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Impact on Households of the Inclusion of Transport and Residential Buildings in the EU ETS

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Key numbers

EUR 1 112 billion	potential carbon costs for EU27 households from transport and residential buildings in 2025-2040
EUR 373	potential annual carbon costs for EU27 per household from transport
EUR 429	potential annual carbon costs for EU27 per household from residential buildings
44%	average rise in energy spending for EU27 households in the 1st income quintile due to emission costs in transport
50%	average rise in energy spending for EU27 households in the 1st income quintile due to emission costs in residential buildings
4.3%	avg. emission cost from transport and residential buildings' share in income for households in the 1st quintile in the EU27 in 2025-2040
3%	avg. emission cost from transport's share in the income of a Spanish household in the 1st quintile
108%	increase in energy spending for a Polish household in the 1st quintile due to emission costs in residential buildings
2.5 times	higher emission costs for households in France with 174 EUR/t CO_2 prices in 2030, compared to the BASELINE scenario

Executive summary/Key findings

The findings in this paper result from the interpretation of modelling results, and through joint discussion between the authors, who shared their knowledge and experience relating to the subject. In this work, we describe the impact on EU households' budgets of applying carbon pricing to the transport and residential building sectors. We analyse different scenarios and, based on the results, suggest mitigating policies that can shield the poorest households that cannot afford to invest in new low-carbon technologies and solutions.

The ongoing discussion about the extension of ETS to transport and residential buildings raises questions about how the extension of carbon pricing is designed and its impact. While a number of options are being examined, the one that seems to be gaining traction is that of having a separate ETS system in these sectors, with prices between the current EU ETS and these sectoral ETS converging over time. This may be one way to address the issue of widely different abatement costs in the sectors currently covered and those being considered.

Introducing an ETS system in transport and residential buildings would result in significant benefits in terms of emission abatement effectiveness and feasibility. However, modelling exercises show that, **to achieve the required 40% reduction, it would be necessary to reach EUA prices of 170 EUR/t CO_2** (in 2015 prices). At the EU27 level, such high prices **would lead to an enormous cost for households – EUR 1112 billion in 2025-2040** – and have a potentially devastating impact on EU industry under the current EU ETS.

To keep CO_2 prices and costs for consumers at politically and socially acceptable levels, a **carbon pricing mechanism should be coupled with other complementary policies to tackle emissions in the road transport and building sectors.**

Higher prices would disproportionally affect poorer households as their price elasticity is lower[1]. Moreover, the upfront costs in emission abatement, which are usually high, are a barrier to switching to low-carbon technologies or implementing energy efficiency solutions. It is estimated that emission costs would impose **an average yearly cost increase in energy spending of 44% in transport and 50% in residential buildings for households in the first (poorest) income quintile.** These factors, together with the consideration that consumers lack the ability to plan long-term investments, may risk unduly penalising low-income households.

The poorest member states are more vulnerable to the impact of the extension of carbon pricing. Some of the Eastern European countries, which have a colder climate and use more heating, will face higher emission costs. As can be expected, countries with lower energy consumption are less resistant to energy price changes. It is therefore important for the former to provide strong incentives that redistribute resources, like the solidarity mechanism.

If carbon pricing is extended to road transport and buildings, our proposals are outlined below:

→ Offering revenue recycling schemes to assist vulnerable people. For residential buildings, this could be transfer payments,

[1] Their disposable income is lower, so the increase means a higher share of their total spend.

direct energy bill assistance or targeted energy efficiency programmes for the poorest households. In the transport sector, revenues can be recycled by providing consumer rebates for low-carbon and electric vehicles and tax breaks for lower-income households to offset the increase in fuel prices due to carbon pricing.

- → Implementing new and enhancing current energy efficiency and renewable energy policies, as well as legislation specifically targeting the building and the transport sectors, which has the potential to accelerate the deployment of renewable energy solutions and lower energy demand, thus putting downward pressure on equilibrium EUA prices.
- → Maintaining and strengthening EU tools, like the solidarity mechanism that redistributes resources in favour of poorer member states. With this, **it should be required that 100% of the revenues generated by solidarity allowances should be spent on energy and climate purpose.**
- → **Increasing the Modernisation Fund and Innovation Fund to mitigate the impact of the ETS extension in those member states where the transition is more challenging,** as well to help bringing to the market breakthrough clean technologies in transport and buildings sectors. To ensure the fair and efficient redistribution of resources, the allocation of funds should also take into account countries' actual investment needs and relative capabilities, as well as the national level of GDP per capita.

Introduction

In its Communication entitled *Stepping up Europe's 2030 climate ambition* (EC, 2020) published in September 2020, the European Commission (EC) confirmed the intention to include road transport and buildings in the Emission Trading System, previously suggested in the European Green Deal. As emphasised by the EC, covering all emissions from fossil fuel combustion by the EU ETS (Emission Trading System) would result in significant benefits in terms of effectiveness and feasibility. The EC pointed out that "already now, the EU ETS directly or indirectly covers around 30% of buildings' emissions from heating. This is related to the system's coverage of district heating and due to electric heating". Only a minor part of transport – electric vehicles, which account for 1% of road transport – indirectly falls under the scope of the EU ETS.

The Rationale of carbon pricing extension

The EC's rationale for proposing to extend carbon pricing to these two sectors is based on three main considerations:

- → The slow pace of decarbonisation in transport and buildings
- → The efficiency gains of a larger carbon market with a single price
- → The need to ensure ETS liquidity as the CAP gets tighter

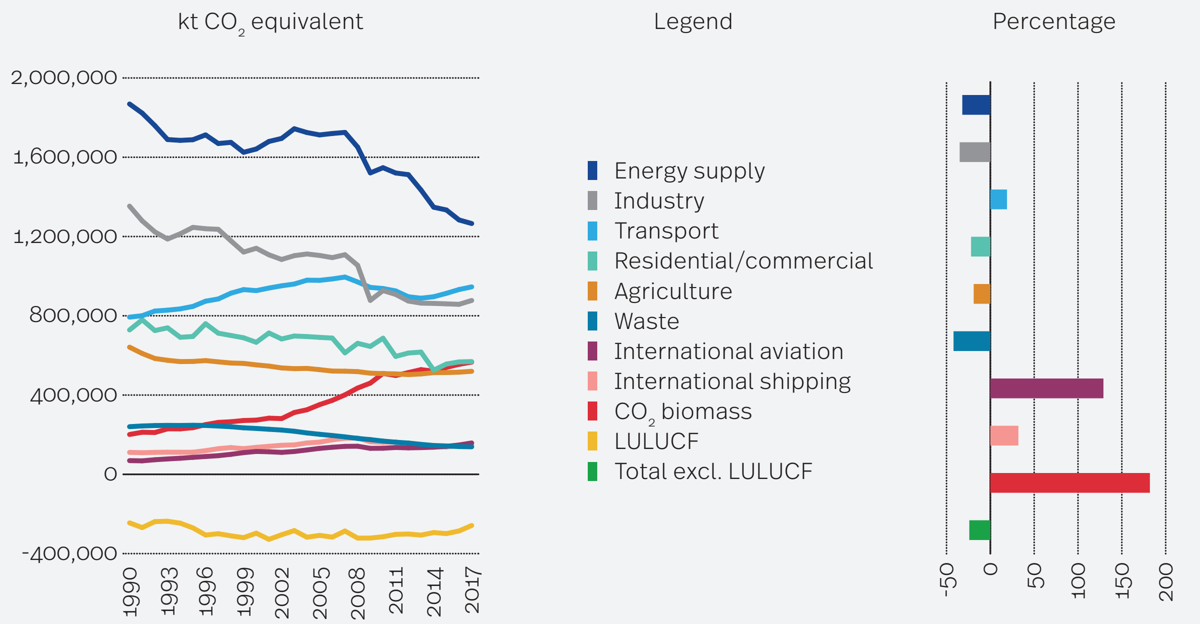
First, the proposal to apply carbon pricing to these two sectors stems from the acknowledgment that both transport and buildings have a relatively poor track record of reducing emissions. The building sector accounts for around 40% of the EU energy consumption and is responsible for 36% of the Bloc's GHG emissions. Energy efficiency improvements are too slow, with just 1% of building stock in the EU renovated every year and 75% of buildings beeing energy inefficient. In the road transport sector, emissions are 23% higher than in 1990, with a recent upward trend. Both sectors are therefore far from aligned with the trajectory towards zero emissions. If their decarbonisation proceeds at its current pace, other sectors of the economy will have to bear the bulk of the abatement efforts to achieve the 2030 emissions reduction target of 55%. Current ETS sectors, especially industry, are also more exposed to international competition than transport and buildings, which constitutes another strong incentive to design new and more effective policy incentives to speed up decarbonisation in these sectors and ensure more effective burden sharing across the EU.

The ETS has proved an effective tool for reducing emissions, with sectors covered by the ETS reducing their emissions faster than those outside it. Additionally, the CAP ensures certainty in delivering an environmental outcome and revenues can be recycled into the economy to smooth potential distributional issues connected to the transition, as well as to accelerate the uptake of clean technologies.

Secondly, a cap-and-trade system increases the efficiency of a determined emissions reduction pathway and allows a specific abatement target to be achieved at the lowest cost by equalising marginal abatement costs across sources of GHG emissions. Moreover, extending carbon pricing to other sectors would contribute to levelling the playing field across EU member states and economic sectors, reducing the potential for sectoral and geographical distortions (CERRE, 2021). The ETS is technology neutral and does not involve the risk of picking and choosing winning technologies. Rather, it allows the cheapest abatement option to prevail.

Thirdly, an extension of the ETS could also be functional when it comes to addressing a challenge that the EU ETS is likely to faces in the medium to long term. In fact, as the decarbonisation of the EU economy proceeds and the ETS CAP is tightened, the EU carbon market will inevitably shrink, potentially creating some liquidity issues. Against this backdrop, the addition of new sectors could also be a way to ensure that the ETS has sufficient liquidity in coming decades (Marcu et al., 2021).

↘ Chart 1. **Greenhouse gas emissions by aggregated sector**



Source: prepared by PEI based on EEA.

Structure of the study

This study aims to provide a starting point for a discussion on the impact of the ETS extension on households, especially the poorest ones. For this, we evaluate the potential costs of introducing an ETS mechanism in the transport and residential building sectors, based on different scenarios. We use two approaches. The first makes use of an exogenous EUA price, drawn from three different scenarios, to evaluate the potential costs of the extension. In the second approach, on the contrary, the price is calculated endogenously within the model as the ETS price needed to deliver the desired emissions reduction (-40%) in the transport and building sectors, in line with an overall 62% target for the whole ETS. We compare the emission abatement obtained and the related CO_2 prices.

We focus on the EU27 households with the lowest income and we carry out three country case studies: Poland, France and Spain. In the second approach, we consider different scenarios for ETS extension: carbon-tax equivalent, inclusion in the existing ETS and policy-mix application. With this, we consider its impact on emissions reduction and its socio-economic implications. In our recommendations, we focus on protecting the poorest households and the countries with the lowest GDP. We recommend a policy mechanism that partially removes the burden from households and contributes to emission abatement the most.

The article has the following structure: in the first chapter, we provide an overview of the possible options for extending the ETS. In the second chapter, we present our assumptions and calculate the ETS extension costs for households in the EU27, Poland, France and Spain. In the third chapter, we present the results of the analysis performed using the macroeconometric model, E3ME, widely used for impact assessment by the European Commission. In the next chapter, we focus on how to mitigate the impact on households of extending the ETS to buildings and road transport.

1. Options of the extensions

There are four main decisive points in the formation of the EU-wide model of carbon pricing for transport and buildings. The first point is the choice between ETS or carbon tax, the second is the scope of both sectors, the third the market level (targets) of intervention and the fourth is the relation to the current EU ETS. Based on the literature review, there seems to be one main scenario being discussed.

Of the two basic carbon pricing mechanisms – emission trading system and carbon tax – the EC seems to reject the possibility of subjecting either of the two sectors to a carbon tax at the EU level. The carbon tax, which imposes a fixed charge per unit of emissions, offers system participants predictability but provides no information on the rate or scale of reduction over a specific period. Instead, the EU ETS[2] was chosen not only for its established position in the EU, but also because it offers relative predictability concerning the volume of emission reductions, despite the uncertainty about future emission allowance prices.

A significant issue when it comes to including the transport and buildings in the ETS mechanism is the definition of specific sub-sectors. Transport primarily comprises road, rail, aviation and maritime transport. Road transport accounts for more than 71% of emissions, whereas aviation and maritime transport represent 14% and 13% respectively. As aviation is already in the process of being included in the EU ETS and maritime transport is still a more efficient form of transport (but also considered for different options as part of one of the carbon pricing mechanisms), the EC's focus is on passenger cars, which are responsible for the majority (60%) of emissions from road transport.[3] Buildings account for 36% of total emissions in the EU (EC, 2019). Of that, residential buildings represent 70%, with the rest coming from commercial and institutional buildings (Eurostat, 2020). As in the case of transport, the EC's focus seems to be on the biggest and slowest-improving sector; that is, residential buildings.

Another necessary decision is determining the market level for the system operation. There are three levels comprising different groups of entities: *upstream* – producers of transport fuels (including electricity) and suppliers of energy for buildings; *midstream* – car manufacturers (no such option in the case of buildings); *downstream* – owners or users of vehicles and buildings (Jarno, 2016). Choosing between these solutions involves choosing between the cost of the system (administration),[4] rising as the number of administered entities increases, and the strength of the market signal conveyed, which is greater the more direct the influence on the final consumer. Based on the Impact Assessment Report and other pieces of literature, the upstream approach seems to be the clear favourite.

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[2] For installations covered, the system sets up a cap on emissions and the initial distribution of emission allowances allocated or available for purchase at a price. Entities covered by the system can decide on their further business strategies, e.g. investing in low-carbon technologies or buying an additional number of allowances. These activities are subject to market rules.

[3] The remaining emission sources are as follows: (a) delivery vans up to 3.5 tonnes, (b) lorries and buses, (c) motorcycles and other vehicles used for road transport.

[4] Monitoring, reporting and verification (MRV) are substantially higher in the downstream approach.

↘ **Table 1. Basic ETS scenario alternatives to the "no extension" scenario**

Source	European Commission IAR (2021) (also Bruegel and PIK (2021))	European Commission IAR (2021)	Cambridge Econometrics (2020)	Cambridge Econometrics (2020)	Agora Energiewende (2021)	Agora Energiewende (2021)
Name of the scenario and relation to the EU ETS	Separate RB&RT ETS. Ref. Scen. 1	Separate ETS for all emissions from the combustion of fossil fuels not covered by the EU ETS. Ref. Scen. 2	Direct inclusion of B&T in the EU ETS. Ref. Scen. 3	Separate ETS with price equal to the EU ETS. Ref. Scen. 4	Extending the EU ETS to B&RT fuels. Ref. Scen. 5	Separate ETS for building heat and/or road transport a Ref. Scen. 6
Subsectors	Residential buildings and road transport	Residential buildings, road transport, small non-EU ETS industries, fossil fuel use in agriculture, forestry, off-road machinery, non-electric railway and military sector	Not defined	Not defined	Not defined	Not defined
Market level	upstream	upstream	Not defined	Not defined	Not defined	Not defined
Year of implementation	2025 Separate until at least 2030	2025 Separate until at least 2030	2020	2020	2025	2025 and possible merger with the EU ETS after 2030

Source: prepared by PEI based on European Comission, Bruegel&PIK, Cambridge Econometrics, Agora Energiewende.

Lastly, it is crucial to define the relationship between the existing EU ETS and the system for the new sectors. One option might be the direct inclusion of transport and buildings in the EU ETS (an approach challenged by the report in *Cambridge Econometrics* in 2020). Another option, which is currently more prominent (Bruegel, Agora), is to establish a separate ETS for the two sectors, which could be integrated into the EU ETS after the prices in the two systems converge.

In the current debate on the possible introduction of carbon pricing in the EU transport and building sectors, there are currently six basic alternatives to non-action (see Table 1). These options were presented in three reports: the EC's IAR, *Cambridge Econometrics* and Agora & Ecologic. Behind each of these basic options, there are different sets of assumptions and different sub-options, yet options 1, 4 and 6 seem similar enough to assume that the future process will entail the creation of a separate ETS for these two sectors from 2025, with the possible option of extension after 2030. An additional paper by Bruegel set out the mechanisms that would enable the newly-created ETS and the existing EU ETS to be smoothly aligned.

Among the economic issues, consideration must be given to consumers' reduced ability to plan long-term investments (underinvestment by businesses due to risk concerns; possible short-termism of individual consumers when it comes to investing in buildings or cars; tenants' lack of influence over the choice of heating system).

These problems create a third kind of problem, of a political nature. A failing EU ETS can be harmful for a range of stakeholders, which creates an implementation risk that politicians are not willing to take. Again, this boils down to potentially high carbon prices in the new sectors (described below), as industries face international competitiveness issues and uncertainty due to carbon price volatility, and end users are potentially forced to bear the "transferred" cost of these high carbon prices.

2. Scenario-based analysis

The following sections present the assumptions and impact on households' budgets of expanding the ETS system to transport and residential buildings. The calculations are based on existing data and a series of assumptions about future carbon prices trajectories. In the next chapter, a different methodology is used to shed light on the subject from two different angles. Here, we do not focus on the macroeconomic consequences, but rather on the financial impact on households in the various scenarios in our country case studies.

2.1. Methodology

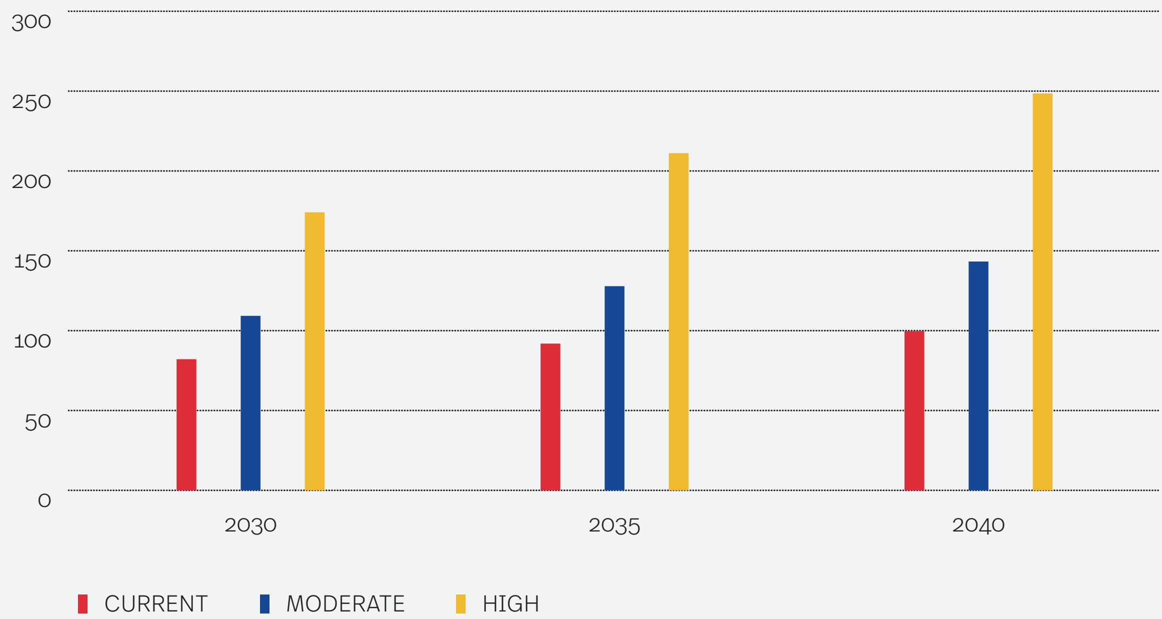
We calculated the cost of expanding the ETS system for three countries (Poland, France and Spain), as well as for the EU27. These countries vary in their emission intensity, the share of heating in heat energy consumption and household income. We present the following calculations: the cumulative costs for households in 2025–2040, the annual average costs per household for particular sectors and the CO_2 price path, followed by a comparison of these costs with total household spending on energy and income.

Explanation of EUA prices assumptions

The calculations are based on four carbon pricing scenarios for 2025-2040. The initial 2020 value for each scenario is EUR 23 per tonne of CO_2 based on the Cambridge Econometrics model. The prices for the years 2030 and 2040 (in 2015 prices) were applied as follows:

- BASELINE – the price corresponds to the current ETS levels; in 2030 – EUR 55 per tonne of CO_2, in 2040 – EUR 60 per tonne of CO_2
- CURRENT– the carbon price as estimated by CAKE/KOBIZE until 2030 to meet the target of a 55% reduction in CO_2 emissions (CAKE, 2020); extrapolation until 2040; in 2030 – EUR 80 per tonne of CO_2, in 2040 – EUR 100 per tonne of CO_2
- MODERATE – based on estimates from the *2021 State of the EU ETS Report* (Marcu et al., 2021); in 2030 – EUR 109 per tonne of CO_2, in 2040 – EUR 143 per tonne of CO_2
- HIGH – the carbon price in 2030 comes from the Cambridge Econometrics model (E3ME). The hypothetical EUA price needed to decarbonise transport and buildings in a new EU-wide ETS; prices until 2040 estimated using the same econometric approach as in previous scenarios.

↘ Chart 2. Assumed carbon pricing paths (in EUR/t CO_2)



Source: prepared by PEI based on PEI calculations, estimates by CAKE/KOBIZE and ERCST, Wegener Center, BloombergNEF and Ecoact (2020), and Cambridge Econometrics (2021).

Methodology for transport

In the case of the road transport sector, CO_2 emission costs can be determined on the basis of data concerning total fuel consumption (in ton of oil equivalent per year by engine type) or annual distance driven by fuel type (petrol, diesel) and the emission intensity of the fuels consumed (i.e. road transport emissions per km).

The annual carbon price for the EU27 was calculated using the following formula:

$$cost\_CO_2 = \sum_t vehicle\_km_t \cdot emiss\_int_t \cdot price\_CO_2$$

where:

$cost\_CO_2$ – denotes the total (yearly) cost of the carbon price for emissions from transport in a given year (for passenger cars)

$vehicle\_km_t$ – the distance driven by passenger cars running on fuel (technology) *t* (petrol, diesel, LPG, CNG, hybrid)

$emiss\_int_t$ – the average road transport emission for technology *t* (by fuel)

$price\_CO_2$ – the carbon price per tonne of carbon dioxide according to the paths assumed.

To calculate the emission costs, it is necessary to use data on transport performance[5] and the average emission intensity of vehicles for the fuels used to determine the total road transport emissions during a year. Those emissions would be subject to a carbon price that depends on the functioning of the emission trading system.

The modelling of carbon pricing for emissions from transport, in a scenario in which the ETS covers the sector, includes the following assumptions:

- the rate of growth in transport activity (passenger-km or vehicle-km) for particular types of vehicles (by fuel used)
- the degree of the phase-out of vehicles with internal combustion engines (ICEs) by fuel consumed (varying rates for ICE cars that run on petrol and diesel)
- the rate of road transport electrification (passenger cars)
- improvement in the emission intensity of fleet vehicles.

Methodology for residential buildings

The inclusion of residential buildings in the ETS would involve introducing carbon prices on:

- space heating
- hot water heating
- cooking.

When modelling carbon prices for emissions from residential buildings covered by the ETS, the assumptions are as follows:

- the energy consumption of households in the EU27 (for the purposes listed above)
- exogenously assumed improvement in the energy efficiency of buildings
- improvement in the emission intensity of the energy mix used by households.

The annual carbon (CO_2 emissions) cost for the EU27 was calculated using the following formula:

$$cost\_CO_2 = energy\_use \cdot emis\_int \cdot price\_CO_2$$

where:

cost_CO$_2$ – denotes the total (yearly) cost of the carbon price for emissions from residential buildings in a given year for the EU27

energy_use – energy consumption by households in ton of oil equivalent in the EU27

emis_int – the average emission intensity of energy consumed by households in the EU27

price_CO$_2$ – the carbon price per tonne of carbon dioxide according to the paths assumed.

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[5] Vehicle-km, the number of kilometres driven per year by all passenger cars.

Costs for households

In our calculations of the costs for household of extending the ETS, we only included households that contribute to CO_2 emissions. In the transport sector, those are households that use ICE and PHEV cars. For residential buildings, this is the cumulative number of households that use a fossil-fuel heating system. As a result, in transport sector, households that use electric vehicles are excluded from the cost calculation. For residential buildings, households' emissions from electricity used for heat consumption are already included in EU ETS system and are paid by power plants.

2.2. Scenarios

The calculations are based on data from several sources. The main data for the transport sector comes from the JRC IDEES database (Integrated Database of the European Energy Sector) (IDEES). The database contains time series on historical activity in the transport sector in 2000-2015. The transport activity covers the EU27 and is disaggregated for individual EU countries.

Activity is expressed in the number of kilometres travelled by passenger vehicles and differentiated by fuel type: petrol, diesel, LPG, CNG, hybrid, and electric cars.

- → The average mileage for passenger cars was taken from the IDEES database.
- → The emissions data for the transport and residential sectors comes from the European Energy Agency (EEA).
- → Households income, spending on energy (electricity, gas and other fuels), final energy consumption, population projections and GDP growth were taken from the Eurostat and OECD databases.

The data for 2020 was extrapolated based on historical time series using simple regression models.

Based on anticipated CO_2 prices paths, the pace of the phase-out of ICE passenger cars was estimated. To satisfy the demand for transport related to GDP growth and the decrease in ICE activity, the deployment of electric cars was modelled (Chart 3). Electric cars' attractiveness for consumers is related to the CO_2 costs for ICE cars and varies between different countries. In our scenarios, improvements in energy efficiency and emission intensity were assumed until 2040. From 2020, newly-registered cars in the EU should meet the target of 95 g CO_2/km (Regulation No. 443/2009, 2009; Regulation 2019/631, 2019). Countries' emission intensities were adjusted based on this target and the withdrawal rate of ICE cars. Based on transport activity, emission intensity and CO_2 prices paths, the costs of ETS for the transport sector were calculated.

The scenarios for passenger cars analysed assume annual average activity growth of 0.7% in the EU27. Transport activity depends on the increase in the number of households and GDP growth, and varies between countries. The electrification of passenger transport could reduce emissions by approx. 22% in 2030 compared to 2005 in the BASELINE scenario and from 24% to 30% in analytical scenarios (Table 2). The reduction scenarios presented could be achieved by phasing out ICE cars and replacing them with low-carbon vehicles (electric and hybrid cars). Assuming that ICE vehicles fuelled by diesel are replaced with low-carbon technologies 1.5 times faster than

ICE vehicles fuelled by petrol, the fleet will be structured like in Chart 3.

Our calculations for the energy demand in residential buildings includes heat for space heating, water heating and cooking. Space heating accounts for 75% of the final energy demand in residential buildings in the EU27. Energy efficiency in residential buildings is expected to improve significantly, reducing energy demand. Pursuant to Directive 2018/2002 on energy efficiency, EU member states are obliged to achieve new annual savings of 0.8% of final energy consumption throughout the period from 2021 to 2040. Emission intensity improvements arise from buildings' thermo-modernisation and changes in the energy mix. This translates into an emission reduction of 37% in 2005-2030 against 2005 in the BASELINE scenario and from 40% to 47% in analytical scenarios (Table 2). Like in the transport sector, energy intensity improvements in the residential sector were adjusted to CO_2 price paths (Chart 4). Consumers' elasticity to CO_2 price changes is assumed to be 50% higher than in the transport sector. The calculation of CO_2 emission costs is related to energy demand and emission intensity.

EU27

In the BASELINE scenario, total emissions (in the transport and residential building sectors) decrease by 29% from 851 Mt CO_2 in 2005 to 516 Mt CO_2 in 2030. In the analytical scenarios, the percentage reduction in emissions over this period ranges from -32% (CURRENT scenario) to -38% (HIGH scenario).

↘ **Table 2. Summary of scenarios for EU27**

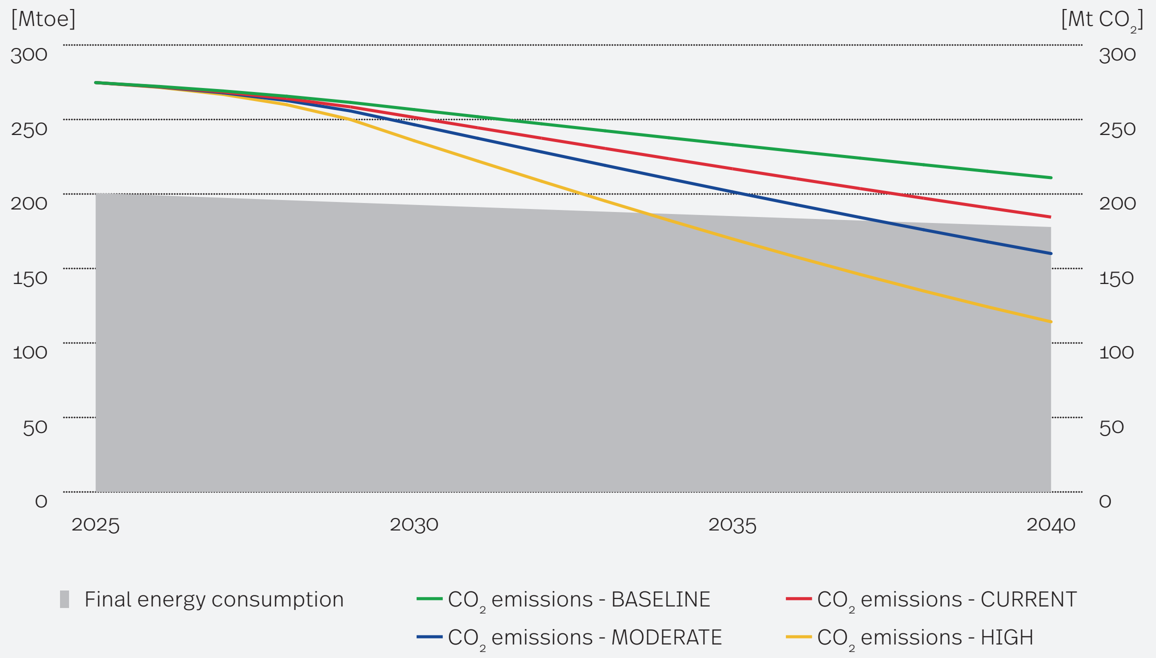
Scenario	Transport	Residential	Total
	CO_2 reduction in 2030 (%)	CO_2 reduction in 2030 (%)	CO_2 emissions Mt in 2040 (%)
BASELINE	-23	-37	481
CURRENT	-24	-38	427
MODERATE	-25	-40	377
HIGH	-28	-42	281

Source: prepared by PEI.

↘ Chart 3. Fleet structure by technology in the EU27 (%)

Source: prepared by PEI.

Chart 4. Final energy consumption and emission decrease in residential buildings in the EU27



Source: prepared by PEI.

2.3. Analysis of the cost for households

EU27

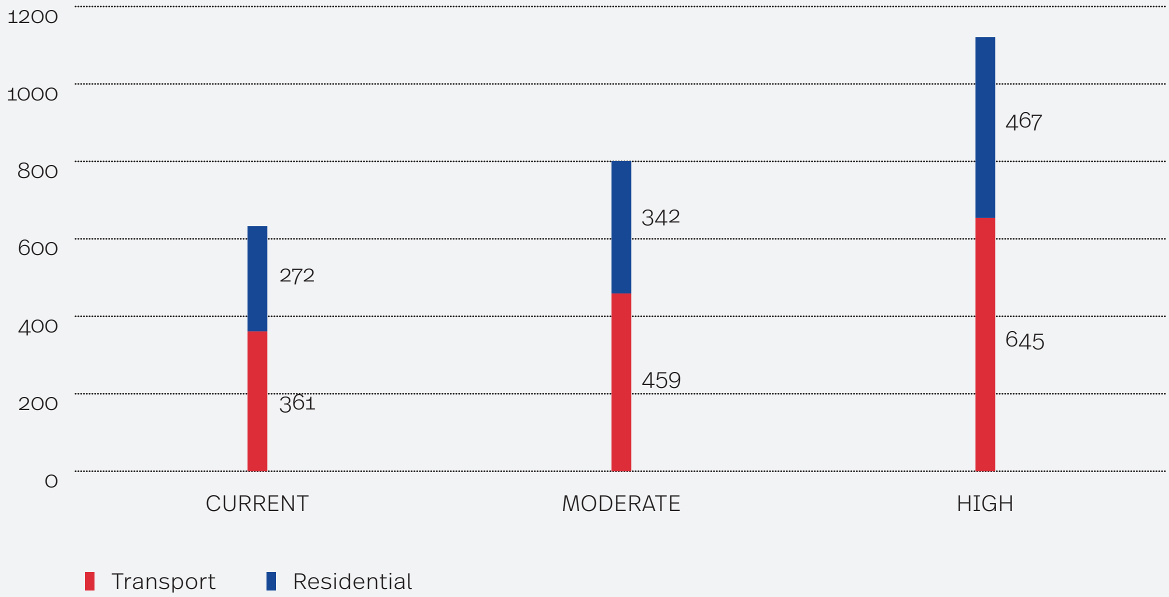
In the analytical scenarios for the carbon pricing paths in road transport and residential buildings, the costs for households range from approx. EUR 600 billion to approx. EUR 1112 billion in 2025–2040 in the EU27. In the CURRENT scenario, the total cost is 40% higher than in the BASELINE one. In the MODERATE one, it is around 80% higher, and almost two-and-half-times higher in the HIGH scenario.

In the transport and residential building sectors, emission costs relate to households that use fossil-fuel-powered cars and heating systems. In the scenario calculations, the emission costs per household are obtained based on the number of households that contribute to emissions. According to the PEI's assumptions about the rate of phasing out ICE cars and the electrification rate, the percentage of households that will contribute to CO_2 emissions varies from 93% in 2030 to 85% in 2040 in the BASELINE scenario. In the HIGH scenario, this is in the 87-54% range.

In the CURRENT scenario, the average cost from the transport sector remains the same in 2030-2040; around EUR 150. In the MODERATE scenario, the mean cost of using ICE cars increases by 10% over the same period. The highest increase in the cost for households can be observed in the HIGH scenario – around 20% in 2030-2040 (up to EUR 373). In this case, the CO_2

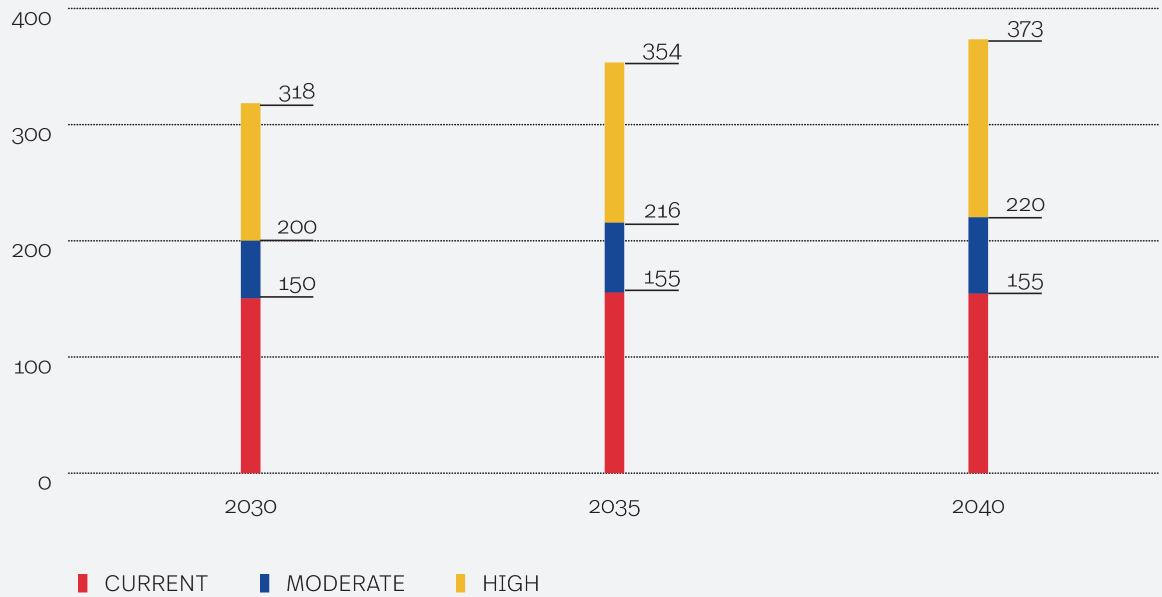
price increases by 50% while ICE activity decreases by 50% and emission intensity drops by approx. 16%. Higher CO_2 price growth does not translate proportionally to the use of electric vehicles.

Chart 5. Costs of charges for CO_2 emissions (carbon prices) from transport and residential buildings for all households in the EU27 in 2025–2040 (in EUR billion, 2015 prices)



Source: prepared by PEI.

Chart 6. Annual average CO_2 emission cost from transport per household using an ICE vehicle in the EU27 (in EUR, 2015 prices)

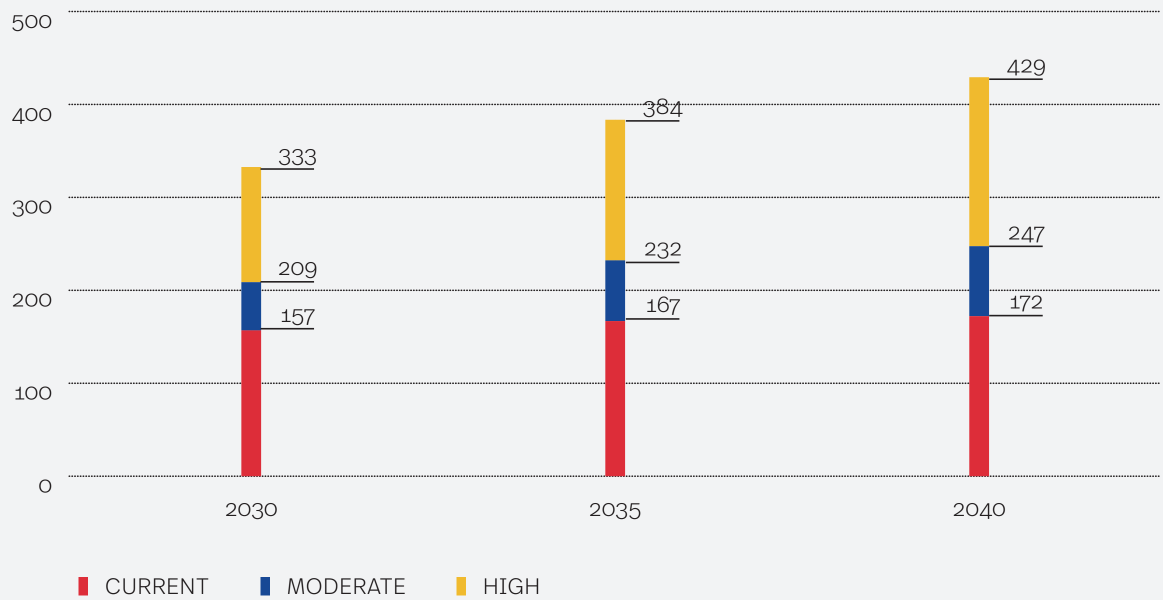


Source: prepared by PEI.

In the case of heating (space heating, water heating and cooking) consumption in residential buildings, households may be charged the related emission costs when purchasing fossil fuels. According to the assumed increase in the energy efficiency of buildings and reduced energy usage, demand will decrease until 2040. In 2020, around 69% of households account for the emissions from residential buildings in the EU27. In the HIGH scenario, this share will have decreased two-fold by 2040.

In 2030-2040, the average cost for households that contribute to CO_2 emissions increases slightly from around EUR 160 to EUR 170. In the MODERATE scenario, this growth is faster: around 20% over the same time period, from EUR 210 to EUR 250. The highest increase in cost (by 30% - up to EUR 429) is in the last scenario. In our calculations, improvement in emission intensity corresponds to a decrease in the number of households that use fossil fuels in their heating systems.

↘ Chart 7. **Annual average CO_2 emissions cost (carbon prices) from residential buildings per household using fossil fuels for heating and cooling in the EU27 (in EUR, 2015 prices)**



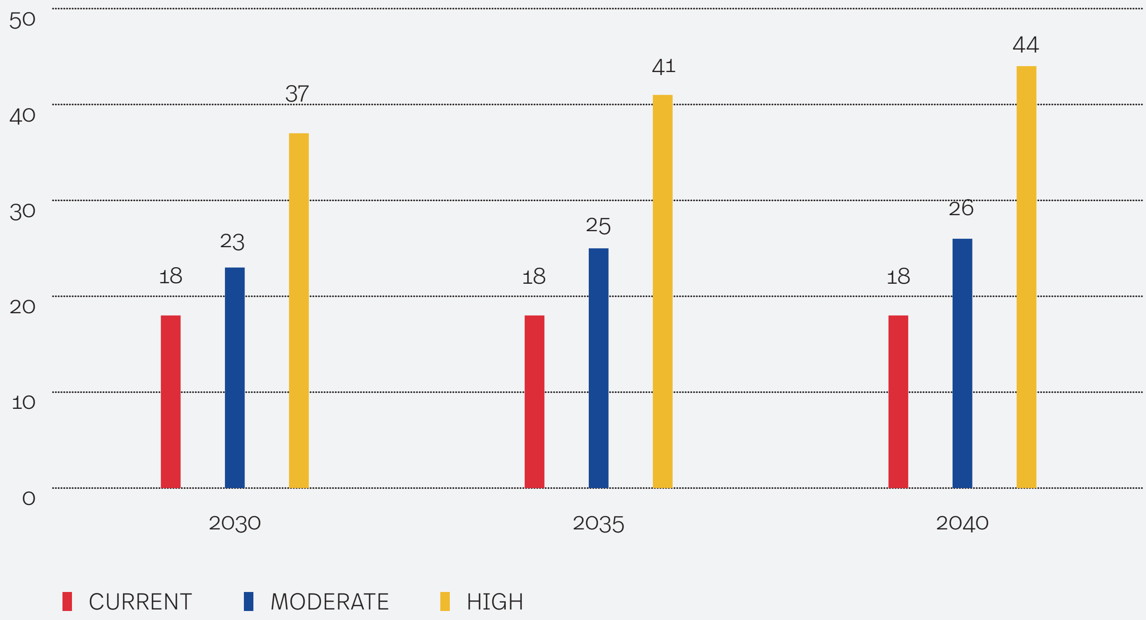
Source: prepared by PEI.

In 2020, on average, households in the EU spent 5.9% of their total spending on energy (electricity, gas and other fuels). In the first quintile (the 20% households with the lowest income), this was 7.2%.

In the CURRENT and MODERATE scenarios, additional spending on electricity, gas and other fuels due to emission costs from transport will rise to around 20-25% for first quintile in 2030-2040. This results from the similar level of CO_2 prices. In the HIGH scenario, it adds an additional 44% in 2040 to their energy expenses.

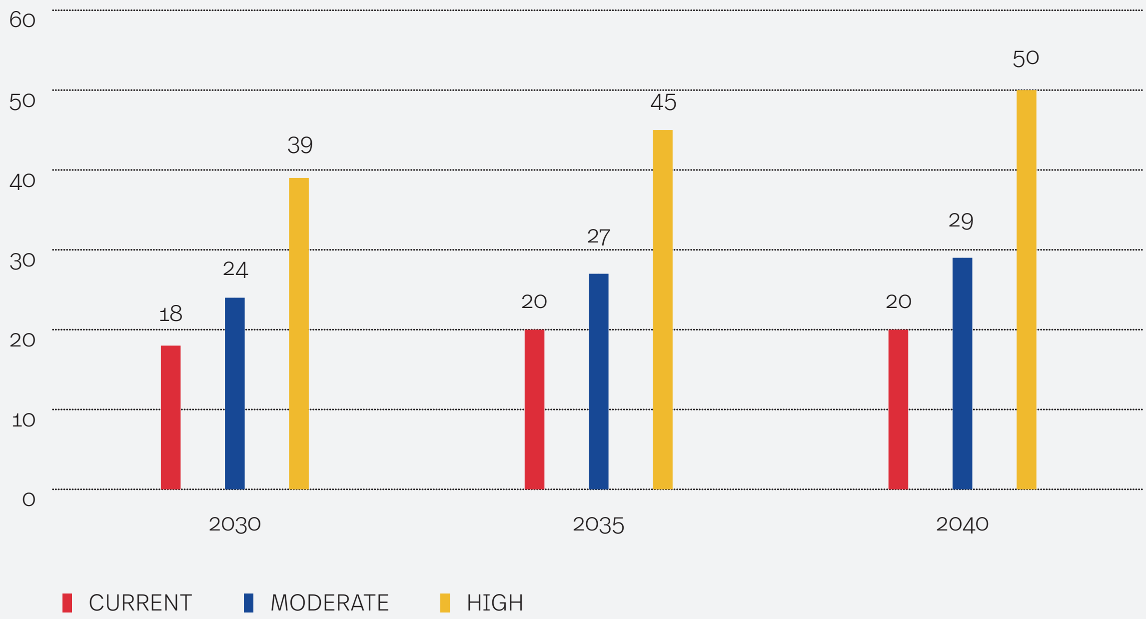
In the residential building sector, the increase in household spending on energy carriers will be similar to that in the transport sector in the CURRENT and MODERATE scenarios. In the HIGH scenario, the spending on heating will rise by 11 percentage points in 2030-2040 which will result in 50% additional spending on electricity, gas and other fuels due to residential emissions.

↘ Chart 8. Additional spending on electricity, gas and other fuels due to transport emission costs for households in the first income quintile (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

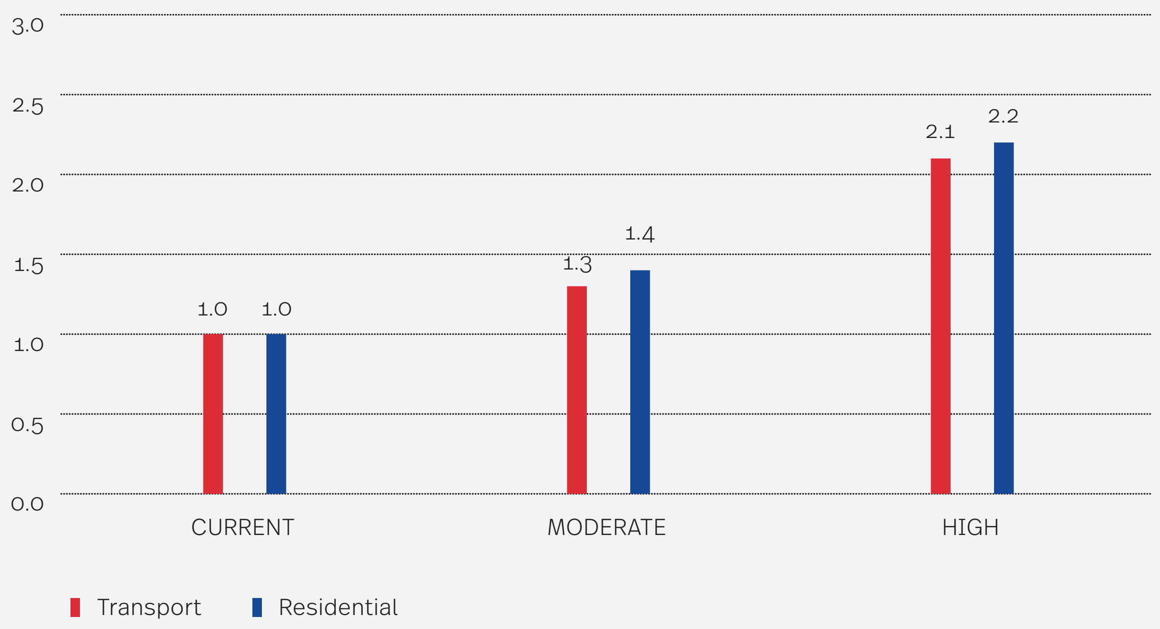
↘ Chart 9. Additional spending on electricity, gas and other fuels due to residential buildings emission costs for households in the first income quintile (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

The cost of CO_2 for households in the first quantile compared to their income is around 1% in the CURRENT and MODERATE scenarios and two times higher in the HIGH scenario. The average annual household income in the first quintile was nearly EUR 12,000 in 2020. Added shares of transport and residential average emission costs in first quintile households reach 4.3% in HIGH scenario.

↘ Chart 10. **Average emission costs in 2025-2040 compared to household income in the first quintile (%)**



Source: prepared by PEI based on PEI analyses and Eurostat data.

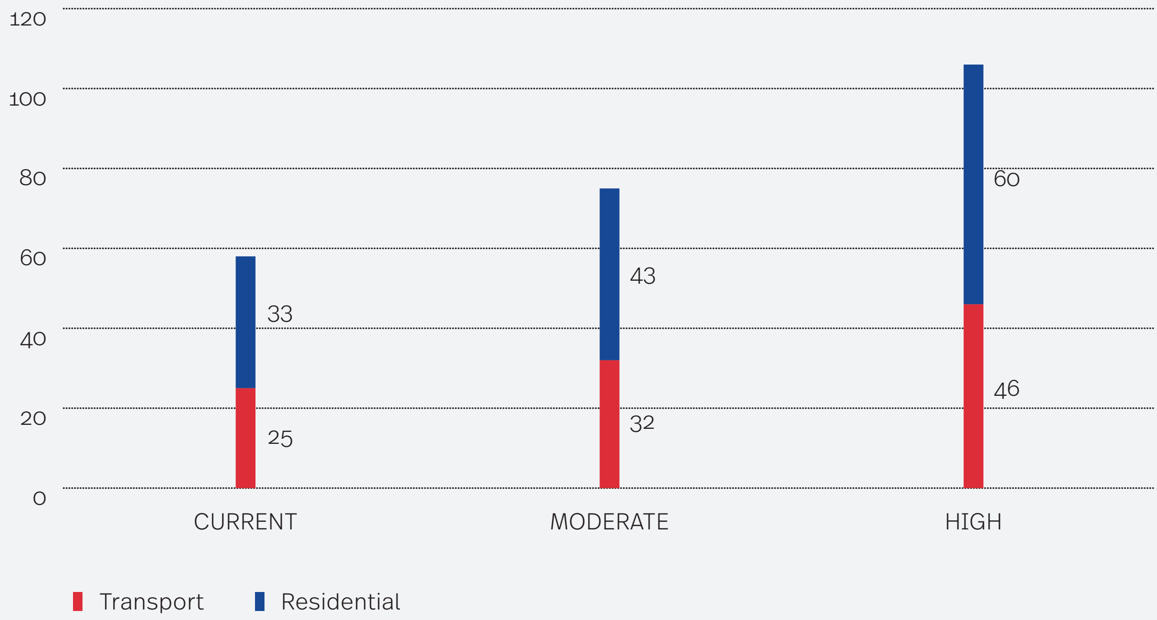
Poland

In Poland, in all of the analytical scenarios for the carbon pricing paths in transport and residential buildings, the costs for households compared to the BASELINE scenario is higher than in the EU27. In the MODERATE scenario for Poland, the total cost is 84% higher than in the BASELINE scenario, while in the HIGH scenario it is 163% higher. The share of residential building emission costs is 57% of the total costs in Poland. This is approx. 15 percentage points higher than in the EU27.

According to the PEI's assumptions on the rate of ICE car phase-out and electrification rate, the percentage of households that will contribute to CO_2 emissions ranges from 91% to 85% in the BASELINE. The range in the HIGH scenario is much broader: from 87% in 2030 to 61% in 2040.

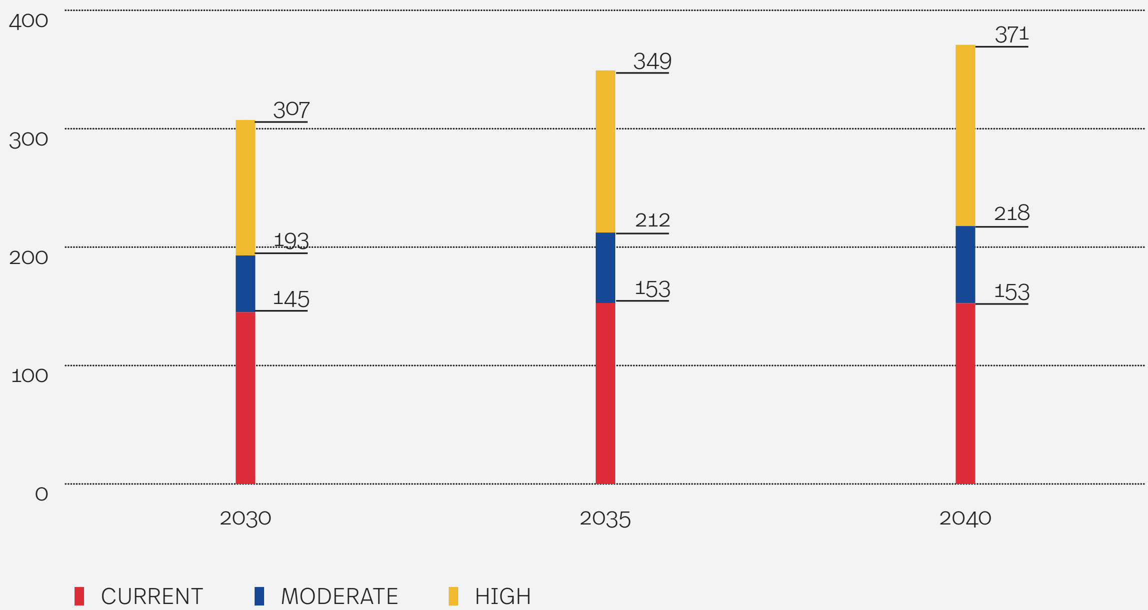
In the CURRENT scenario, the average cost from the transport sector remains fairly stable, rising by just 6% in 2030-2040. It rises by 13% in the MODERATE scenario and by 20% in the HIGH scenario over the same period.

↘ Chart 11. Cost of charges on CO_2 emissions (carbon prices) from transport and residential buildings for all households in Poland in 2025–2040 (in EUR billion, 2015 prices)



Source: prepared by PEI.

↘ Chart 12. Annual average CO_2 emissions cost (carbon prices) from transport per household using an ICE vehicle in Poland (in EUR, 2015 prices)



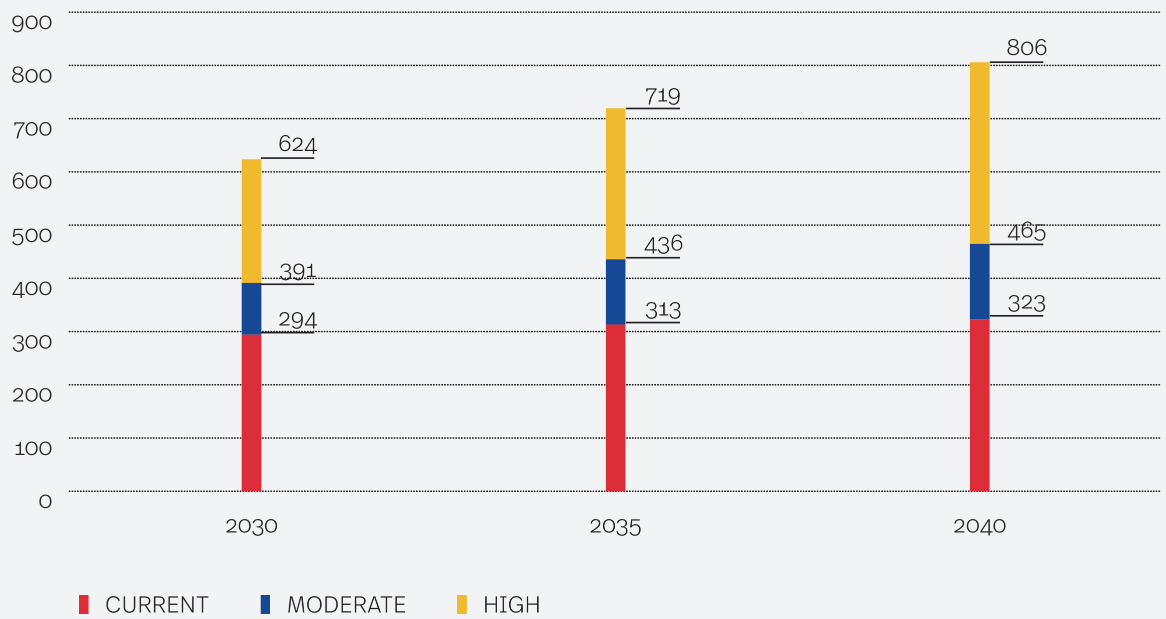
Source: prepared by PEI.

In the case of residential buildings in Poland, around 62% of households accounted for emissions in 2020. In the CURRENT scenario, this share decreases to 51% in 2040 and to 36% in the HIGH scenario.

Average costs for households that contribute to CO_2 emissions are fairly stable also in the CURRENT scenario, with an increase from EUR 294 in 2030 to EUR 323 in 2040. The highest cost increase (29%) is observed in the HIGH scenario, where average CO_2 emissions costs rise from EUR 624 in 2030 to EUR 806 in 2040.

In 2020, the average share of energy spending in total household spending was 10.5%. In the first income quintile, it was 11.7%.

Chart 13. Annual average CO_2 emissions cost (carbon prices) for residential buildings per household in Poland (in EUR, 2015 prices)



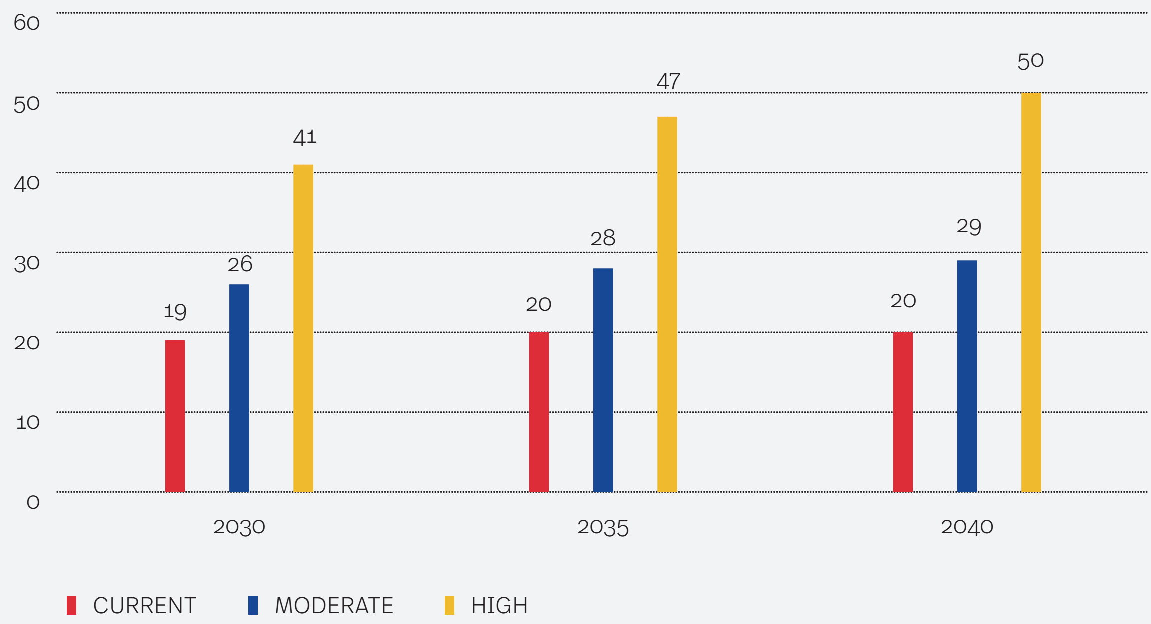
Source: prepared by PEI based on PEI analyses and Eurostat data.

In the CURRENT and MODERATE scenarios, spending on electricity, gas and other fuels due to emission costs from transport will rise by 20% to 29% in the first income quantile. In the HIGH scenario, the average cost of emissions in 2040 will be around 50% higher.

For residential buildings, the increase in household spending on energy carriers in 2040 for consumers in the first quintile ranges from 43% in the CURRENT scenario to 108% in the HIGH scenario. This increase is more than twice that in the EU27 (50% in 2040 in the HIGH scenario).

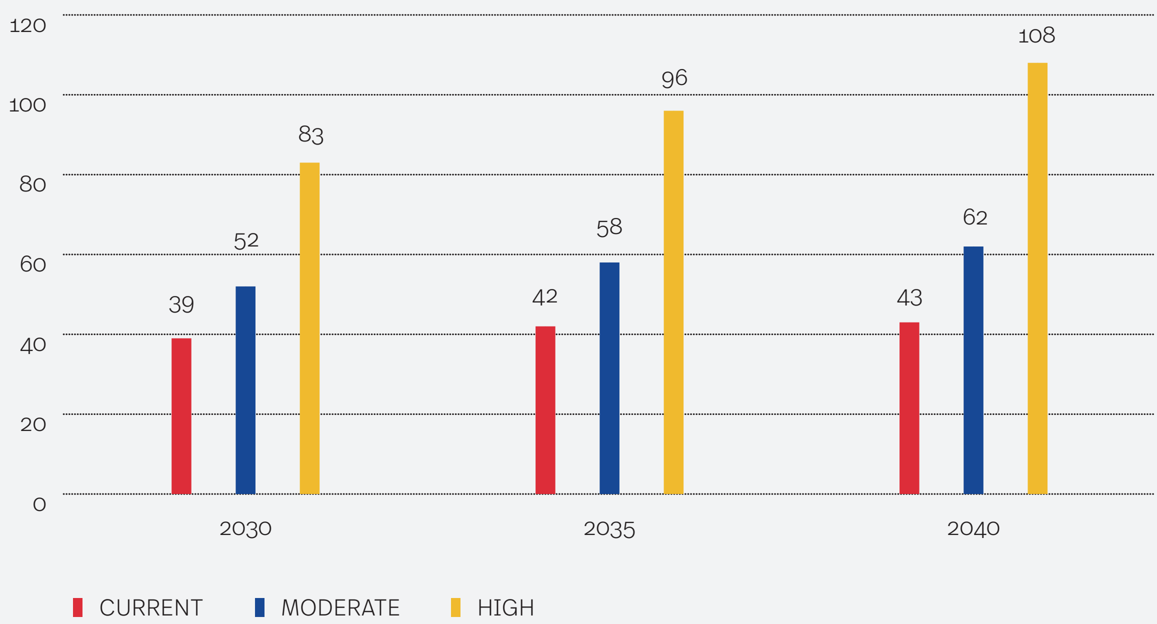
For both sectors, the cost of CO_2 for households in the first quantile, relative to their income, is two-times higher in the HIGH scenario than in the CURRENT scenarios. This is the result of two factors: high emissions and the low income of the first quintile of Polish households (EUR 5000, 57% lower than the EU27 average).

↘ Chart 14. Additional spending on electricity, gas and other fuels due to transport emission costs for households in the first income quintile - Poland (%)



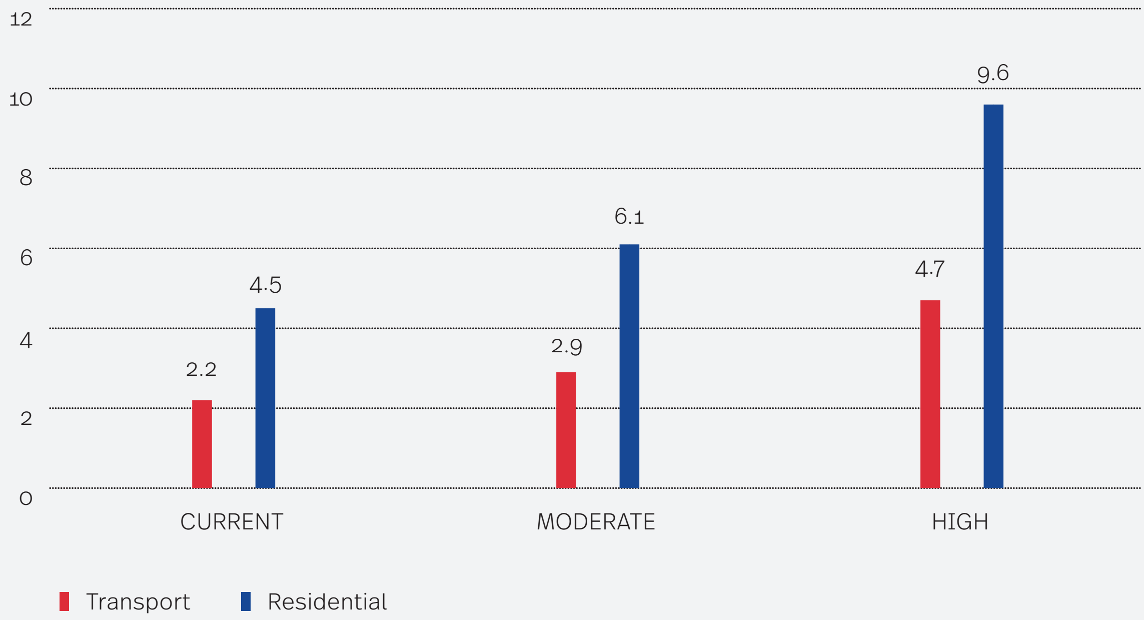
Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 15. Additional spending on electricity, gas and other fuels due to residential buildings emission costs for households in the first income quintile - Poland (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 16. Average emission costs in 2025-2040 compared to household income in the first quintile - Poland (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

France

In the case of France, in the CURRENT and MODERATE scenarios for transport and residential buildings, the increase in costs for households compared to the BASELINE scenario is at the same level as in the EU27. In the HIGH scenario, this cost is 2.5 times higher than in the BASELINE one. Residential building emission costs account for about 43% of total costs (the same level as in the EU27).

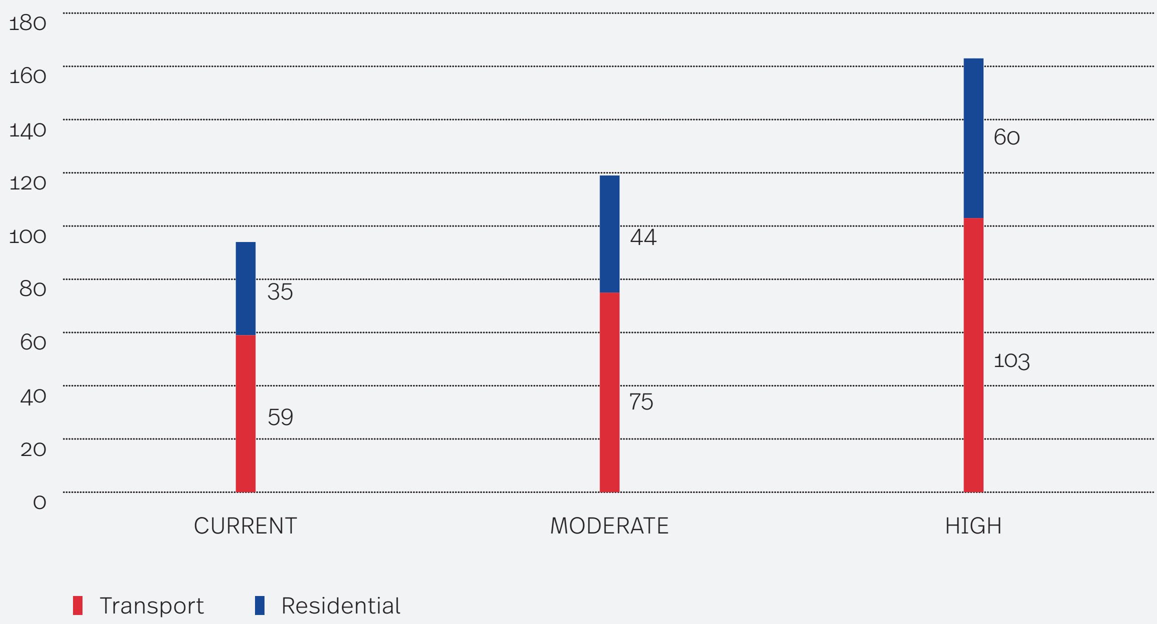
In the CURRENT scenario, the average cost from the transport sector remains at the same level in 2030-2040, about EUR 100 (nearly EUR 50 lower than in the EU27). In the MODERATE scenario, the mean emission cost from using ICE cars increases by 20% over the same period. The highest growth in the cost for households is observed in the HIGH scenario – around 25% in 2030-2040.

In France, 61% of households used “emitting energy carries” for heating in 2020. In 2030-2040, the average cost for households that contribute to CO_2 emissions is at the same level in the CURRENT scenario, about EUR 150-160. In the MODERATE scenario, this grows by around 20% over the same time period. The highest increase in cost (30%) is in the last scenario.

In the CURRENT scenario, spending on electricity, gas and other fuels due to emission costs from transport will rise about 20% in 2030-2040. In the MODERATE scenarios, this is 30%. This results from the similar level of CO_2 prices. In the HIGH scenario, the cost varies from 40% to 50% of energy expenses in 2030-2040.

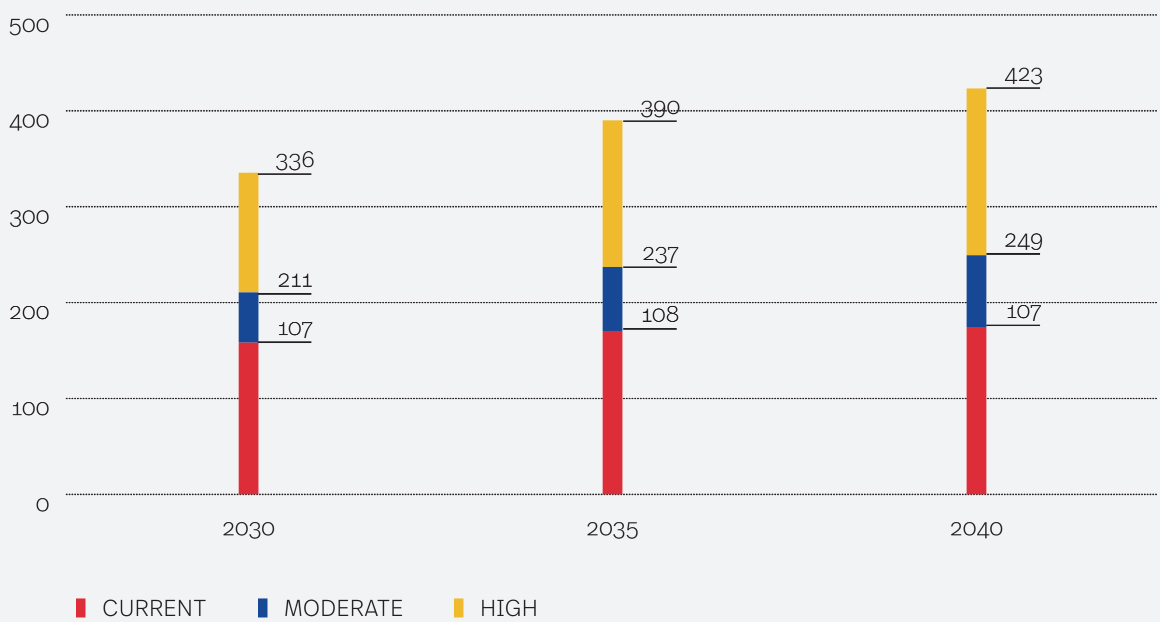
In the residential building sector, growth in spending on electricity, gas and other fuels is at the same level as in transport sector.

Chart 17. Cost of charges on CO_2 emissions (carbon prices) from transport and residential buildings for all households in France in 2025–2040 (in EUR billion, 2015 prices)



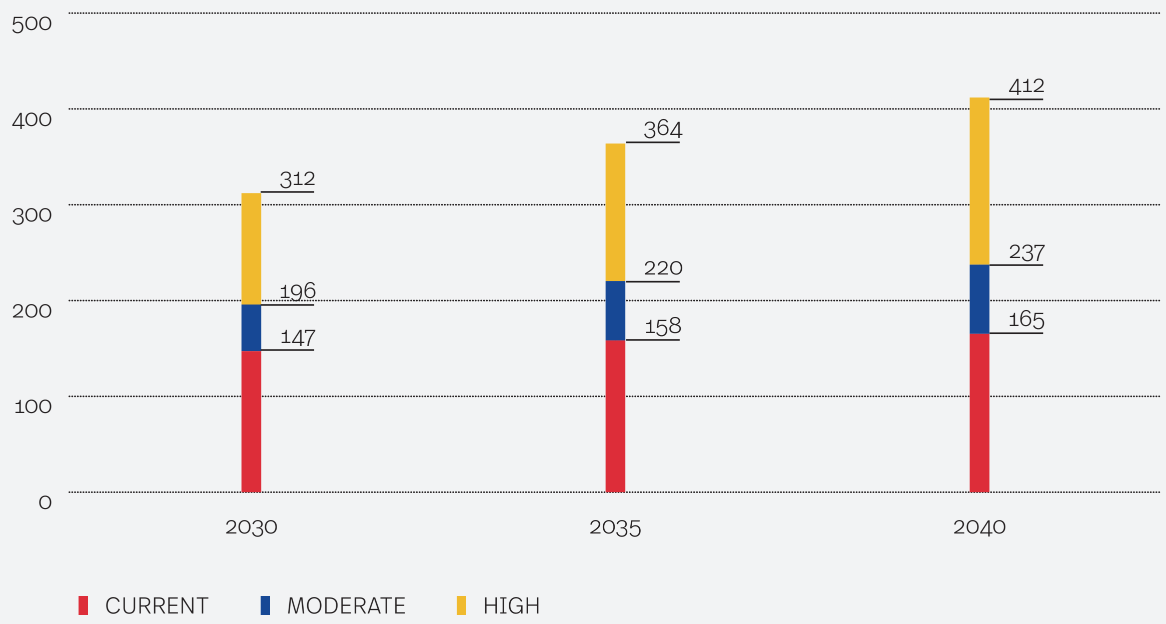
Source: prepared by PEI based on PEI analyses and Eurostat data.

Chart 18. Annual average CO_2 emissions cost (carbon prices) from transport per household in France using an ICE vehicle (in EUR, 2015 prices)



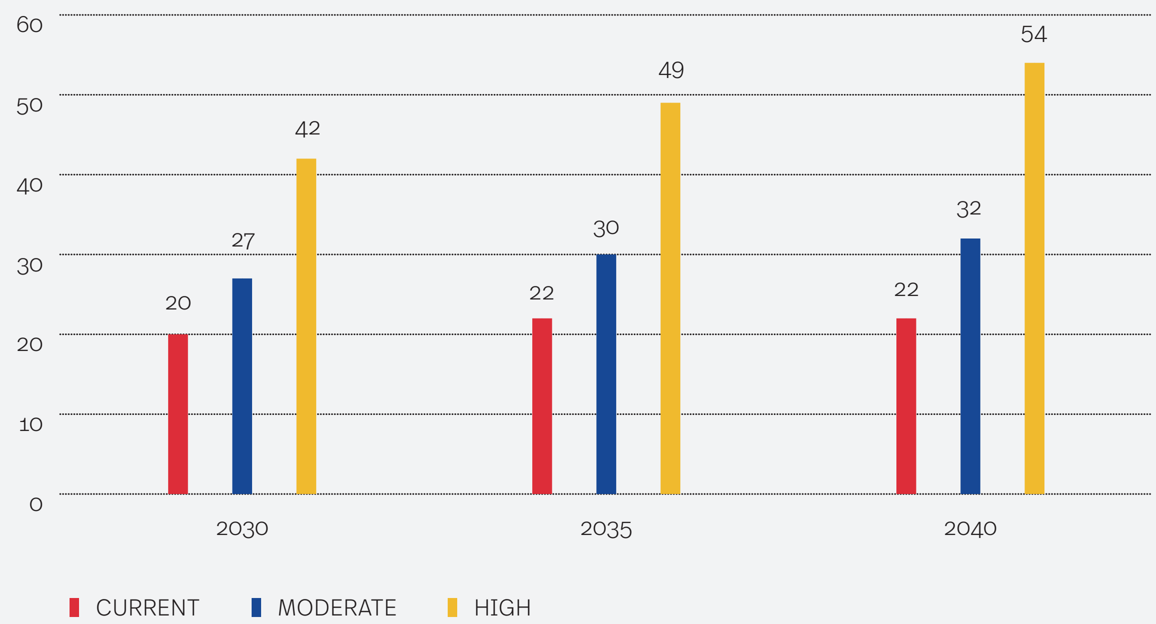
Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 19. Annual average CO_2 emissions cost (carbon prices) in residential per household in France (in EUR, 2015 prices)



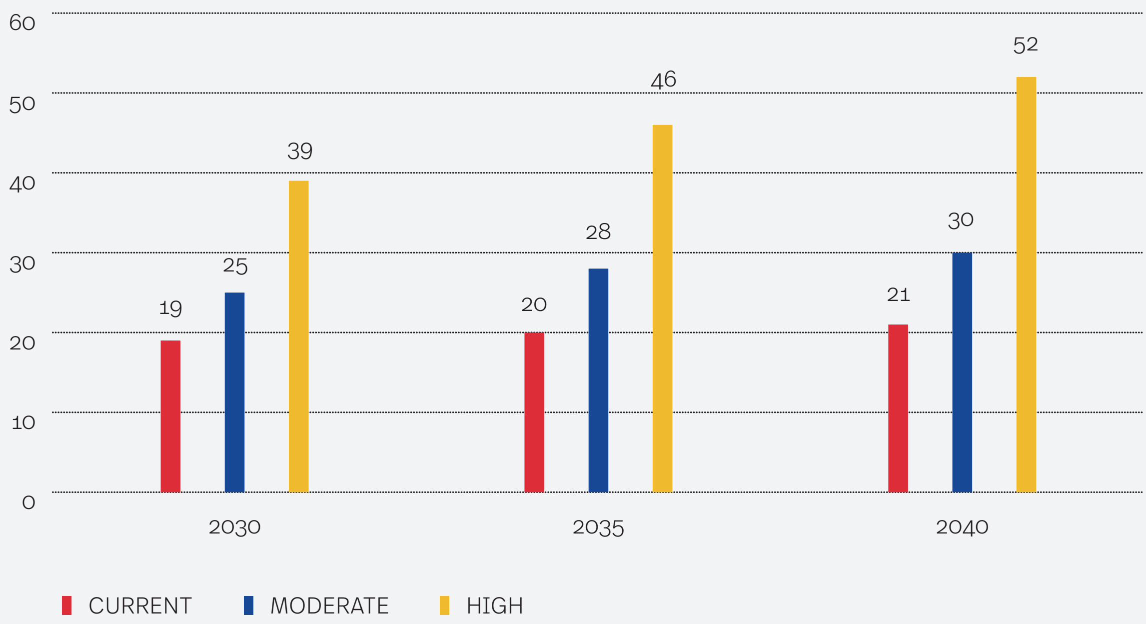
Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 20. Additional spending on electricity, gas and other fuels due to transport emission costs for households in the first income quintile - France (%)



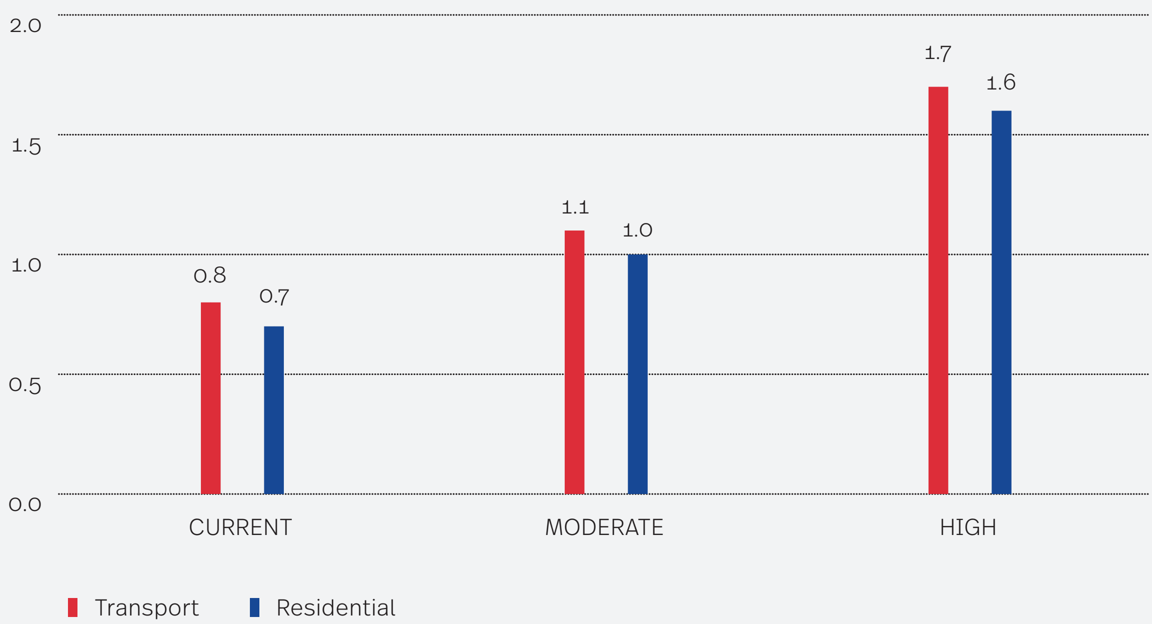
Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 21. Additional spending on electricity, gas and other fuels due to residential buildings emission costs for households in the first income quintile - France (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 22. Average emission costs in 2025-2040 compared to household income in the first quintile - France (%)



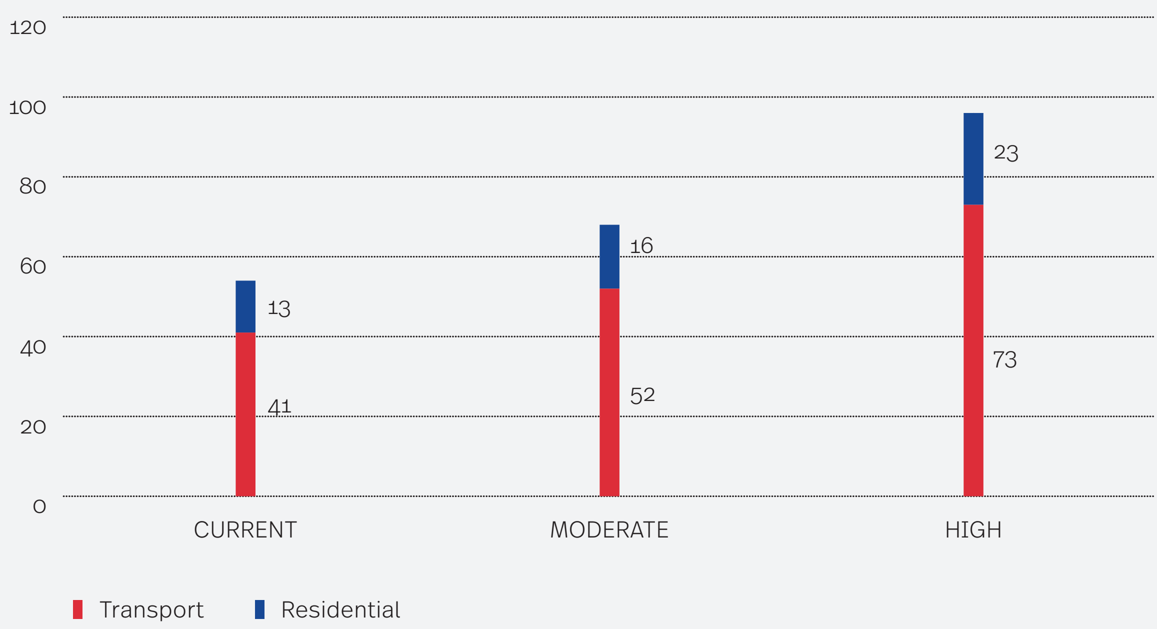
Source: prepared by PEI based on PEI analyses and Eurostat data.

The cost of CO_2 for households compared to their income is below the EU27 average in all analytical scenarios. Average household income in the first quintile was nearly EUR 15,000 in 2020.

Spain

Residential building emission costs account for 24% of total emission costs in 2025-2040. In the HIGH scenario, the total costs of CO_2 is 2.5 times higher than in the BASELINE scenario.

↘ Chart 23. **Costs of charges on CO_2 emissions (carbon prices) from transport and residential buildings for all households in Spain in 2025–2040 (in EUR billion, 2015 prices)**



Source: prepared by PEI based on PEI analyses and Eurostat data.

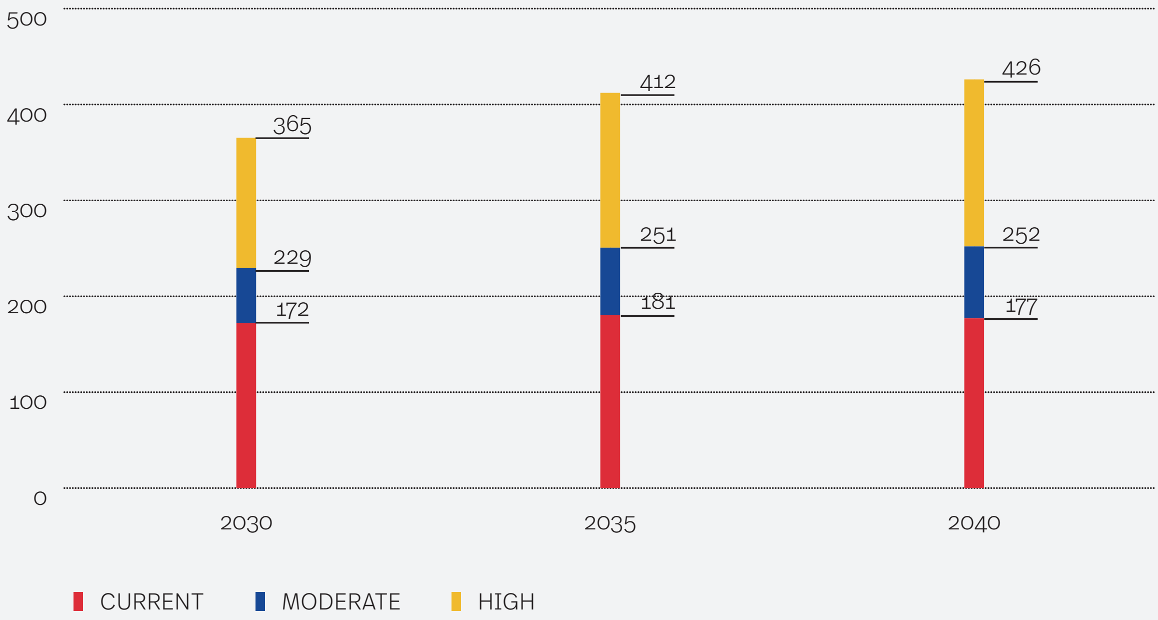
In the CURRENT scenario, the average cost from the transport sector remains at the same level in 2030-2040, about EUR 180. In the MODERATE and HIGH scenarios mean cost from using ICE cars increases by 10-15% in 2035-2040 compared to 2030.

In the CURRENT and MODERATE scenarios, the increase in households' emission costs from heating is at the same level as for using ICE cars. In the HIGH scenario, the emissions cost from using ICE cars is 30% higher in 2040 than in 2030.

In Spain, emission costs from transport amount to 20% of spending on electricity, gas and other fuels in the CURRENT scenario, 31-34% in the MODERATE one and approx. 55% in the HIGH scenario in 2030-2040.

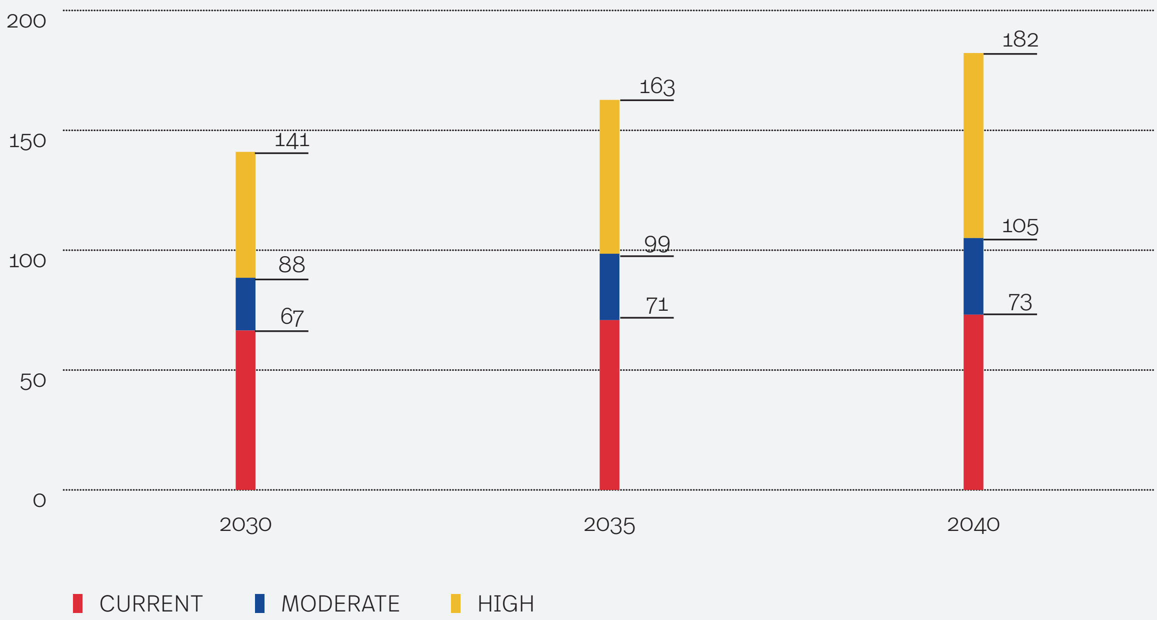
Energy consumption per household for heating purposes is half that in the EU27 which is lower than in the other cases analysed. The costs from residential buildings are more than two times lower than in the transport sector.

↘ Chart 24. Annual average CO_2 emissions cost (carbon prices) from transport per household using an ICE vehicle in Spain (in EUR, 2015 prices)



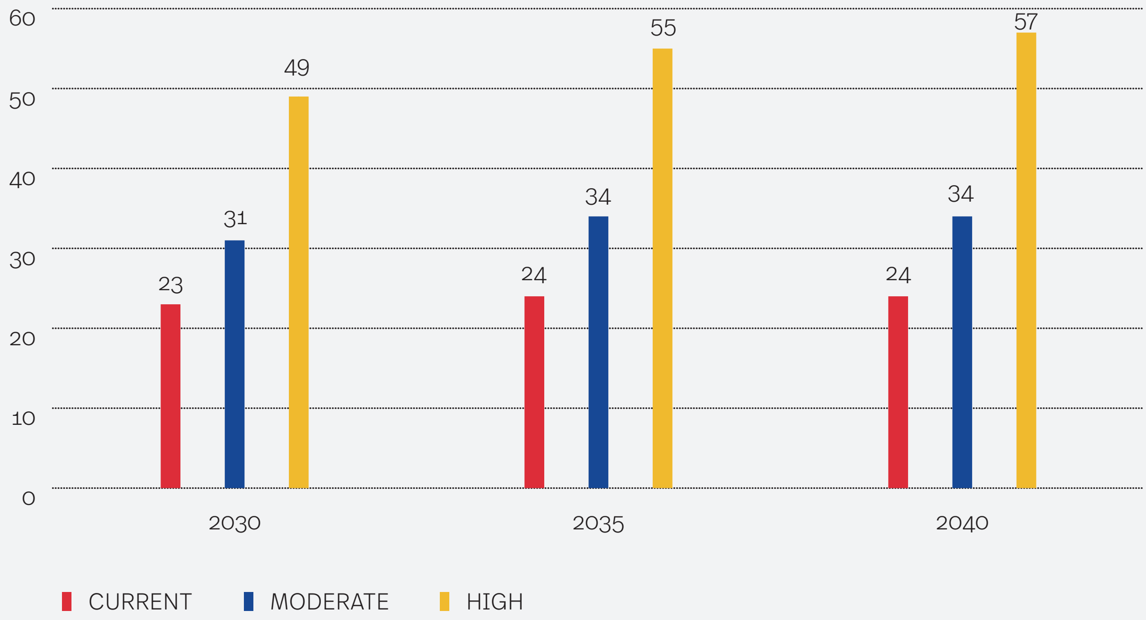
Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 25. Annual average CO_2 emissions cost (carbon prices) in residential per household in Spain (in EUR, 2015 prices)



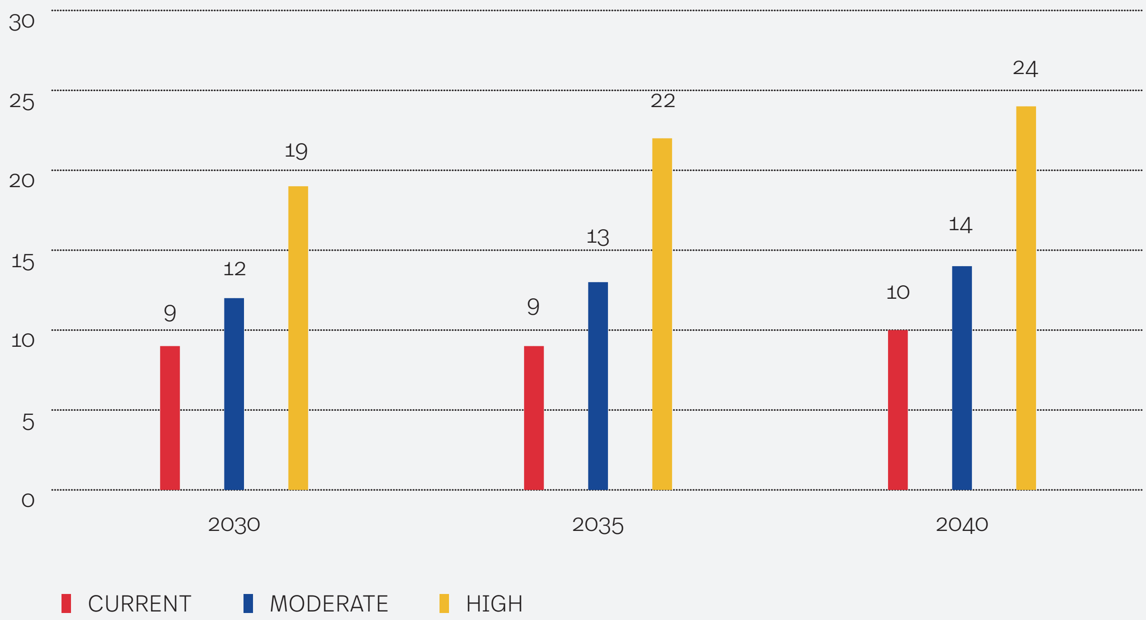
Source: prepared by PEI based on PEI analyses and Eurostat data.

↘ Chart 26. Additional spending on electricity, gas and other fuels due to transport emission costs for households in the first income quintile - Spain (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

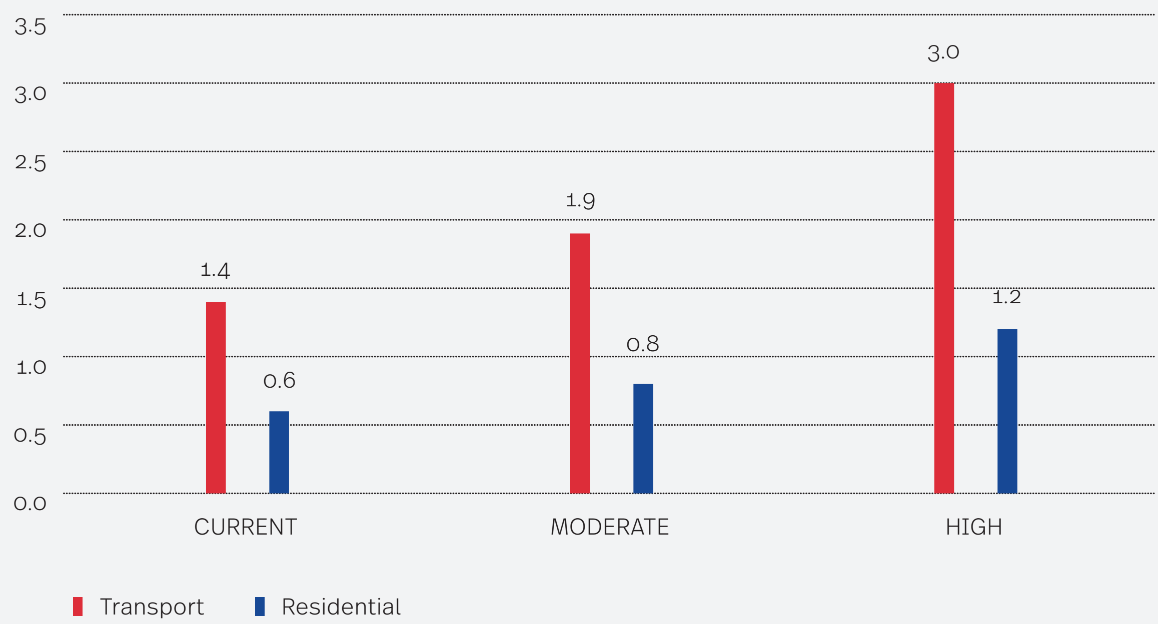
↘ Chart 27. Additional spending on electricity, gas and other fuels due to residential buildings emission costs for households in the first income quintile - Spain (%)



Source: prepared by PEI based on PEI analyses and Eurostat data.

The CO_2 cost for households compared to their income varies from 1.4% to 3.0% for transport, depending on the scenario. For residential buildings, this share is much lower, ranging from 0.6% in the CURRENT scenario to 1.2% in the HIGH one. The average household income in the first quintile was EUR 9200 in 2020.

Chart 28. **Average emission costs in 2025-2040 compared to household's income in the first quintile - Spain (%)**



Source: prepared by PEI based on PEI analyses and Eurostat data.

3. Macroeconomic implications

Unlike the previous one, this chapter is based on scenario-based analysis performed using Cambridge Econometrics macro-econometric model E3ME, which is widely used for impact assessment by the European Commission. A different approach to the methodology and scope of calculations offers complementary results.

We designed multiple scenarios to achieve the target emission reductions in the road transport and building heating sectors. These scenarios were then compared in terms of their macroeconomic implications (the effects on economic output and employment and the distributional impact) and environmental outcomes (GHG emissions).

This chapter is structured as follows: first, the scenarios are presented. After that, the analytical approach is discussed. Finally, we present our conclusions based on the scenario comparisons, with recommendations on which climate policy tools for the two sectors could achieve the desired emissions reductions with minimal distributional distortions and the largest possible economic implications.

3.1. Scenario design

↘ Table 3. Scenario design

Scenario 1	Scenario 2	Scenario 3	Scenario 4
Carbon tax equivalent to the baseline ETS price is applied to transport and buildings	Transport and buildings are included in an extended ETS	Policy mix applied to ensure emission reduction target is met	Parallel ETS is established for transport and buildings

Source: prepared by PEI based on Stenning, Bui, Pavelka (2020); Fazekas et al. (2021).

In the first scenario modelled, a carbon tax equivalent to the baseline ETS price is applied in the transport and building sectors: this makes technologies with high emission factors, namely those using fossil fuels, more expensive, therefore creating more incentives for consumers to switch to low-carbon technologies, further reducing emissions in these sectors.

The second scenario assumes that transport and buildings are included in the extended ETS, along with the current ETS sectors.

In the third scenario, policy measures are introduced into the two sectors to deliver the required emission reduction in each year leading up to 2030, without the introduction of an ETS or carbon price in these sectors.

In the fourth scenario, a single/parallel ETS is introduced to achieve the 40% emission reduction compared to 2005 in the non-ETS sectors by 2030. The price is introduced in 2025[6] and set equal to the ETS price that year (from the E3ME model). The model then calculates the prices required to meet the emission reduction target in each of the following years.

[6] Effectively as a carbon tax in the E3ME model.

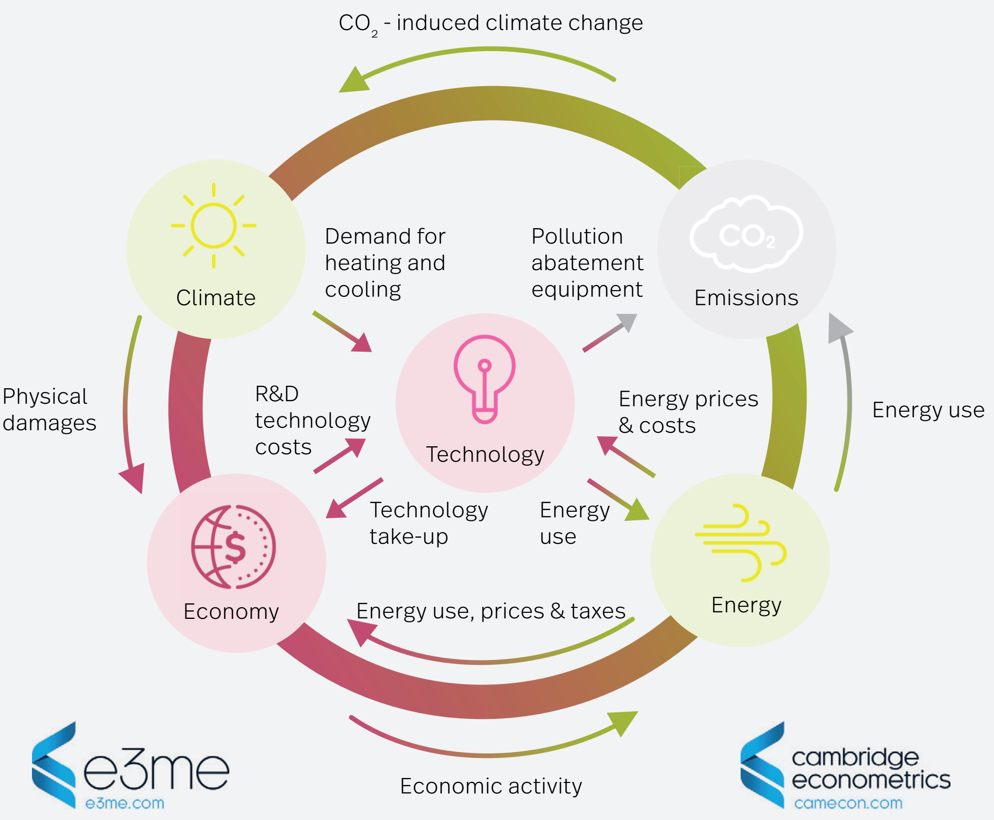
3.2. Analytical approach

E3ME is a computer-based model of the world's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe and beyond for policy assessment, forecasting and research purposes.

E3ME as an E3 model

Figure 1 shows how the three components (modules) of the model – energy, the environment and the economy – fit together. The economy module provides measures of economic activity and general price levels for the energy module; the energy module provides measures of emissions of the main air pollutants for the environment module, which can provide measures of damage to health and buildings. The energy module provides detailed price levels for the energy carriers distinguished in the economy module and the overall price of energy, as well as energy use in the economy.

↘ Figure 1. E3 linkages in the E3ME model



Source: Cambridge Econometrics, e3me.com.

Technological progress plays an important role in the E3ME model, affecting all three Es: the economy, energy and the environment. The model's endogenous technical progress indicators (TPIs), a function of R&D and gross investment, appear in nine of E3ME's econometric equation sets including trade, the labour market and prices. Investment and R&D in new technologies also appears in the E3ME's energy and material demand equations to capture energy/resource-saving technologies and pollution abatement equipment.

The FTT models

In addition to the treatment of technology through TPIs, E3ME also captures low carbon technologies in the power, transport and residential heating sector through its interactions with the Future Technology Transformation (FTT) models, which measure the substitution of technologies in response to changes in costs (both purchase and operational). These models can assess shifts in technology and the impact on energy demand/emissions better than simple (linear) elasticity of demand, as found in many macro models.

The FTT models have a number of important characteristics:

- → Households are modelled according to a distributed curve of preferences (i.e. investors are heterogenous, with different willingness to adopt new technologies)
- → The models do not model specific non-market barriers (i.e. split incentives in rented properties, which dramatically reduce the take-up of new technologies, even when they have cheaper levelized costs)
- → The models assume that technologies are perfect substitutes (e.g. that a heat pump can be "dropped in" as a replacement for a gas boiler in all circumstances, and without considering the need for energy efficiency to reduce peak heating need)
- → The responsiveness to changes in technology costs is calibrated based on historical data.

Some of the assumptions (e.g. perfect substitution, lack of non-market barriers) have the potential to lead to over-estimates of the responsiveness to price changes. The baseline rates of decarbonisation in these industries are therefore adjusted to ensure that the model produces results in line with other studies.

The implications of using this modelling framework for this analysis

The use of these modelling tools, and in particular the FTT models, to assess changes in demand for specific technologies in response to changes in fuel costs has specific implications for the analysis. Using these models, we can better assess the long-term responsiveness of these sectors to changes in the costs of specific technologies, since we are able to capture changes in purchasing decisions, rather than simply assess the short-term elasticity (which is dominated by a change in demand for the final output in response to price changes, rather than changes in the technology used). This approach also allows for non-linear responses, i.e. for elasticities to change, which is a key critique of the standard approach, where a single coefficient is estimated based on historical data.

However, these models also make some simplifying assumptions, which could lead to the over-estimation of elasticities. In particular, the models assume that technologies are perfect substitutes (e.g. a heat pump can be "dropped in" to replace a gas boiler, whereas – in most cases – substantial energy efficiency improvements are required at a property to switch to a heat pump for heating) and a lack of non-market barriers (e.g. split incentives in rented properties, which severely reduce the take-up of low-carbon heating technologies in this type of building).

The approach taken through the combination of E3ME and FTT models is a more detailed top-down approach. Yet while the FTT models do not treat consumers as a homogeneous mass (a typical shortcoming of macro models), they fail to take into account the full details of specific individual investment decisions in the way that a bottom-up stock model might. This modelling should not be interpreted as a perfect representation of these sectors, but as a less simple representation than is typically included in macro models.

3.3. Scenario results comparison

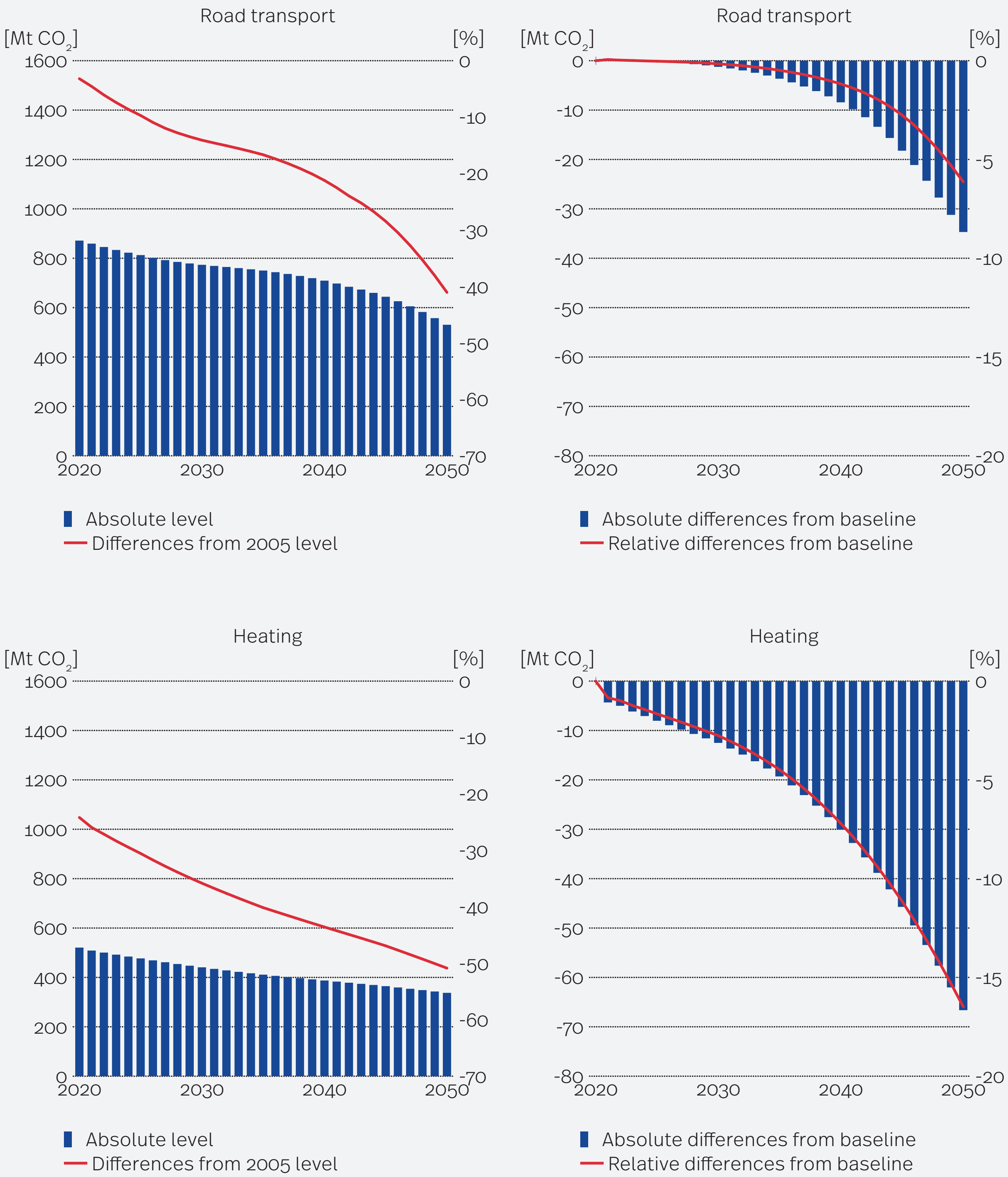
Emissions impacts

↘ Table 4. Emission Impacts

Scenario 1	Scenario 2	Scenario 3	Scenario 4
The additional reduction in transport is small while, in the building sector, it is expected to have a more substantial response.	Road transport emissions are projected to decline more rapidly after 2040 (driven by the increasing take-up of EVs from this point) and additional reductions in building emissions are projected to be slow and steady, reflecting the long operational life of heating installations.	Emission reductions achieved by design. There is a greater reduction in emissions from road transport than heating relative to the baseline, explained by the faster turnover of the car fleet compared to boilers, but also by the ability of consumers to change mode of transport more easily than is the case for heating.	

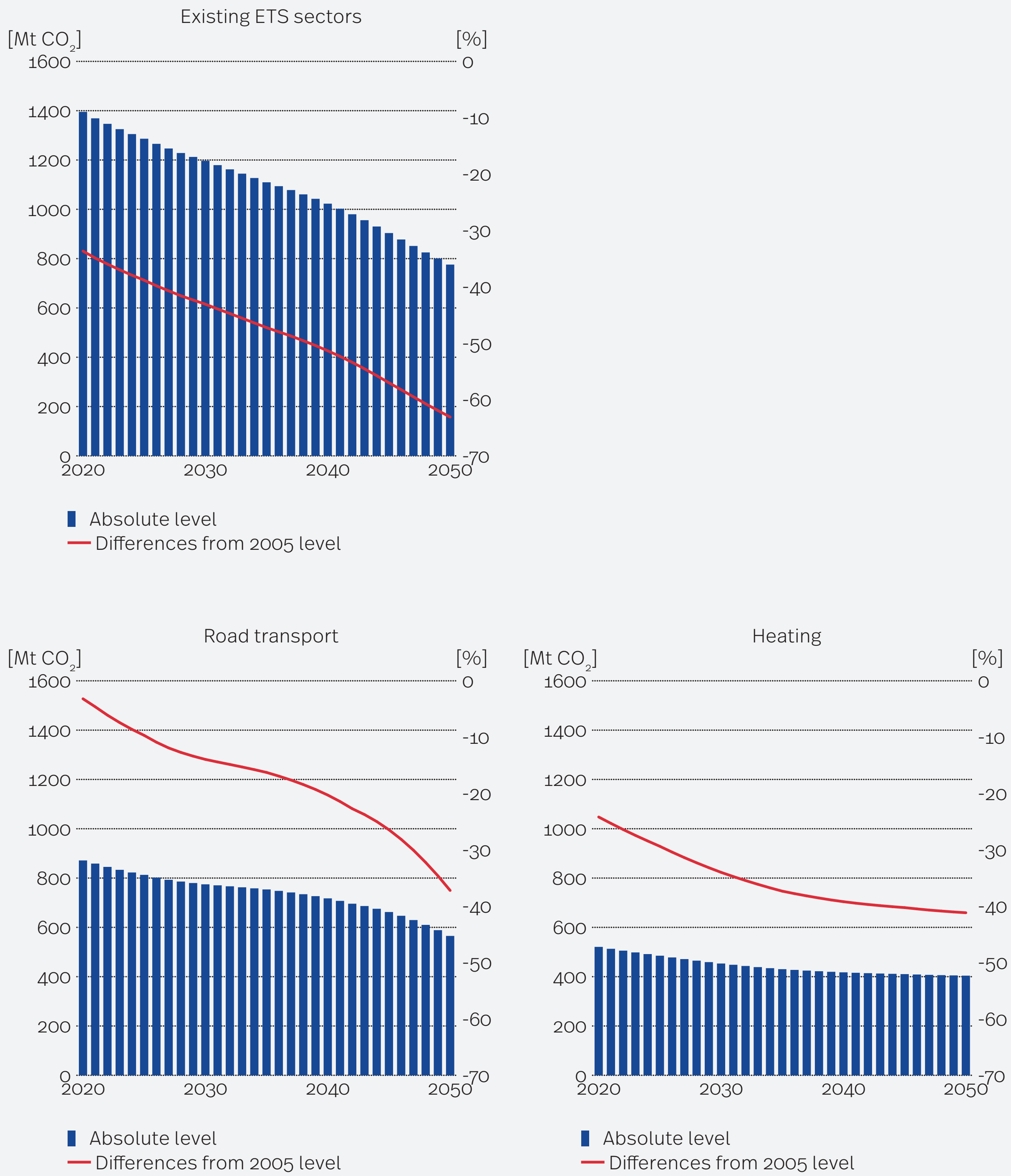
Source: prepared by PEI based on Stenning, Bui, Pavelka (2020); Fazekas et al. (2021).

↘ Chart 29. Transport and building emissions in Scenario 1



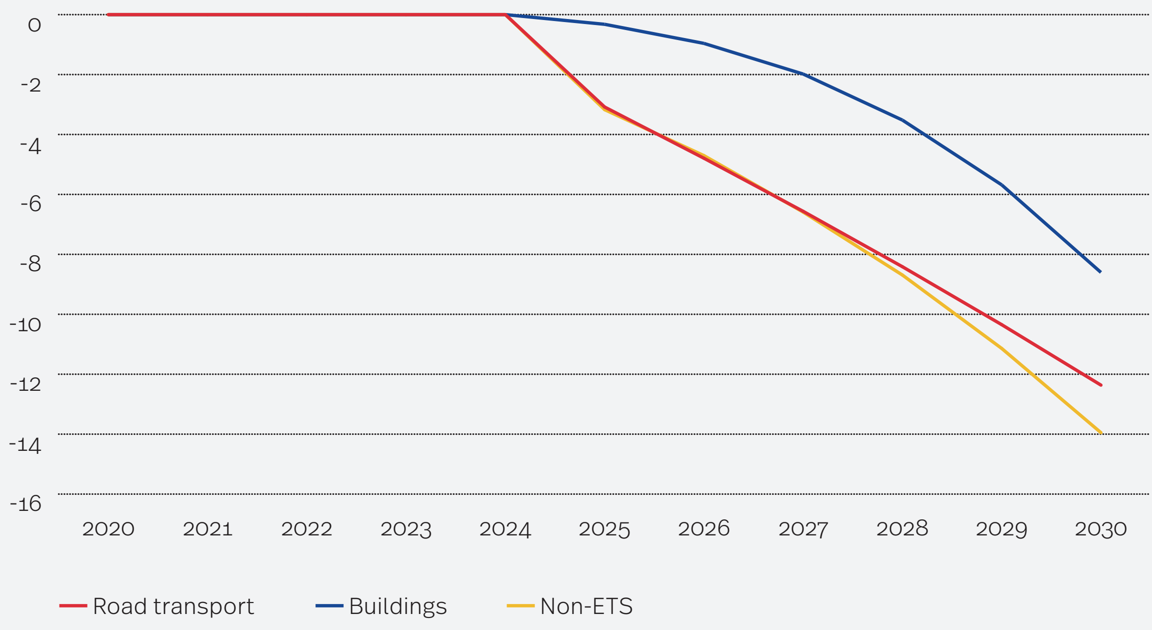
Source: prepared by PEI based on Stenning, Bui, Pavelka (2020).

↘ Chart 30. Transport and building emissions in Scenario 2



Source: prepared by PEI based on Stenning, Bui, Pavelka (2020).

↘ Chart 31. Transport and building emissions in Scenario 3 and 4 (% difference from baseline)



Source: prepared by PEI based on Fazekas et al. (2021).

Socioeconomic impacts

↘ Table 5. GDP and employment impact: at the EU aggregate level, total employment impact mirrors GDP impact in all the scenarios

Scenario 1 C price as tax (revenue recycling)	Scenario 2 Extended ETS	Scenario 3 Parallel ETS	Scenario 4 ETS (no revenue recycling)
GDP impact reflects the trends for the ETS price assumptions, as higher allowance prices lead to more revenues being recycled.	Slightly higher macroeconomic impact, peaking around 2030, then declining the competitiveness of the existing ETS sectors is negatively affected.	Positive macroeconomic impact observed relative to the NECP baseline. i) low-carbon technology costs decrease, leading to higher technology take-up, ii) household savings on energy bills and iii) higher investments (providing a form of economic stimulus).	Worse economic outcomes as revenue is taken out of the economy causing negative GDP effects as households have less disposable income, and increasing prices in industries that face higher heating and transport costs. This ultimately leads to a loss of competitiveness for the firms affected.

Source: prepared by PEI based on Stenning, Bui, Pavelka (2020); Fazekas et al. (2021).

It is important to note that the assumptions about how revenue from the sale of allowances will be used has a significant impact on research outcomes. If it is assumed that governments will use carbon tax revenues collected from the ETS to e.g. pay off their debts, the socio-economic impact will be negative. In contrast, if governments use those revenues to compensate vulnerable households by paying them subsidies, decreasing tax burdens or to fund investment in cleaner technologies, the impact will be positive.

The introduction of a carbon price for these sectors makes fossil fuel-based technologies more expensive, creating incentives for consumers to opt for some combination of reducing demand and switching to low-carbon technologies, reducing emissions in these sectors.

4. Potential cost mitigation

The European Commission's proposal to extend the EU ETS to new sectors – especially road transport and buildings – has raised two types of concern. Firstly, critics of the proposal argue that applying carbon pricing to non-ETS sectors would shift responsibility away from member states, which are currently required to achieve emission reduction targets in these sectors as part of the emissions sharing regulation, and would weaken incentives to adopt national measures to abate emissions (Transport&Environment et al., 2019). Those who oppose the extension also point to its severe impact on lower-income households, who would see their fuel and heating prices rise without necessarily being able to switch to cleaner fuels to cut emissions. Here, we focus particularly on the second point of this critique, analysing how the extension can be designed to mitigate the impact of carbon pricing on households. However, it will also be argued that an extension of carbon pricing should not come at the expense of existing sectoral policies, which should be strengthened and aligned with the new EU climate ambitions.

To succeed, the EU transition towards a zero-carbon economy must be economically and socially sustainable. As agreed by many experts and observers, policymakers need to root climate solutions in social equity and fairness to avoid a popular backlash. In fact, the European Commission has committed to conduct the transition 'in a fair and inclusive way', ensuring that 'no-one is left behind'. Against this backdrop, the extension of carbon pricing to new sectors should not only be assessed according to its environmental and economic effectiveness, but also in terms of its impact on households.

There are few empirical studies assessing how carbon pricing for transport and heating fuels is passed on. A recent analysis of the Swedish Carbon tax found that the whole cost has been passed on to end customers (Andersson, 2019). Past studies have instead found evidence that fuel taxes tend to be passed on quasi-completely (Resources for the future, 2020). Moreover, analyses that estimate *ex-ante* the impact of carbon pricing on GHG emissions usually assume full pass through to end-use consumers.

It should be also noted that the impact of carbon pricing in the building and road transport sectors will vary widely across EU member states, depending on the age and quality of their building stock and vehicle fleet, the distances travelled per household and the choice of means of transport.

Moreover, within countries, higher prices would disproportionately affect poorer households for several reasons. Firstly, transport and heating costs represent a higher share of total revenues and total spending for lower-income groups. Moreover, consistent with the expectation that lower-income households already keep heat and fuel consumption to the minimum necessary, their demand is less price elastic (Lampietti, Meyer, 2002). Finally, the usually high upfront costs of substantial emission abatement options in these two sectors make it more difficult for poorer households to switch to low-carbon solutions or to implement measures to increase energy efficiency. This leads to higher welfare losses for poor households than for affluent ones that can afford the upfront costs involved in switching to low-carbon alternatives or carrying out energy renovations.

Complementary Policies

As seen in the previous chapters, carbon prices in the road transport and building sectors would have to skyrocket to EUR 174 in 2030 (in 2015 prices) to achieve *alone* emission reduction objectives in line with the objectives of the EU Green Deal. In fact, previous calculations have shown that the current carbon price trajectory, both in the low-, medium- and high-price scenarios, would fail to deliver the 40% emissions reduction in those sectors that is consistent with the overall 62% emissions reduction envisaged by the EU Commission for the ETS. When price is instead treated as an endogenous variable, we saw that an ETS created solely for these two sectors would need carbon prices above EUR 150 per tonne in 2030 to trigger the necessary abatement to achieve emissions objectives, mainly due to the low-price elasticity of demand in these two sectors. These levels of EUA equilibrium prices would translate to heating and transport fuel costs that would probably be socially and economically unsustainable.

This suggests that carbon pricing alone should not be presented as a silver bullet for tackling emissions in the road transport and building sectors. This would impose an unfair burden on low-income households and would probably be very harmful for economic activity. Moreover, if these sectors were to be integrated into the current ETS, existing ETS sectors where emissions are more responsive to price incentives would need to abate emissions more rapidly to reach the overall ETS target for 2030, with the risk of significant competitive losses for EU industry. In isolation, extending the ETS would risk imposing considerable costs on households and on the whole economy, while not providing the tools for adopting low-carbon solutions.

All this points to the need to combine carbon pricing in these sectors with other complementary policies that could address non-price sensitive abatement potentials and market failure that carbon price does not tackle, while also keeping carbon prices at levels that are politically and socially acceptable. Energy efficiency and renewable energy policies, as well as legislation specifically targeting the building and the transport sectors, has the potential to accelerate the deployment of renewable energy solutions and lower energy demand. Effective complementary policies would reduce the share of emission reduction driven by the ETS. This would lower the demand for carbon permits and would put downward pressures on EUA prices. In the absence of other non-price-based policies, carbon prices would be pushed to unsustainable levels.

The track record of the California Cap-and-Trade (CaT) system supports the thesis that complementary policies alongside an ETS have the potential to reduce equilibrium EUA prices. The California cap-and-trade market for GHGs has the broadest scope of any GHG market in the world and covers nearly all anthropogenic emissions except agriculture, including emissions from transport and buildings. The California ETS also includes a set of complementary policies, including renewable portfolio standards for the deployment of RE capacity in the power sectors and vehicle performance standards. Previous studies have calculated that this policy framework has a major impact on GHG prices and that the more significant these complementary policies are, and the more effective they are when it comes to reducing GHG emissions, the lower the expected equilibrium price of CaT allowances (Yang et al., 2017).

The literature also suggests that complementary policies tend to be more important in sectors that are less responsive to the price of carbon, such as the transport and building sectors, where assets with a long lifespan are rarely replaced and turnover rates are slow (Gundlach, Minsk, Kaufman, 2019). Available infrastructure in the transport sector significantly affects consumers' response to carbon pricing. Similarly, high upfront capital investments are characteristic of operations aimed at improving the energy efficiency of buildings and constrain private households' capacity to retrofit their buildings in response to price incentives. This is also due to the fact that, contrary to large businesses, private actors tend to overweigh current costs and underweight future benefits. This, coupled with the limited information that they have about the costs associated with their energy consumption and options for reducing them, affects the rationality of households' reaction to CO_2 prices.

In the building and road transport sectors, cost-effective energy improvements would significantly reduce the energy bill impact of carbon pricing on end-users. Different authors have highlighted several non-price barriers specific to investments in energy efficiency improvements, especially in the case of private households. These include asymmetric Information, principal agent problems and limited access to capital (Cowart, 2011) and are generally considered a major factor behind households' and businesses' failures to carry out energy efficiency investments (Gillingham et al., 2009). These barriers, which are beyond the negative externalities caused by energy production and consumption, cannot be overcome by pricing policy alone and need to be addressed through targeted energy efficiency programmes.

Policies designed to support innovation, the use of new technologies and households' switch to low- and zero-carbon alternatives therefore play an important role alongside carbon pricing, especially in the road transport and building sectors, where there is a concrete risk of carbon lock-in, especially in the case of more vulnerable families.

In light of the above, the option of keeping sectors newly covered by the EU ETS (or part of a newly-created, separate ETS) in the Effort Sharing Regulation – also outlined in Option ETS_2.2 and ETS_2.3 in the Commission Impact Assessment accompanying the Climate Target Plan communication – seems more appropriate for mitigating the carbon price impact on new and old ETS sectors.

Strengthening the current EU policy framework

Current renewable, energy efficiency and transport policies should be strengthened to lower energy demand and to incentivise the deployment of renewable energy solutions. Moreover, binding national emission reduction targets as part of the ESR ensure that member states are incentivised to effectively implement policies to achieve the reductions required. In this respect, the July Fit for 55 legislative package will be a crucial opportunity to revise both the relevant EU renewable and energy efficiency energy policies and the financial framework aimed at rolling out sustainable renewable energy projects to ensure that they are fit-for-purpose and contribute to the cost-effective deployment of renewable energy sources.

In particular, in the context of the revision of the Renewable Energy Directive, the overall renewable energy target should be revised upwards – as mandated by Article 3 of the Directive, and be made binding not only at the EU level, but also the national one.[7] The sub-target for renewables in transport should also be strengthened.

[7] In line with the results of the OPC https://ec.europa.eu/energy/sites/default/files/summary_opc.pdf [access: 11.06.2021].

Likewise, the upcoming review of the Energy Efficiency Directive will be an important opportunity increase energy efficiency ambitions. Article 7 of the directive obliges member states to deliver a minimum level of energy savings through national energy efficiency policies and measures. In 2020-2030, they need to deliver annual real saving equal to 0.8% per year, down from 1.5% during the previous period. Energy saving obligations should be strengthened.

In addition, increasing the level of ambition of national targets and of the overall EU's 2030 energy savings target to at least 45% would send a strong signal to investors and contribute to the success of other Commission initiatives such as the Renovation Wave. In the context of the directive, minimum energy efficiency standards and labelling for a variety of products such as boilers, household appliances and lighting should also be enhanced. This could further reduce energy consumption and promote investments aimed at enhancing the energy efficiency of buildings.

As part of the Fit for 55 package, the Commission has also committed to revise the Energy Performance of Buildings directive. In this regard, the introduction of mandatory minimum energy performance standards (MEPS) for all types of buildings could help improve the performance of the worst-performing buildings while tackling one of the root causes of energy poverty.

In relation to the road transport sector, the European Commission is expected to propose a revision of the post-2021 CO_2 standards for light-duty vehicles (LDVs), including passenger cars and vans. Legislation sets targets for EU fleet-wide CO_2 emissions, which in 2030 have to be 37.5% and 31% lower than in 2030 for cars and vans respectively. Those targets should be strengthened, as well as the super credit system to accelerate the uptake of low- and zero-emissions vehicles. Moreover, the 2017 Commission proposal to amend the *Eurovignette* Directive and extend rules to charge vehicles based on their CO_2 emissions to passenger cars would provide a further incentive for the uptake of low-carbon and electric vehicles, if adopted by the Parliament and the Council.

The role of ETS revenues in cost mitigation and their distribution

While complementary policies like the one described above can play an important supportive role in sustaining the uptake of clean technologies and therefore reducing demand for EUA allowances and putting downward pressure on prices, a robust accompanying system of financial compensation is needed to avoid lower-income households shouldering the burden of the EU's rush towards net zero.

In this respect, ETS revenues have the potential to play a crucial role. Reinjecting ETS auctions proceeds back into the economy, targeting lower income households, could offset the regressivity of carbon pricing in the road transport and building sectors. Moreover, well-designed subsidies perform better than carbon pricing in helping those currently trapped in fossil-fuel based technologies to switch to low- and zero-carbon alternatives.

Since 2013, around 80% of the money generated through ETS auctions has been spent by member states on climate and energy purposes. This share has recently declined, though, coupled with a considerable increase in revenues due to the rising EUA price. To ensure that member states keep reinjecting ETS revenues into the economy to mitigate negative impacts of carbon pricing, Article 10(3) of the ETS Directive should be amended to increase the share of auctioning revenues that has to be spent on climate and energy purposes from the current 'at least 50%' to 100%. Moreover, to counter the potential regressive nature of the ETS, member states should be required to spend at least 20% of the revenues on addressing social issues in lower- and middle-income households; for example, on fighting energy poverty. The ERCST, with the CEEP, already proposed this amendment in a previous work (Marcu et al., 2021). If carbon pricing is extended to new sectors where equity issues are even more pressing, the urgency of this addition will only increase. Furthermore, the introduction of carbon pricing in the building and road transport sectors would make it more important to expand the list of eligible expenditures to be financed with ETS revenues in Article 10(3) to infrastructural investments, i.e. those needed to connect RES to the grid.

Poorer member states are likely to be disproportionately affected by the extension of carbon pricing to new sectors. Most Eastern European countries expressed concerns about energy poverty and equity issues and called for the strengthening of the Effort Sharing Regulation, where different national targets are based on member states' relative wealth. In light of this, if the upcoming review enhances the role of carbon pricing and expands the ETS to new sectors, it will be crucial to safeguard and strengthen tools that redistribute resources in favour of poorer member states. The solidarity mechanism, which redistributes 10% of the total quantity of allowances to the 16 poorer member states, is a fundamental tool in this respect. However, the impact of this instrument could be undermined by the fact that, under current rules, from 2026 solidarity allowances will be taken into account when determining the share of allowances that each member state must inject into the MSR. The ERCST has estimated that this would decrease the total number of solidarity allowances by 10% (Marcu et al., 2021). If solidarity allowances are no longer preserved from MSR injections, poorer member states will be disproportionately affected. As a result, Article1(5) of the MSR Decision (2015/1814) should be amended to safeguard the solidarity mechanism after 2025, especially if carbon pricing is extended. As for regularly auctioned allowances, 100% of the revenues generated by solidarity allowances should be spent on energy and climate purposes.

The role of the ETS Funds

The increase in the EU's climate ambitions and in emissions reduction targets has generated calls to increase the size of the Modernisation Fund (MF), which is currently funded by the auctioning of 2% of allowances and supports investments in ten lower-income EU member states to modernise their energy systems and improve energy efficiency. If more stringent climate targets are coupled with the extension of carbon pricing to new sectors, the rationale for increasing the size of the Modernisation Fund will be even stronger, to mitigate the impact of the ETS extension in member states where the transition is more challenging.

The Modernisation Fund was originally designed to cover 3-9% of additional investment needs connected to the 2030 climate and energy framework (EC, 2014), which the European Commission estimated at EUR 300 billion per year in 2014 to meet the 40% target. Today, the Commission estimates that around EUR 300 billion per year in additional investment is needed across EU countries to meet the 2030 target of 55%. To determine the right size of the Modernisation Fund in light of the increased size of the challenge, an analysis of investment needs associated with the EU Green Deal – and to the potential extension of carbon pricing – should be performed in eligible member states, taking into account their specificities. This calculation would help understand to what extent the size of the Modernisation Fund should be increased in the face of the new target.

Besides ensuring that the size of the Modernisation Fund is aligned with the increased ambitions, its resources must be distributed fairly and efficiently. Currently, eligible member states receive MF funds according to their share of GDP in 2013 (50%) and their share of verified emissions (50%). However, these two criteria fail to reflect the goal of the fund: financing investment aimed at making the energy systems of eligible countries fit for the transition. Therefore, in addition to the aforementioned criteria, the allocation of the Modernisation Fund's resources should take into account countries' actual investment needs and relative capabilities to redirect funds to member states where there are more obstacles to investments in the energy sector. Moreover, to truly reflect the relative capabilities of member states, it seems reasonable that the national level of GDP per capita should be factored in when determining the share of funding from the Modernisation Fund. This is even more important in the context of the extension of carbon pricing, which, as already mentioned, will disproportionately affect households with fewer financial resources.

Another powerful tool at the EU's disposal for facilitating and speeding up the transition towards a zero-carbon economy is the Innovation Fund (IF). Established in 2015, the fund is designed to provide support for the demonstration of innovative low-carbon technologies. At present, revenues for the Innovation Fund come from the auctioning of 450 million allowances from 2020 to 2030. The first call for large-scale projects received 311 applications, for a total of EUR 21.7 billion in requested financial support. There have been 232 applications for small-scale, requesting EUR 1 billion in support. However, the total resources available for these two calls amount to just EUR 1.1 billion, highlighting a significant imbalance in supply and demand. What is more, the total Innovation Fund resources for Phase 4 of the EU ETS – currently estimated at EUR 18 billion – would not even be enough to finance the first call for proposals.

The higher climate targets as part of the EU Green Deal have led many observers and stakeholders to argue that the IF should be strengthened in line with the EU's higher climate ambitions. Moreover, as EU industry is now being called on to reduce its emissions during its new decade, together with the power sector, developing breakthrough clean technology capable of reducing emissions in so-called hard-to-abate sectors is more urgent than ever. If carbon pricing is extended to road transport and buildings, where recent progress in emissions reductions has been largely insufficient, the IF will have a crucial role to play in bringing to the market innovative technologies that could reduce demand of emissions permits and therefore lower the equilibrium price of allowances. Moreover, it is important to ensure that the Fund finances projects across the EU in a geographically-balanced way and direct resources are also directed to member states with fewer capabilities, as they will be the most affected by the extension of carbon pricing.

How to Use ETS revenues

Revenue recycling schemes for assisting vulnerable groups and offsetting the impact of higher heating and fuel prices can include measures such as transfer payments, direct energy bill assistance or targeted energy efficiency programmes. Various cap-and-trade systems around the world have these type of measures in place.

The Australian and British Columbian schemes offer specific transfer payments to low-income households in the form of lump-sum payments or an increase in tax benefits. Some of the ETS revenues could be recycled in this form, making the payments proportional to the increase in heating bills caused by carbon pricing.

In the building sector, another measure should be used to provide direct bill assistance to poorer households, who would be the most penalised if there is a price on carbon. Several members of the Regional Greenhouse Gas Initiative (RGGI) provide direct energy bill assistance to households to mitigate the financial burden for low-income families. In 2018, 16% of RGG investments funded direct bill assistance (RGGI, 2020), saving end consumers USD 10.7 million in bills. Typically, direct bill assistance takes the form of a credit on a consumer's electricity bill.

Compared to direct bill assistance, targeted energy efficiency programmes have the advantage of not undermining the carbon price signal and preserving the incentive to reduce energy consumption. Maryland, for example, recycles part of its carbon revenues to finance the Multifamily Energy Efficiency and Housing Affordability (MEEHA) programme, which contributes towards energy efficiency upgrades for new apartment buildings or those undergoing renovation. Similarly, Vermont uses 100% of revenue in its heating and process energy efficiency programme, of which 50% has to be used to support energy retrofits for lower- and middle-income consumers. In the EU, France already invests part of its ETS auctioning revenues in the Habiter Mieux programme (Agence nationale de l'habitat (ANAH), 2020), which funds building renovations for low-income and energy-poor households. Other EU countries should establish similar programmes, especially if carbon pricing is applied to the building sector.

In the transport sector, revenues can be recycled to accelerate the uptake of low-carbon and electric vehicles by providing consumers rebates for low-carbon and electric vehicles and tax breaks to lower-income households to offset the increase in fuel prices due to carbon pricing. The rationale for government investment in low-carbon technologies in the transport sector is also very strong due to the high upfront costs of charging infrastructure. The Californian GGRF (Greenhouse Gas Reduction Fund) has long supported to transition towards zero- and low-emission vehicles by providing rebates for low emissions cars, trucks and buses, providing financial rebates for clean vehicles purchases and capital grants to expand intercity rail and transit services.

5. Research insights/Conclusions

- The analysis shows that, if well designed, more rapid decarbonisation in these two sectors leads to very positive macroeconomic impacts in Europe.
- The EU ETS can be considered as a tax on the marginal use of technologies.
  - It is not clear that this addresses the key obstacle to the take-up of low-carbon technologies, the higher upfront purchase price
  - It risks unduly penalising low-income households that cannot afford to invest in more expensive low-carbon technologies
  - Without mitigating policy (which could also dilute the effectiveness of the levy), it could prove to be unpopular with the general public (the *gilets jaunes* movement was, at least publicly, linked to the imposition of higher taxes on fuels in France).
- It is unclear how interaction between the ETS and the Effort Sharing Regulation (ESR) would be managed. Moving transport and heating out of the ESR would make decarbonisation of (in particular) transport more difficult, since there would be little incentive for member states to keep current fuel taxes in place, while putting these sectors into both the ESR and the ETS would lead to an unclear shared responsibility for achieving emission reductions in these sectors. There is a serious risk that ESR targets could be missed in this scenario and that national governments would blame the EU.
- The analysis suggests that there is no scope for relaxing national policies, if the ETS were to be widened. Indeed, the extended ETS would require substantive additional support to deliver the required savings. This kind of policy must consider sector-specific challenges, such as the slow rate of fleet renewal and the challenge that this causes to low-income consumers.
- The poorest member states are more vulnerable to the impact of the extension of carbon pricing. Some of the Eastern European countries, which have a colder climate and use more heating, will face higher emission costs. Therefore it is important to provide strong incentives that redistribute resources, like the solidarity mechanism.
- Although a fixed emission reduction target would be met within a single ETS, it would impose high carbon prices across both existing and new ETS sectors, and would force much of the abatement to take place in existing ETS industries due to their greater responsiveness to price changes.
- Including buildings and transport in the ETS would not deliver the required emissions reductions in these sectors. This kind of policy would have undesirable social effects because it would push up average spending on gas-fuelled household heating and increase the cost of running a fossil-fuel vehicle, before taking into account reductions in demand as a result of higher prices.
- At the same time, low-income households, which are most financially constrained, are likely to be hardest hit by this policy, with little scope to invest in new technologies and little discretionary spending on heating and transport that can be cut without affecting their quality of life.

- In addition, because the building and transport sectors are relatively unresponsive to the carbon price, an extended ETS would force companies in the existing ETS sectors to do more to compensate. This would lead to a loss of competitiveness in these sectors and therefore small reductions in output and employment.
- Achieving the target reductions with policy measures (where road transport and buildings remain covered by the national climate targets, as regulated by the EU's Effort Sharing Regulation, ESR) would deliver substantial economic benefits, while encouraging the take-up of low-carbon technologies and avoiding some of the potential regressive distributional impacts associated with the introduction of an ETS for these sectors (which taxes marginal fuel use but does not necessarily help consumers afford new low-carbon technologies).
- An EU-wide carbon price would require very high allowance permit prices to deliver equally rapid decarbonisation of these sectors by 2030, reaching EUR 180 per tonne (in 2015 prices) by 2030.
- There is a need to further develop mechanisms like Modernisation Fund and Innovation Fund to mitigate the impact of the ETS extension in those member states where the transition is more challenging and provide incentives for the private sector to introduce clean technologies in transport and building sector. To ensure the fair and efficient redistribution of resources, the allocation of funds should also take into account countries' actual investment needs and relative capabilities, as well as the national level of GDP per capita.
- Without any revenue recycling, the parallel ETS would have a negative impact on output and employment.
- With 100% revenue recycling, the ETS scenario could increase economic activity in Europe while delivering the same emissions reductions. The extent of revenue recycling, and how this revenue is used, substantially alters the socioeconomic outcomes of ETS.
- If a share of the revenues is used for low-carbon technologies and building energy efficiency, it leads to lower low-carbon technology costs for all consumers, as well as lower carbon prices.
- If revenues are recycled back to consumers (through tax cuts or lump-sum transfers), the rebound effect leads to higher consumer spending and economic activity.

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Appendix

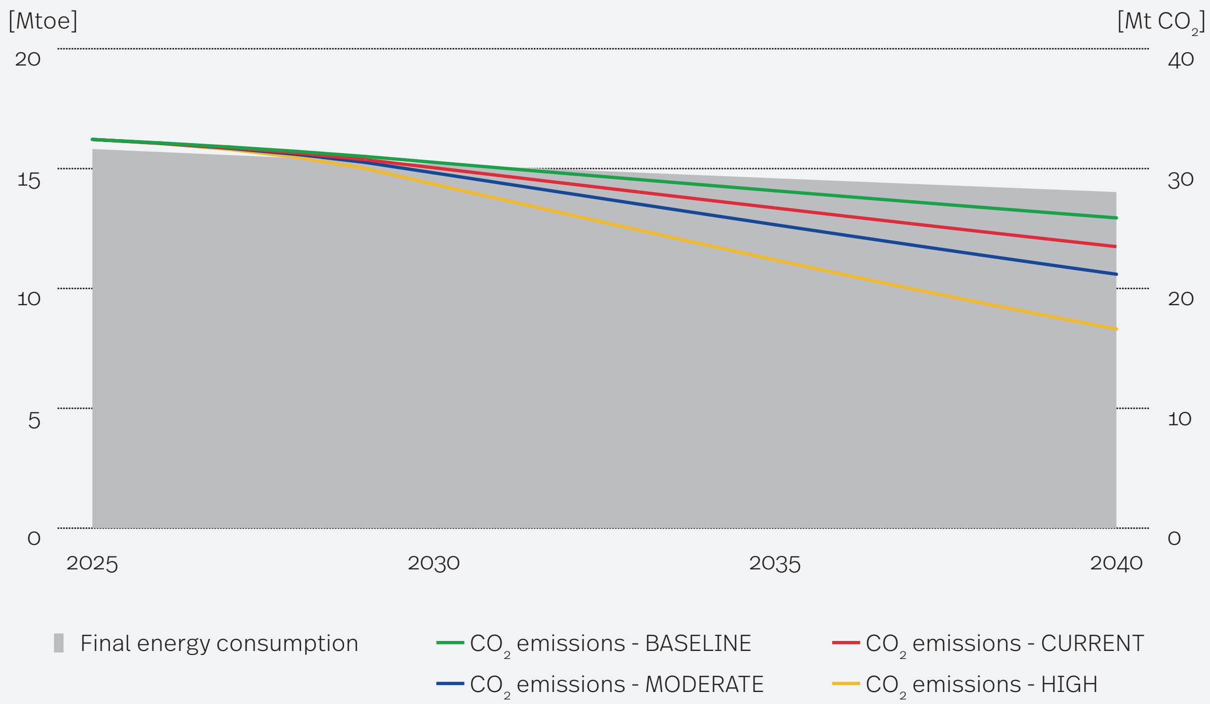
Poland

↘ Table 6. Summary of scenarios for Poland

Scenario	Transport	Residential	Total
	CO_2 reduction in 2030 (%)	CO_2 reduction in 2030 (%)	CO_2 emissions Mt in 2040 (%)
BASELINE	26	-27	45
CURRENT	25	-29	41
MODERATE	23	-30	37
HIGH	20	-32	30

Source: prepared by PEI.

↘ Chart 32. Final energy consumption and emissions decrease in residential buildings in Poland



Source: prepared by PEI.

↘ Chart 33. **Fleet structure by technology in Poland (%)**

Source: prepared by PEI.

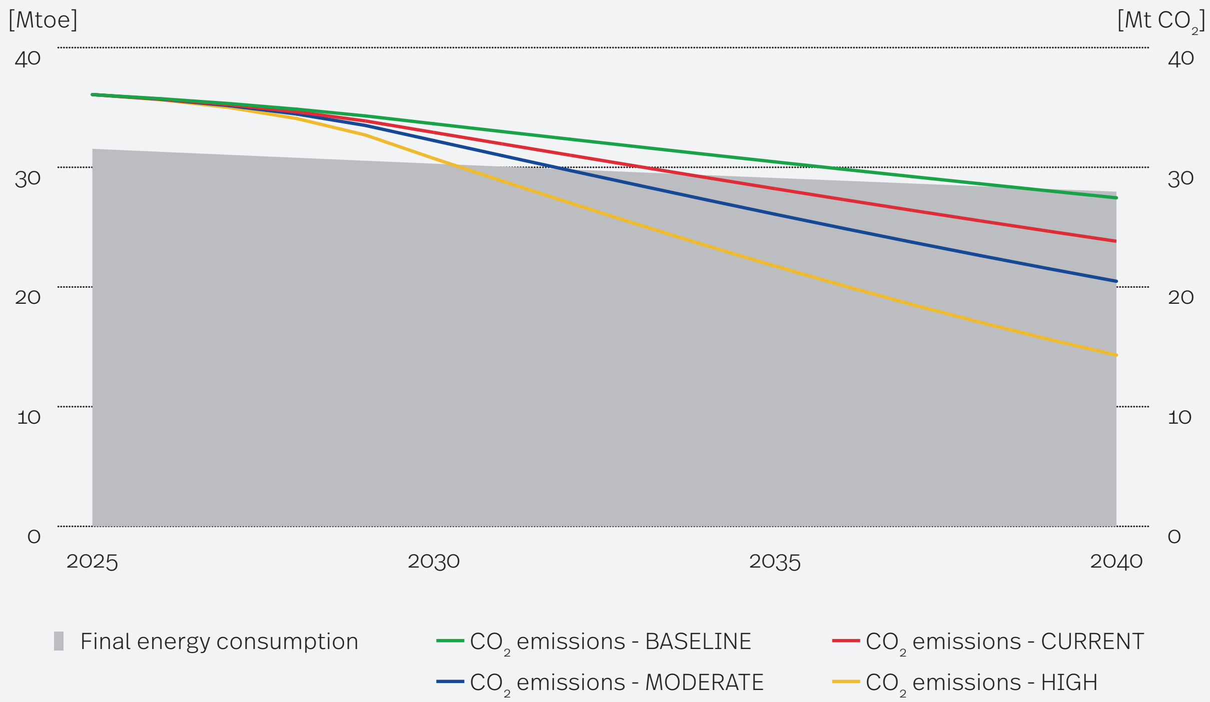
France

↘ Table 7. Summary of scenarios for France

Scenario	Transport	Residential	Total
	CO_2 reduction in 2030 (%)	CO_2 reduction in 2030 (%)	CO_2 emissions Mt in 2040 (%)
BASELINE	-24	-51	74
CURRENT	-26	-53	65
MODERATE	-27	-55	57
HIGH	-30	-59	41

Source: prepared by PEI.

↘ Chart 34. Final energy consumption and emissions decrease in residential buildings in France



Source: prepared by PEI.

↘ Chart 35. Fleet structure by technology in France (%)

Source: prepared by PEI.

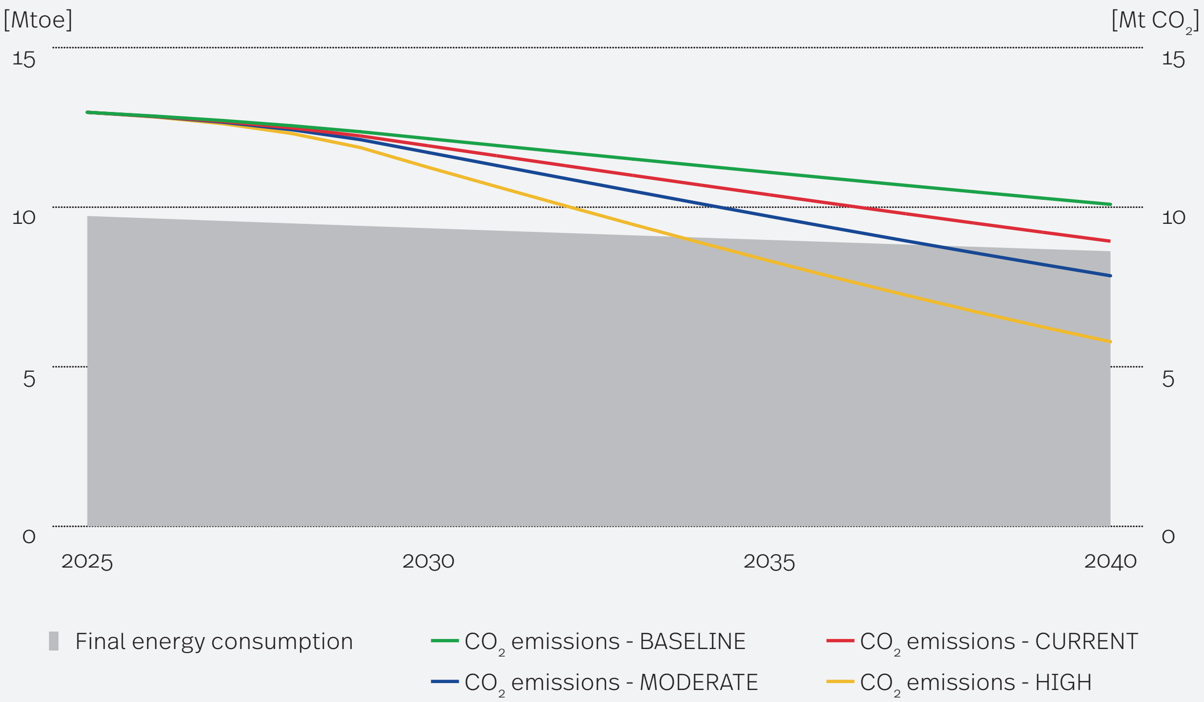
Spain

↘ Table 8. Summary of scenarios for Spain

Scenario	Transport	Residential	Total
	CO_2 reduction in 2030 (%)	CO_2 reduction in 2030 (%)	CO_2 emissions Mt in 2040 (%)
BASELINE	-31	-42	42
CURRENT	-33	-43	38
MODERATE	-34	-44	33
HIGH	-36	-46	26

Source: prepared by PEI.

↘ Chart 36. Final energy consumption and emissions decrease in residential buildings in the Spain



Source: prepared by PEI.

↘ Chart 37. **Fleet structure by technology in Spain (%)**

Source: prepared by PEI.

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The Polish Economic Institute

The Polish Economic Institute is a public economic think-tank dating back to 1928. Its research spans trade, macroeconomics, energy and the digital economy, with strategic analysis on key areas of social and public life in Poland. The Institute provides analysis and expertise for the implementation of the Strategy for Responsible Development and helps popularise Polish economic and social research in the country and abroad.

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