Macroeconomic Impacts of ETS Revenue Allocation: A Post-Keynesian Analysis of Decarbonization Strategies in the EU

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1. Introduction

The European Union Emissions Trading System (EU ETS) has played a critical role in reducing greenhouse gas (GHG) emissions across the EU since its inception in 2005, generating over €175 billion in revenues. Member States have the discretion to allocate the ETS revenues for climate and energy-related purposes. However, the effectiveness of how these funds are used has become a central question in the broader context of achieving the EU's climate goals. Given the introduction of new decarbonization initiatives under the "Fit for 55" package, this paper aims to explore the macroeconomic and environmental impacts of different revenue recycling strategies.

The study employs the post-Keynesian E3ME macroeconomic model, which deviates from the traditional equilibrium-based models. E3ME combines elements of econometrics, input-output analysis, and system dynamics to provide a more flexible and empirically grounded approach. Unlike CGE models, which assume market optimization, E3ME captures real-world behaviours and constraints, including demand limitations, technological change, and market imperfections. Two scenarios were tested in comparison to the baseline up to the year 2050: the "High Ambition" scenario, where all ETS revenues are allocated to green investments, and the "Low Ambition" scenario, where only 50% of the ETS revenues are directed toward green policies.

The results of the study reveal significant macroeconomic and environmental impacts depending on how ETS revenues are recycled. In the "High Ambition" scenario, the EU's GDP increases by up to 0.5% by 2050 compared to the baseline. Investments in renewable energy and energy efficiency drive this growth, with the renewable energy sector alone benefiting from an additional €200 billion annually. Employment in green industries also rises, adding approximately 350,000 new jobs by 2050. This scenario also achieves a 2.3% reduction in EU emissions, primarily due to improved energy efficiency and a shift toward electric vehicles. In contrast, the "Low Ambition" scenario, results in a less favourable economic outlook. GDP growth is minimal, and emissions are projected to rise by 2.6%, driven by higher energy demand and slower technology adoption. Employment outcomes are similarly weaker, with a projected net loss of 1% in total employment in Eastern European countries, such as Lithuania and Romania, by 2050.

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2. Background

Overview of the EU ETS scheme

The European Union Emissions Trading System (EU ETS) was established in 2005, and since then contributed to a 47% reduction in emissions from European power plants and industrial sites. The system sets a cap on the total amount of greenhouse gases (GHG) which covers energy, manufacturing, and aviation sectors. The EU ETS cap is expressed in emission allowances with one allowance giving the right to emit one tonne of CO2 equivalent. These allowances are auctioned, and traded between companies. As the cap tightens over time, the supply of allowances shrinks, pushing companies to find ways to reduce their emissions. Although most allowances are sold at auction, some are allocated for free, particularly to sectors facing competitive pressure. The price of allowances is set by the EU carbon market. Since 2013, the EU ETS has raised more than EUR 175 billion in revenue (European Commission, 2024a). This revenue flows primarily into national budgets, and EU Member States are required to use it to fund renewable energy, energy efficiency, and low-carbon technology projects that reduce emissions.

EU ETS revenue recycling

Under the EU ETS, Member States have the authority to decide how to allocate their share of auctioning revenue, however, the EU ETS Directive encourages Member States to use at least half of their auctioning revenue for climate and energy-related purposes, along with all revenues from aviation activities, on environmental initiatives. Between 2013 and 2022, Member States dedicated 76% of their EU ETS revenues to sustainability-related projects. However, some countries are significantly below this number, for example, Italy spends only 50% of the revenues on climate projects, while the rest go to the general government budget (Dimitrova, 2024).

The majority of these revenues are directed towards enhancing energy efficiency in households and businesses, compensating energy-intensive industries and electricity providers for higher carbon costs, promoting renewable energy use, and supporting electric mobility and public transport. For instance, Estonia, Italy, and Latvia dedicate a significant share of these revenues to renovating public buildings such as schools and government facilities, while in France, Germany, Greece, and Slovakia, industries vulnerable to carbon leakage receive compensation for higher electricity prices caused by ETS costs, and Portugal compensates electricity providers for shifting to less carbon-intensive fuels. (Marten & van Dender, 2019)

The collected revenues flow not only to the national budgets for countries to decide for themselves its usage, but also to EU wide funds: Innovation Fund and Modernisation Fund. The Innovation Fund prioritises breakthrough clean technologies and large-scale flagship projects that offer substantial added value and the potential for significant reductions in greenhouse gas emissions. Projects supported by the fund span a broad range of sectors, including energy-intensive industries, renewable energy, energy storage, net-zero transportation and buildings, hydrogen solutions, and carbon capture, utilisation, and storage. The Modernisation Fund specifically supports 13 lower-income Member States to modernise their power sector. It also supports the upskilling of workers and aids in the decarbonization of industries.

In 2024, total auctioning revenues generated by the scheme amounted to 43.5 billion euros, of which 33 billion went directly to Member States, 1.7 billion to Innovation Fund, 5.6 billion to Modernisation Fund, and 3 billion to REPowerEU program (Dimitrova, 2024), which was established in 2022 to phase out Russian fossil fuel imports.

EU ETS 2

ETS has evolved through multiple trading phases. It is currently in its fourth phase (2021–2030). The ETS Directive has been updated several times to align with the EU’s climate targets. Significant recent updates occurred to employ ETS for achieving the "Fit for 55" package of reforms to align with the goals of the "European Green Deal." Central to this initiative is the 2030 target of cutting net emissions by at least 55% compared to 1990 levels. One of the key revisions was the creation of a new, separate emissions trading system, known as ETS 2, which will extend the list of sectors covered by the system to include emissions from fuels used in buildings, road transport, and smaller industries that are currently outside the scope of the existing EU ETS. ETS 2 is expected to be fully operational by 2027, though its launch could be delayed until 2028 if energy prices remain exceptionally high (International Carbon Action Partnership, 2022).

Additionally, the emissions cap has been tightened, with the goal of achieving a 62% reduction in emissions by 2030 compared to 2005 levels. The free allocation of emission allowances will be gradually reduced and tied to companies' decarbonization efforts, with free allowances for the aviation sector being phased out completely by 2026 (European Commission, 2024a). Another important change is the requirement for Member States to spend their ETS revenues in alignment with climate objectives. The European Commission has emphasised that stricter rules are necessary, shifting the language from "should" to "shall," making it mandatory for Member States to direct 100% of ETS revenues, except for a portion allocated to industry compensation, towards climate action (Haase et al. 2022).

A portion of the revenues generated from ETS 2 will also go towards supporting vulnerable households and small businesses through the new Social Climate Fund, established under the "Fit for 55" package. This fund is designed to mitigate the social impact of carbon pricing in the sectors covered by ETS 2 and will mobilise €86.7 billion between 2026 and 2032 (European Commission, 2024b).

3. Literature review

With new rules imposed for Member States’ revenue recycling options, as well as the new Social Climate Fund being established, the question arises on the successes of these decarbonisation strategies both in environmental and macroeconomic impacts. While the literature on evaluating the impact on different schemes of ETS revenue recycling is scarce, there are a few studies overviewing both the historical impact up to date, and performing simulation models to estimate the future trends.

The 2021 WWF report critically reflects on the historical ETS revenue expenditure, highlighting that between 2013 and 2019, Member States raised €49 billion in revenues through the EU ETS, of which €13.3 billion was not spent on climate action, and part of the rest may even have financed activities which are counterproductive to a clean and just transition. The WWF report also argues for major funding forgone due to free carbon allowance for some industrial sectors. Similarly, the authors of the report by the Ecologic Institute (2022) argue that while auction revenues offer a significant opportunity for Member States to fund climate action initiatives, there are inconsistencies in how Member States use ETS revenues, with some countries allocating a significant portion to non-climate-related expenditures. They thus advocate for stricter regulations to ensure that all revenue from ETS auctions is directed toward climate mitigation and adaptation projects, suggesting that this would enhance public acceptance of the system and increase its effectiveness.

There are a couple of studies that applied the mainstream computable general equilibrium (CGE) model to estimate the possible outcomes of the new ETS directive. The first study, conducted by the Energy Policy Group (2023), employs a stochastic general equilibrium model, MEMO, to evaluate the impact of a general carbon tax across several European countries, focusing on its effects on GDP and consumer welfare, and then discussing the simulation results in the context of the ETS and ETS 2. The simulation predicts that Poland would experience the largest GDP reduction, around 1% by 2032, compared to a baseline scenario, with smaller impacts observed in Bulgaria, Romania, and Germany. Although the modelled carbon tax is more comprehensive than the proposed ETS 2, the study provides insights into how carbon pricing might influence different national economies. The study assumes that the carbon tax would be entirely passed on to consumers, which might not occur in real-world scenarios due to competitive pressures. Furthermore, the paper explores three revenue recycling scenarios: lump-sum transfers, price subsidies for low-income households, and the reduction of other distortionary taxes. The analysis shows that, prior to redistribution, the tax imposes a higher relative burden on lower-income households, highlighting the regressive potential of such policies.

The second study, Goulder and Hafstead (2022), employs the PACE model, a multi-region, multi-sector CGE) model, to examine how recycling auction revenues from the EU ETS impacts both carbon prices and sectoral outcomes. The analysis focuses on three aggregated sectors—extractive activities, industries covered by ETS, and non-ETS sectors—and differentiates energy carriers such as coal, natural gas, and renewables. Their model explores the interaction between auction revenue recycling and electricity levy exemptions for energy-intensive industries. The scenarios tested differed in assumptions in, first, which agents financially support transition to renewable energy, and, secondly, whether the ETS revenues are used as transfers to households as a lump sum, or as financial support to power generation from renewable energy. The study reveals that auction revenues used to reduce national levies result in a 1.8% increase in ETS carbon prices but a 5.9% decrease in the non-ETS carbon constraint. A notable finding is that sectors benefiting from electricity levy exemptions, such as energy-intensive industries, fare worse when revenues are redirected toward supporting renewable energy, as opposed to transferring revenues to households.

Both the MEMO and PACE models, used by the studies, rely on mainstream economic assumptions, particularly market optimization and general equilibrium. In these CGE models, firms and consumers are assumed to act rationally, maximising profits and utility, respectively, with firms optimising production based on available inputs and constant returns to scale. Both models assume full mobility of labour and capital across sectors, assuming that resources adjust freely in response to price changes. The MEMO model assumes that a general carbon tax is entirely passed to consumers, reflecting a perfectly competitive market. Meanwhile, the PACE model incorporates sector-specific characteristics but maintains the overall assumption of efficient markets and equilibrium.

On the other hand, Cambridge Econometrics (2022a) report employs the E3ME model, a post-Keynesian computational model that links economy, energy, and the environment without assuming market equilibrium or optimization, as well as Future Technology Transformation (FTT) model, which measures the substitution of technologies in response to changes in costs. The study focuses on the EU27's target to achieve a 55% reduction in GHG emissions by 2030 compared to 1990 levels. It examines how emissions reductions in non-ETS sectors, particularly road transport and buildings, could contribute to this target, adopting a scenario with a 40% emissions cut by 2030 from 2005 levels. Two scenarios are considered. The first, the "Policy Measures" scenario, models emissions reductions in road transport and buildings through policy measures like tightening emissions standards, banning combustion engine vehicles, and improving energy efficiency in buildings. The second scenario, "ETS," introduces an emissions trading scheme to achieve the 40% reduction target. Sensitivity analysis explores different revenue recycling options, such as income tax cuts, lump sum transfers, and VAT reductions, each impacting households and economic sectors differently. The findings showed that using revenues to cut income taxes benefits higher-income households, while lump sum transfers provide more relief to lower-income households, while using ETS revenues to reduce employers' social security contributions lowers labour costs, and boosts employment, whereas reducing VAT lowers consumer prices, benefiting all households more evenly.

4. Methodology

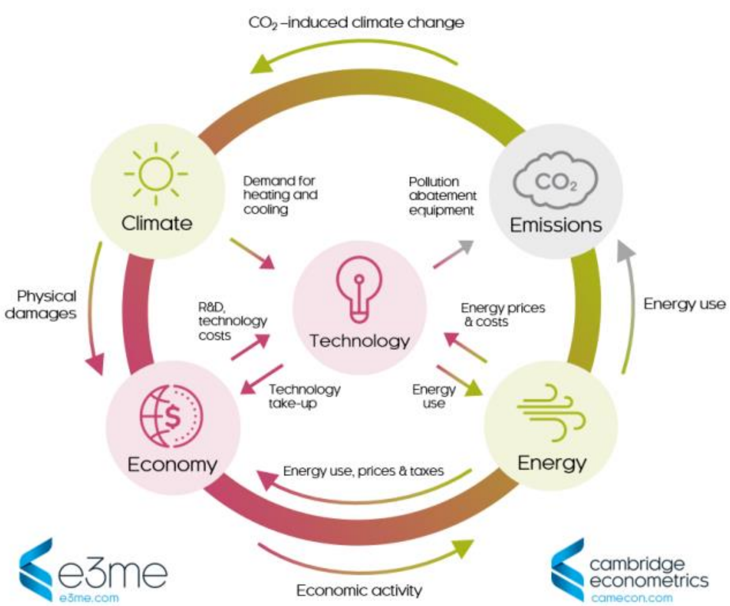
E3ME model

Our study uses the E3ME model to test further scenarios of ETS revenue recycling options in the EU, and its effects on climate and macroeconomic indicators. E3ME differs significantly from mainstream economic models, such as Computable General Equilibrium (CGE) models, in that it does not assume market equilibrium or optimization. Instead, it emphasises real-world behaviours and interactions, using empirical data to simulate the dynamic relationships between key economic and environmental factors. This allows E3ME to account for market imperfections, demand constraints, and technological changes in a way that traditional CGE models, which assume perfect competition and optimization by agents, often cannot.

E3ME combines elements of input-output analysis, econometrics, and system dynamics. The model consists of 71 regions and over 40 economic sectors, enabling detailed sectoral and regional analysis of policy impacts. E3ME’s econometric foundation allows for dynamic modelling over time, with historical data driving projections. Unlike CGE models, which rely heavily on theoretical assumptions like constant returns to scale and homogeneous agents, E3ME uses a bottom-up approach, emphasising historical relationships in the data. The model includes explicit treatment of energy demand and supply, emissions from energy consumption, and the effects of carbon pricing policies. E3ME also accounts for the feedback loops between energy policy measures and economic growth, something that CGE models typically simplify or overlook by assuming a direct relationship between carbon prices and emissions reductions without feedback from the economy.

Key behavioural relationships embedded in the model are as wage setting, investment, and consumer demand. These relationships are modelled econometrically from historical data, reflecting real-world decision-making under uncertainty and market disequilibrium. For example, instead of assuming that firms and consumers always make optimal choices, as in CGE models, E3ME incorporates the influence of past trends, policy shocks, and imperfect information on decision-making processes. This more realistic depiction of economic behaviour allows the model to capture the path-dependent effects of policies over time, and such economic situations as price stickiness.

Figure 1 E3 linkages in the E3ME model, source: Cambridge Econometrics (2022b)



E3ME's key difference from mainstream CGE models lies in its rejection of equilibrium assumptions, its empirical foundation, and its ability to model complex dynamic interactions between the economy, energy, and environment. This enables a more nuanced and flexible analysis of policy impacts, particularly in assessing long-term transitions toward decarbonization. In particular, the assumptions based on neoclassical economic theory can lead the model to predict the exact opposite, often economically unfavourable, results of climate policy in comparison to an empirical model like E3ME. The assumption of perfect knowledge and rational behaviour means that the CGE model can ignore the full effects of demand. With assumption of full capacity, in CGE models, any additional demand must displace (or 'crowd out') other activity, leading to economic costs. In contrast, creating additional demand in E3ME allows for an expansion of total activity, for example, by drawing on previously unemployed resources. Figure 1 illustrates main loops and relations in the model.

Data Sources

In the E3ME model, historical data for key variables is sourced from well-established databases to ensure accuracy and consistency. Economic and demographic variables, along with emissions data, are predominantly obtained from Eurostat (2021), which provides comprehensive and harmonised statistics across the European Union. The only exception to this is energy use data, which is sourced from the International Energy Agency's World Energy Balances (2022), a global reference for energy statistics.

For the FTT (Future Technology Transformation) Power cost matrices, the IEA World Energy Balances also serve as the primary data source, reflecting the critical role of energy data in shaping technology cost trajectories. While this is largely true for the other FTT submodules as well, these models also draw on a variety of national statistical yearbooks, which provide country-specific insights and further detail, enhancing the robustness and granularity of the data.

Given E3ME's nature as a macroeconometric model designed for impact assessments, it requires a set of exogenous projections for calibration in its endogenous model runs. These exogenous projections are critical for providing a baseline against which the model's internal dynamics can be calibrated and validated. The historical data, as previously described, is used as the foundation for these projections.

Firstly, GDP projections are derived from established sources. For the period between 2018 and 2027, GDP growth rates are taken from the IMF's World Economic Outlook (2022), a widely recognized source for short- to medium-term global economic forecasts. For the longer term, between 2028 and 2050, the European Commission's Ageing Report (2021a) provides the necessary GDP growth rates, which reflect demographic changes and long-term economic trends in Europe. Secondly, energy use projections are sourced from the IEA's World Energy Outlook (2022). This ensures that the model's energy consumption patterns align with globally recognized energy forecasts.

Most economic variables in E3ME are subsequently derived from the GDP pathway described above. However, there is one key exception: sectoral output is linked directly to energy use rather than GDP, reflecting the close relationship between energy consumption and production levels in the model. This approach ensures that both economic and energy projections in the model are grounded in reliable external forecasts while allowing the endogenous dynamics of E3ME to capture interactions and impacts.

Assumptions

In this specific modelling exercise, several key assumptions have been made regarding policy instruments and regulatory frameworks that shape the economic and environmental outcomes across different scenarios. Central to all scenarios are the inclusion of the EU Emissions Trading System (ETS), which targets heavy industry and the power generation sector, the introduction of ETS2, which extends the above program to buildings and road transport, and the Carbon Border Adjustment Mechanism (CBAM), which is supposed to prevent carbon leakage and maintain the competitiveness of EU industries through. These instruments are crucial to driving the decarbonization of various sectors and fostering a sustainable transition in line with European climate goals.

The ETS remains in place throughout the modelled period, continuing to act as the primary market-based mechanism for reducing greenhouse gas emissions across heavy industry and power generation. The ETS price follows the recommendations on harmonised price trajectories set by the European Commission (2023a), while ETS2 is assumed to start in 2027 and is assumed to start with a carbon price of €30 per tonne of CO2, gradually increasing and converging with the ETS price by 2030.

Another critical assumption involves the energy policy landscape. All scenarios incorporate announced EU policies regarding the phase-out of coal and nuclear energy, reflecting the region's commitment to transitioning toward renewable energy sources. However, no assumption is made about an internal combustion engine (ICE) ban, which remains absent from this exercise. The exclusion of this policy reflects the current uncertainty and variability in national regulations regarding the future of road transport technologies.

Taken together, these assumptions create a coherent and realistic policy environment in which the model's endogenous dynamics can assess the economic and environmental impacts of the European Union's climate strategy. By incorporating key regulatory mechanisms, the model is able to simulate the effects of carbon pricing and energy transitions on both industry and the broader economy, while accounting for the interaction between national and EU-level policies.

The representation of the collection and distribution of funds is represented as close to the system outlined in various EU legislation as the restrictions of the model allow. The cap-and-trade mechanism of the EU Emissions Trading System (ETS) is not explicitly represented, meaning that total yearly emissions in the ETS sectors are equivalent to the number of allowances issued. This simplification assumes that emissions in the covered sectors are capped by the total number of allowances available, reflecting the policy goal of reducing emissions over time.

Revenues generated from the sale of ETS allowances are allocated to several key funds, designed to support innovation, modernization, and climate action. A portion of ETS revenues is directed to the Innovation Fund, which receives 2% of total allowances. The allocation of these funds between member states is based on each state's proportional contribution to the EU's total emissions. Another 2% of allowances is directed to the Modernisation Fund, which is distributed according to the provisions set out in EU legislation (2024c), targeting lower-income member states to help them modernise their energy systems and transition toward cleaner technologies. The remaining allowances, from which on top of the above, free allocations are removed, are allocated to member states based on the rules set by Commission Decision(EU) 2020/2166.

For ETS2 revenues are allocated differently. A quarter of ETS2 allowances are allocated to the Social Climate Fund (SCF), which is distributed according to regulations set by the Commission (2021b), targeting support for vulnerable households and communities affected by the green transition. In addition to these allocations, member states are required to contribute an additional 33% of their SCF allocation from their national budgets, supplementing the EU's funding. The remaining 75% of ETS2 revenues are distributed into national envelopes based on each member state's share of total emissions, but the extra national contributions to the SCF budget are deducted from these allocations.

5. Scenario design

As it was previously discussed, the goal of this paper is to assess the potential of the state taking a more active role in achieving the goals of the decarbonisation effort in the European Union. An expedient step in this direction, as the ETS directive encourages, is using incomes from the ETS system on policies that make achieving said goals easier to achieve. According to the European Commission’s Progress Report on Climate Action (2023b), on average member states spent 72.83% of their ETS revenues on climate change and energy purposes. The data shows significant variation across regions, with significant geographical differences in how member states allocate their ETS revenues.

For instance, countries that joined the EU after the 2004 expansions spent significantly below the average, dedicating only 59.38% of their ETS income to climate and energy purposes. In contrast, Southern European countries—including Italy, Spain, Malta, Portugal, Greece, and Cyprus—allocated 67.88%, coming close to the overall average. Meanwhile, Northern European countries, comprising the Scandinavian nations and Ireland, were well ahead, dedicating 100% of their revenues to green policies. The founding EU members, along with Austria, also performed above average, spending 84.3% of their ETS revenues on decarbonization efforts.

The baseline scenarios will assume that countries will keep their current level of ambition in terms of spending ETS revenues on green policies in the modeling timeframe. Given that ETS prices are projected to rise, free allocations are set to decrease, and with the introduction of ETS2 extending the program to additional sectors, ETS revenues are expected to increase significantly. This projected revenue growth raises the possibility that some countries may divert a portion of these funds to non-climate-related policies. To account for this, we explore a scenario where member states reduce their ambition and allocate only 50% of their ETS revenues to green policies, the minimum share mandated by the Fit for 55 package. We label this the ‘Low Ambition’ scenario.

In contrast, we also evaluate a scenario where rising revenues incentivize member states to increase their spending on green policies, leading to a situation where all countries allocate 100% of their ETS revenues to climate and energy purposes. We refer to this as the ‘High ambition’ scenario. In each scenario, the proportion of revenues that is not spent on the aforementioned policies is spent on general government expenditure.

We base our analysis on the International Carbon Action Partnership's (ICAP) (Santikarn et al.,2019) paper, which provides a detailed breakdown of how member states have historically allocated their ETS revenues. This paper distinguishes spending across four key sectors: Energy Efficiency, Renewable Energy, Sustainable Transport, and Research & Development (R&D). To enhance this categorization, we have incorporated an additional element—lump-sum payments to households. This inclusion reflects the provisions of the Social Climate Fund, which explicitly allows for the allocation of ETS revenues to such programs in order to support vulnerable households during the green transition. The final breakdown of spending allocations on green policies is illustrated in **Figure 2**.

Figure 2 Allocation of revenues into green policies

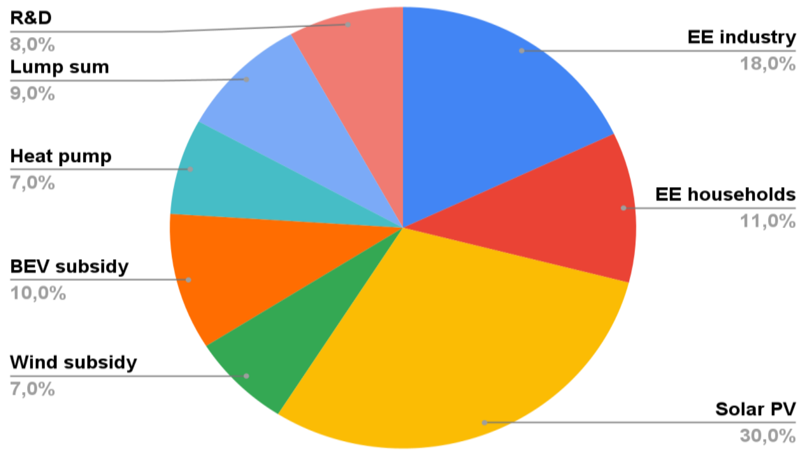


Table 1 Restrictions and leakage rules

Policy	Restriction	Leakage rule
EE industry	No more than 2.5% of the stock each year	Added to next year's allocation
EE households	No more than 2.5% of the stock each year	Added to next year's allocation
Solar PV subsidy	Maximum 15% of the levelised cost	40% added to next year's allocation 60% added to next year's EE household allocation
Wind power subsidy	Maximum 30% of the levelised cost	40% added to next year's allocation 60% added to next year's EE household allocation
BEV subsidy	No restriction	-
Heat pump subsidy	Maximum 30% of the levelised cost	Added to next year's allocation
Lump-sum payments	No restriction	-
R&D	No restriction	-

Certain restrictions have been implemented to prevent overly optimistic assumptions about the uptake capacity of the policies, along with rules for reallocating funds that exceed the policy limits when allocations surpass the set restrictions. Table 1 below outlines the mentioned restrictions and rules.

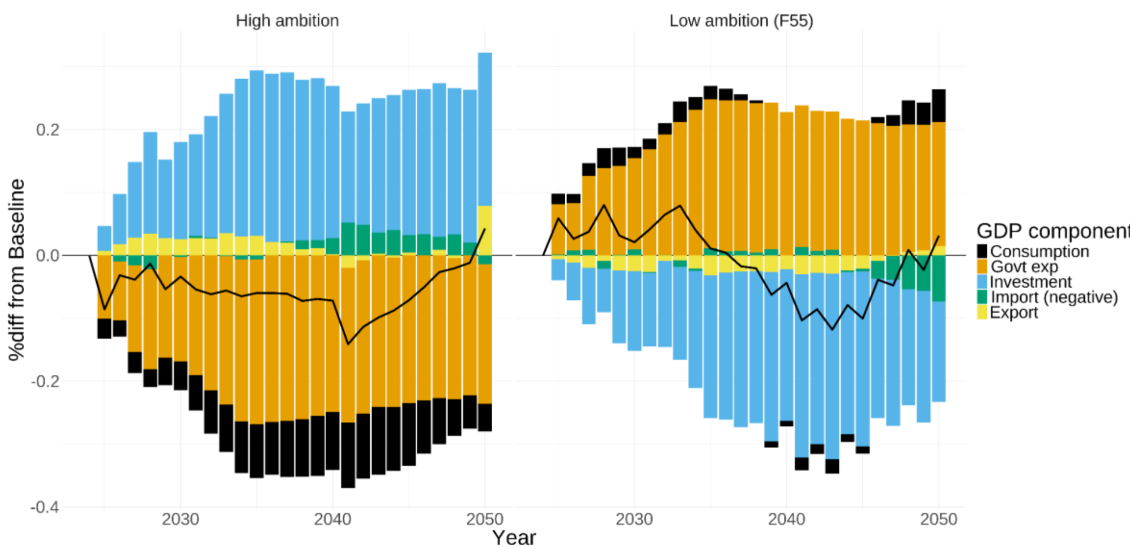
6. Modelling results

Economic impacts

The reallocation of ETS revenues has a significant and far-reaching impact on the EU's economy. The High ambition scenario assumes that a greater proportion of funds are allocated to green investments than in the Baseline scenario. In contrast, the Low ambition scenario demonstrates a declining share of revenues spent on green policies. Consequently, the results demonstrate opposing impacts in the two alternative scenarios in comparison to the Baseline, with a magnitude that is almost equivalent to that of the Baseline scenario.

Figure 3Figure 3 illustrates the impact of revenue reallocation on GDP by component in the High and Low ambition scenarios in comparison to the Baseline. As anticipated, the scenario assumptions exert the most significant influence on the investment and government spending components. In the High ambition scenario, a greater proportion of the ETS revenues are allocated to green policies, directly impacting investment. Conversely, in the Low ambition scenario, resources from green policies are allocated to government spending. The Baseline scenario assumes that the share spent on green policies remains consistent with the 2023 level, situated between the High and Low ambition scenarios.

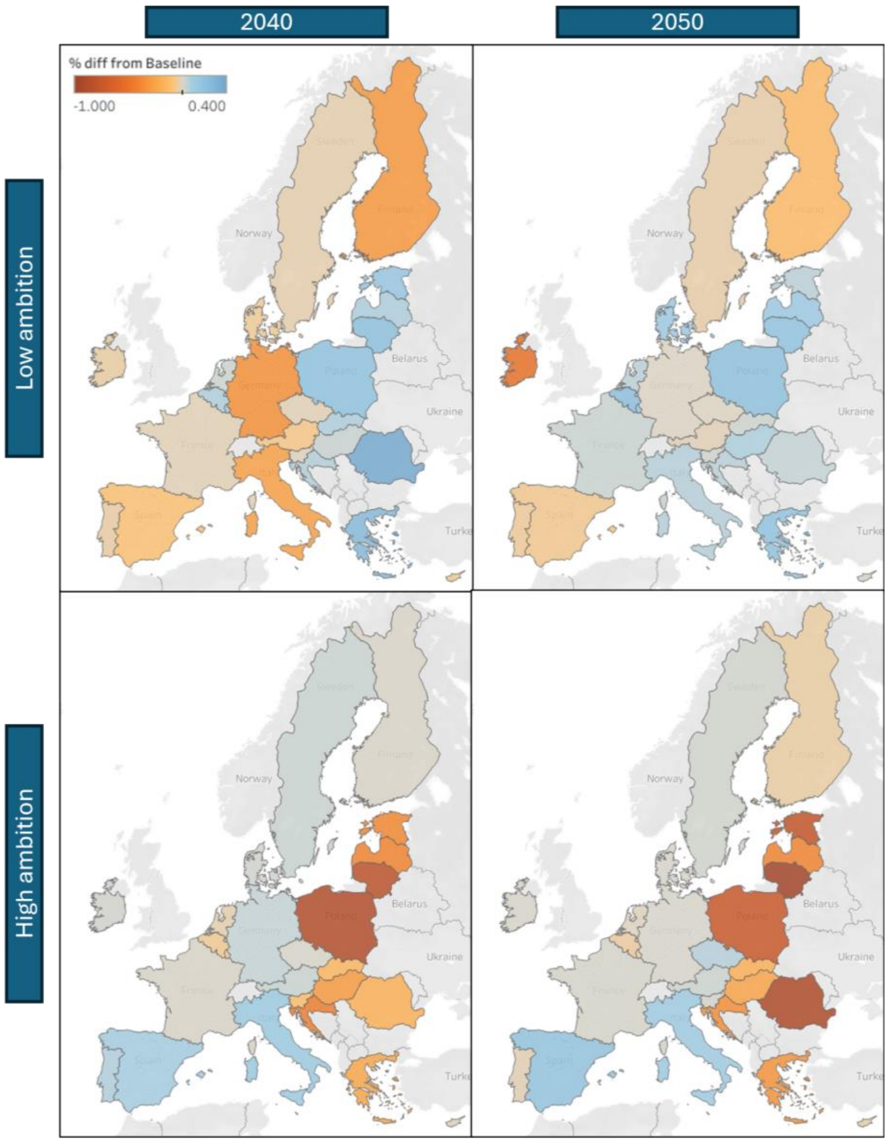
Figure 3 Impacts on the GDP and its components in the EU27, 2023 -2050



In addition to the direct impacts, some indirect impacts are also visible. An increase/decrease in investment results in a corresponding change in prices within the economy. This, in turn, exerts an indirect influence on consumption. Given the elevated price levels projected in the High ambition scenario, a slight decline in consumption is to be expected. In contrast, the opposite is observed in the Low ambition scenario. Furthermore, the same dynamics leads to minor trade impacts.

In general, the results demonstrate that at the EU level, the impacts offset each other, resulting in small negative or positive overall GDP impacts.

Figure 4 Regional differences in the impacts on GDP



A closer examination of the results at the country level reveals a more heterogeneous picture. In the alternative scenarios, the proportion of revenues allocated to green policies and general government expenditure varies across four regions of the EU (North, South, East, West). The regional differences in the GDP results are illustrated in Figure 4. The maps reveal the geographical dimension of the impacts, demonstrating that countries do not react uniformly to the scenarios. The Eastern region is the most significantly impacted in both scenarios. The modelling results indicate that this region would benefit from a lower allocation share to green policies. In contrast, the other regions exhibit a more heterogeneous response, although the economic outcomes are generally more favourable in the High ambition scenario.

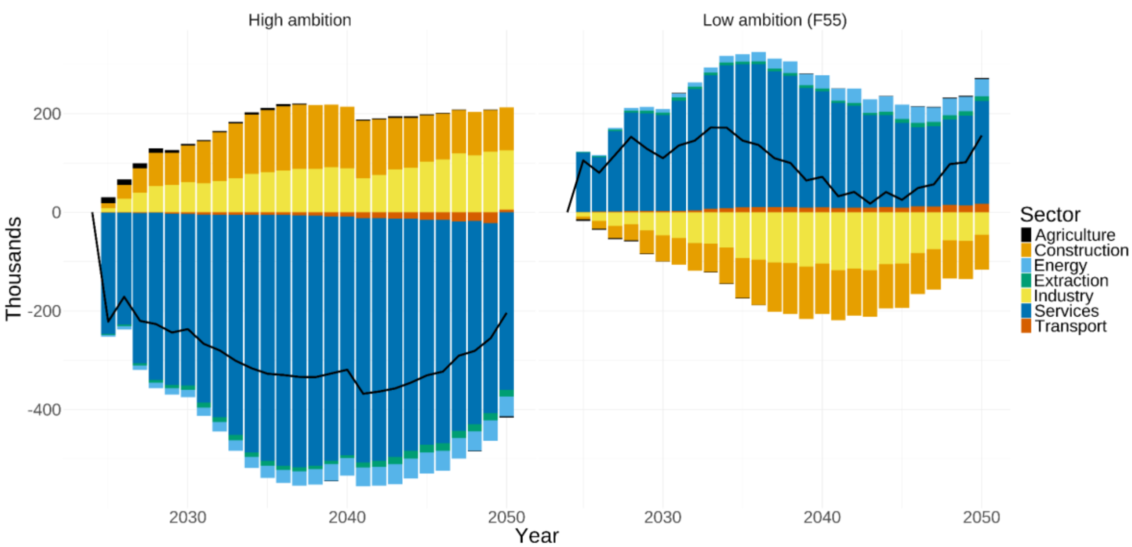
Nevertheless, the economic losses are not substantial, with the largest negative impact estimated at -1% in 2050 in Lithuania.

Employment impacts

The employment effects follow a pattern similar to the GDP outcomes, though the difference between the High and Low ambition scenarios is more pronounced. A significant portion of government spending is directed towards the services sector, which boosts employment there. Likewise, investments in green policies drive job growth in the construction and industrial sectors.

By 2050, total employment is around 350,000 higher in the Low ambition scenario compared to the High ambition. This difference is largely due to the higher labour intensity of the services sector, with reduced government spending in the High ambition scenario, particularly when compared to the Low ambition scenario, contributing to the disparity. Moreover, the energy demand in the High ambition scenario is less than that in the Baseline and Low ambition scenarios, due to the low-carbon investments, such as energy efficiency improvements. This results in a reduction in employment in the energy sector.

Figure 5 Impacts on sectoral employment, 2023- 2050

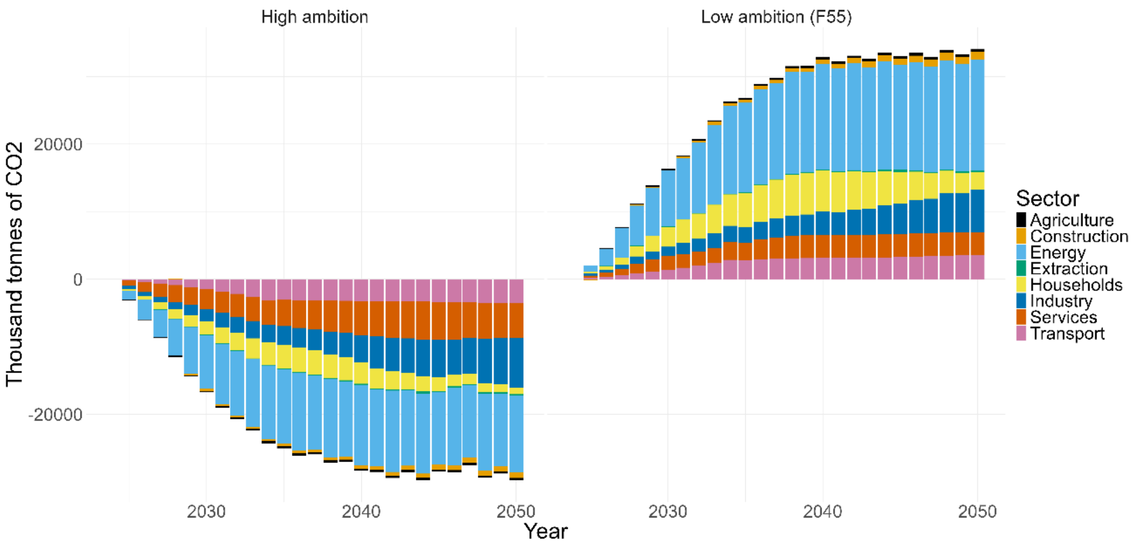


The employment impacts are the most pronounced again in Eastern Europe. In the High ambition scenario, in Romania total employment decreases by 1.4% in 2050, followed by Lithuania (-0.8%), and Poland (-0.6%).

Emissions impacts

The overall emissions impact in the High and Low ambition scenarios is -2.3% and 2.6%, respectively as shown in Figure 6. These reductions are largely driven by greater or lesser investments in energy efficiency. In the Low ambition scenario, total energy demand is 1.2 EJ higher compared to the Baseline, whereas in the High ambition scenario, it is 1 EJ lower. The majority of the emissions impact arises from changes in energy demand, with the most significant reductions or increases occurring in the energy sector.

Figure 6 Impacts on sectoral emission, 2023 - 2050



In addition to energy efficiency, emissions are also affected by technology substitution. In the transport sector, the EU sees 275,000 more electric cars compared to the Baseline in the High ambition scenario, while in the Low ambition scenario, there are 177,000 fewer electric cars.

7. Conclusions

In this study, we utilised the E3ME model to evaluate the economic and environmental impacts of different scenarios related to the allocation of revenues generated from the EU Emissions Trading System (ETS). Our analysis revealed that the level of ambition in spending these revenues significantly influences both GDP and employment outcomes across the EU. The contrasting scenarios—the High ambition scenario, where all ETS revenues are allocated to green investments, and the Low ambition scenario, where only the minimum required share is allocated—highlight the crucial role that policy decisions play in shaping the effectiveness of decarbonization efforts. Notably, the High ambition scenario showed a clear potential for greater investments in green technologies and energy efficiency, leading to notable reductions in emissions.

Regional disparities emerged from our findings, particularly in Eastern Europe, where the economic impacts of reallocating revenues to green policies were more pronounced. While the overall EU GDP effects remained modest, with the largest regional decline at -1% in Lithuania by 2050, employment outcomes indicated that the Low ambition scenario could result in significantly more jobs in the services sector. This emphasises the importance of context-specific policies, as regions with different economic structures may experience varying degrees of benefit from green investments.

However, our analysis is subject to limitations, including the use of a generic spending pattern that lacks country-specific insights, arbitrary restrictions on the uptake of green programs, and insufficient consideration of the global policy landscape. These limitations point to the need for further research to develop a more nuanced understanding of the potential for green investments in diverse national contexts and to assess the interplay between EU policies and global climate actions.

In conclusion, the findings underscore the significance of active state involvement and strategic allocation of ETS revenues in achieving the EU's decarbonization goals. Policymakers must consider the regional variations in economic impacts and adapt their strategies to maximise the effectiveness of climate initiatives. By addressing the limitations identified in this study, future research can contribute to more robust and informed policy frameworks that not only enhance environmental sustainability but also foster economic resilience across the EU.

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