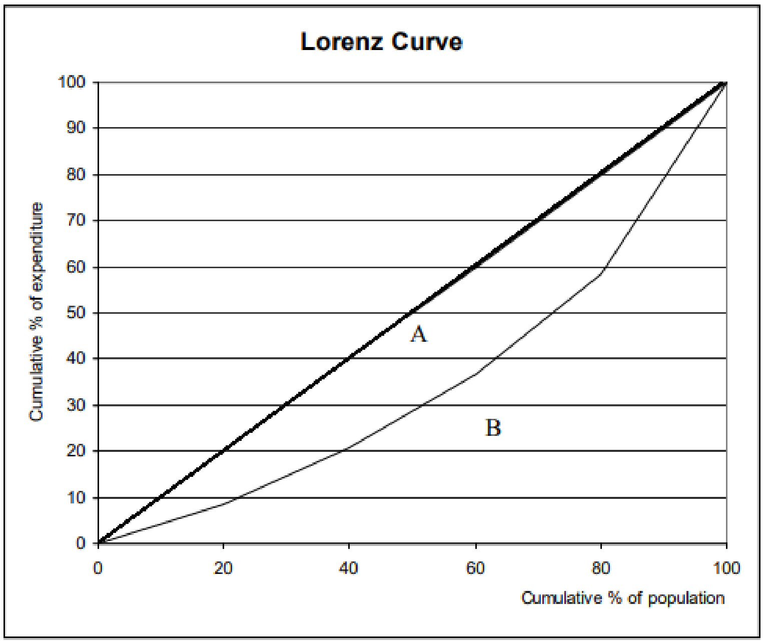


Figure 75: Lorenz curve. Source: World Bank (2005)

The Gini coefficient is produced by calculating the area between the Lorenz curve and the cumulative population axis. The Gini coefficient then defined as followed: A/(A+B), where A and B are the areas shown in Figure 75.

In some cases, the entire Lorenz curve is not known as with the deciles approach for this study. Then, the Gini coefficient can be approximated by using various techniques for interpolating the missing values of the Lorenz curve. If (X_i, Y_i) are the known points on the Lorenz curve, with the X_i indexed in increasing order $(X_{i-1} < X_i)$.[121]

[121] X_i is the cumulated proportion of the population variable, for k = 0,...,n, with X0 = 0, $X_n = 1$.
Y_i is the cumulated proportion of the income variable, for k = 0,...,n, with Y0 = 0, $Y_n = 1$.
Y_i should be indexed in non-decreasing order ($Y_i > Y_i - 1$)

Let N be the total of population, x_i be a point on the X-axis, and y_i a point on the Y-axis. Moreover, y_i is income of an individual/group.

$$\text{Gini} = 1 - \sum_{i=1N} (x_i - x_{i-1})(y_{i-1})$$

When there are N equal on the interval then the formula can be simplified into:

$$Gini = 1 - \frac{1}{N}\sum_{i=1}^{N}(y_i + y_{i-1})$$

D.3.1 Calculating Gini coefficient indices using income groups

In absence of micro level data, Gini coefficient is calculated by taking the mean income of each decile (or quintile) (see Figure 76 and Figure 77) (Logfren et al, 2003).

Figure 76: Mean income per decile. Source: Ellis (2017)

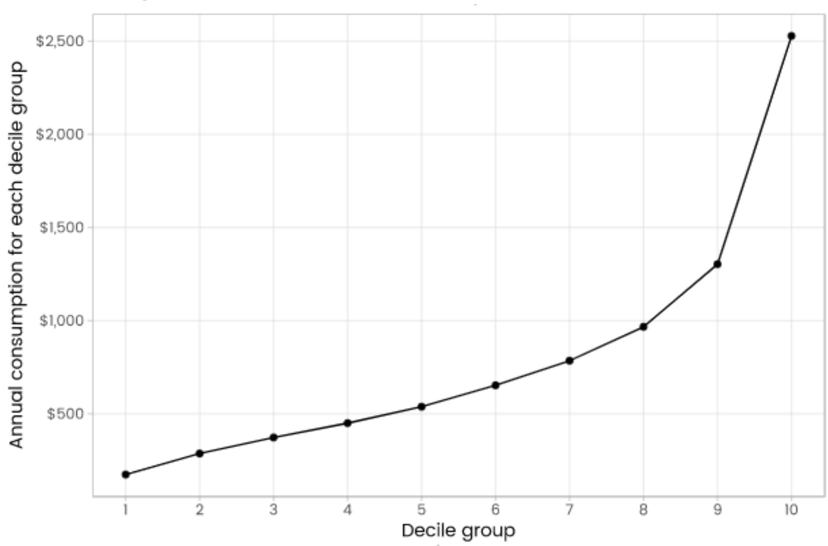
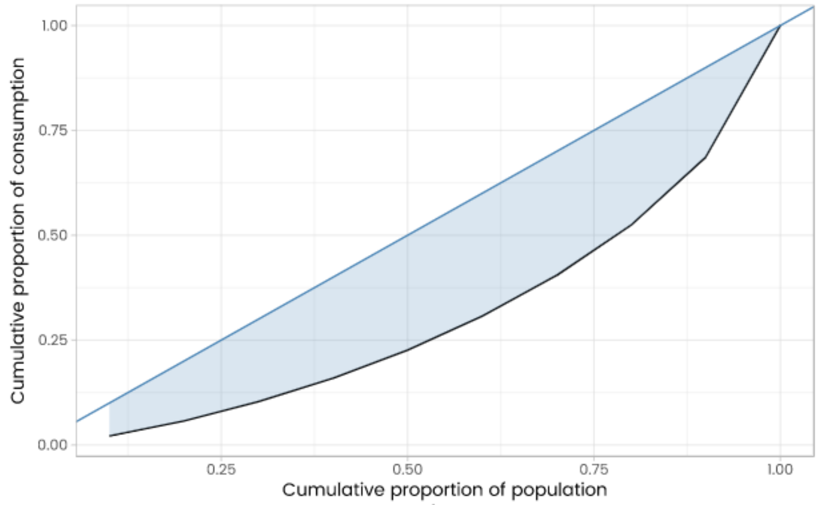


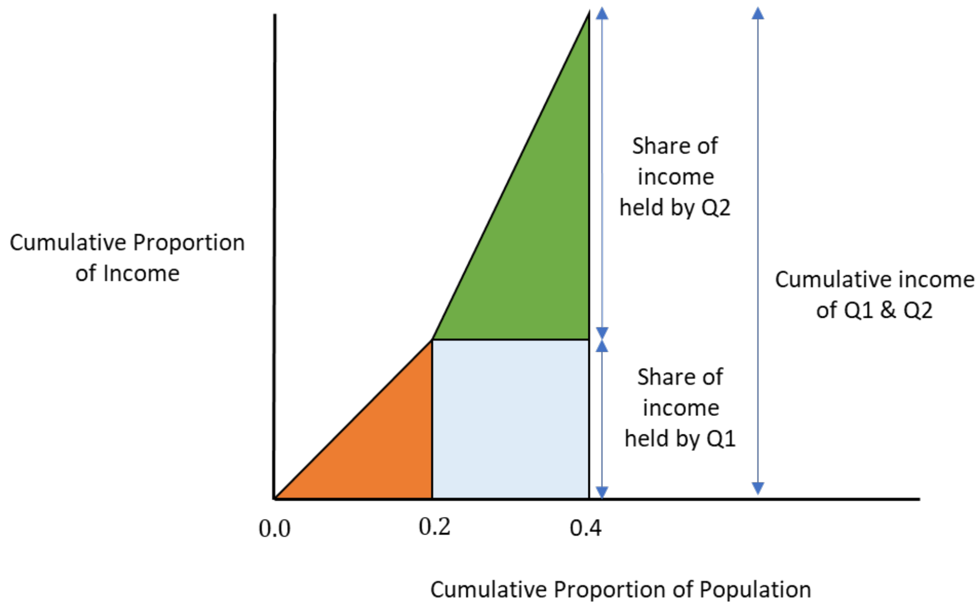
Figure 77: Lorenz curve based on mean income per decile. Source: Ellis (2017)



For instance, in E3ME, the current approach calculates the share of total income received by each decile, by taking mean income values in each decile. Cumulating these shares over quintiles yields 11 points for the Lorenz curve. To complete the Lorenz curve, the current assumption is that income is distributed equally within each decile. This assumption implies a linear interpolation between the decile points.

The Gini coefficient is produced in the standard manner. Given the use of linear interpolation, the area underneath the Lorenz curve can be broken down into a series of rectangles and triangles. Figure 78 illustrates an example of this process for calculating the area underneath the Lorenz curve for the second quintile.

Figure 78: Calculation of the area under the Lorenz Curve for the second quintile



D.3.2 Calculating average Gini coefficient for each region

Within E3ME, the income distribution and GINI coefficients are calculated at member state level using income deciles as a proxy. Given data limitation, it is not possible to calculate a full GINI coefficient for an aggregate region as it would require information on the distribution within deciles to be able to sort the population of each member state in the aggregate region and to derive new income deciles for the aggregate regions.

Given this limitation, a simpler approach was used by taking the weighted average GINI coefficient in each member state, weighted by population. This weighted average GINI coefficient would provide a measure of average inequality within member states in each region but would not capture changes in inequality between member states within each region.

D.4 Composition of regions in Europe

Beyond the EU28 average results, we have carried out the same analysis for four geographic regions.

- **Northern Europe** (Denmark, Estonia, Finland, Latvia, Lithuania & Sweden)
- **Central and eastern Europe** (Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovenia & Slovakia)
- **Southern Europe** (Cyprus, Greece, Italy, Malta, Portugal & Spain)
- **Western Europe** (Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, United Kingdom)

Appendix E. Covid-19 sensitivity approach

E.1 Implementation and assumptions

Uncertainty

At the time of reporting, the pandemic is still in effect and as such the data available on its direct economic impacts (even in the very short term of the current duration of the pandemic) are limited to general trends. The outlook, the duration and severity of pandemic and the lockdown measures are therefore uncertain.

Our assumptions for the effects of the Covid-19 pandemic on the global economy are based on available information published in 2020 April. However, they cannot cover the full range of potential impacts (e.g. faster digitalisation due to work structure changes).

Four types of impacts are considered:

1) A supply shock, due to health impacts and social distancing measures which reduce workforce productivity across the economy.
2) A demand shock, due to reduction of consumption, with permanent effects in several sectors (e.g. travel, social consumption).
3) A reduction in investments, due to the delayed investments and a lack of economic confidence.
4) Impact of government interventions (i.e. increased government expenditures and lump-sum transfers to the labour force).

Supply shock

Supply shocks are applied to all regions on industry level considering supply shock magnitudes based on del Rio-Chanona et al. (2020) taking the possibility of working from home and essential jobs in industries into account and assuming a two month impact period. The range of the assumed supply shock for 2020 is between -1.6% to -15.2%, which already includes a small adjustment for health-related supply disruptions (i.e. symptoms, self-quarantine). Some examples for hardly hit sectors are: tourism, hotels, forestry, manufacturing of metal goods and other transport equipment.

To account for regional differences we have adjusted these industry level supply shocks based on Gottlieb, Grobovšek, and Poschke (2020) using World Bank country classifications.

Demand shock

Demand shocks are calculated based on a variety of sectoral sources and assumptions. There are four major fields where we consider significant impacts: tourism, transport, social consumption (e.g. restaurants, entertainment) and healthcare.

In the case of air transport, we use International Civil Aviation Organization (ICAO) April 27 projections, indicating a loss of revenues from consumer air transport between -57 to -66% by region for 2020 as a whole. We use regional weighting from these ICAO numbers to apply a -55% loss to the tourism sector (based on OECD's 45-70% decrease estimate).

For social consumption (e.g. restaurants, entertainment) and other transport modes we assume an impact that lasts for about 4 months[122]. The magnitude of the impact is estimated using Google Mobility reports (Google 2020). Reported country level reductions were aggregated to E3ME regions and their average was used to calculate an estimated annualized transport and social consumption (e.g. recreation) impact.

Finally, healthcare expenditures were revised upwards, with a 10% from current levels assumption.

Investment

Due to the uncertainty created by the pandemic and the lack of treatment or vaccine for the virus, stock markets have already seen significant drops and a contraction of private investment activity is expected. We represent this by assuming a permanent 5% contraction from baseline private investment levels that does not recover post 2020.

Government revenues

Our assumptions about government interventions focus on fiscal interventions that have currently been implemented to mitigate the economic impacts of Covid-19. These inputs were formed based on Bruegel's fiscal response dataset (Bruegel 2020) and IMF's 'Policy Responses to Covid-19' listing (IMF 2020). We assume that these fiscal interventions have two channels of impact:

1. Increasing direct government expenditures (e.g. investments or general subsidies)
2. Lump-sum transfers to the households.

Other assumptions

Taking account of the slump in oil demand and rift between Saudi Arabia and Russia, we assume a 50% reduction in the oil price from baseline in 2020 and a gradual return to the baseline level over the following five years.

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[122] Capital Economics' data on Chinese impacts indicate that consumption have resumed to original levels in some (e.g. urban road transport), but not in all sectors (e.g. cinema sales) in 4 months.

E.2 Impact on the baseline

Relative to the original E3ME baseline used for the study, the Covid-19 shocks to demand, supply and investment lead to an average reduction in GDP for the EU27 + UK of -3.8%. Beyond 2020, economic activity remains lower as although growth does recover the rebound is insufficient to recover to original baseline levels. Over time, there is some further recovery in output but even by 2030, the European economy is below the level it would have been without Covid-19.

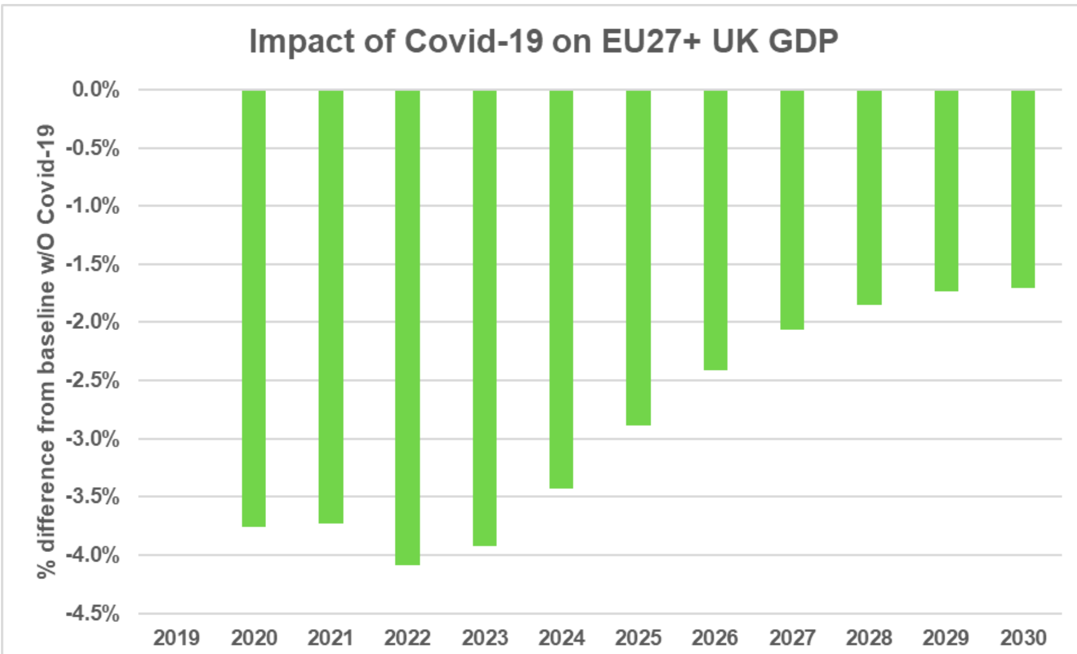

Figure 79: Predicted macroeconomic impacts of Covid-19 on baseline (EU)

Recovery pathway

It is necessary to consider what the expected response is once the pandemic itself is over. For consumption impacts, our assumption is that there will be some bounce back in terms of an economic recovery largely through consumption where delayed consumer expenditure is partially realised. Beyond 2020, the econometric specification for consumption in each country determines the subsequent path, but there is typically no rapid return to the baseline level of spending.

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