CENTER FOR THE STUDY OF DEMOCRACY

ENERGY POVERTY AND DECARBONISATION: ASSESSING THE ECONOMIC IMPACTS OF CARBON PRICING IN CENTRAL EUROPE

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The European Union is facing one of the most difficult energy and climate security crisis in its history. The surge in energy prices that began already before the Russian invasion in Ukraine has starkly revealed the need for a new global strategy for solving the ener-gy policy trilemma of security of supply, affordability and sustainability, all the while minimizing geopolitical risks. The high fossil energy intensity of most Europe-an economies has been a key factor behind the rising energy poverty across the continent.[1] Developing ef-fective policy instruments to accelerate the decarboni-sation of the European economy is therefore not only addressing climate security concerns, but will also pre-serve Europe's economic competitiveness and social welfare.

Carbon pricing mechanisms could be such tools as they provide incentives to consumers to reduce energy consumption, diversify their energy mix away from fossil fuels and invest in renewable energy sources. A comprehensive analysis of the macro- and microeconomic effects of the introduction of a carbon price, developed in collaboration with partners from Germany, Romania, Hungary and Poland, shows that introducing a carbon price, at levels that would achieve a 40% reduction in emissions between 2022 and 2032, would have no significantly negative impact on the countries' macroeconomic performance and would have the potential to improve overall social welfare, as long as tax revenues are redistributed back to the general population.

KEY POINTS

- Carbon pricing is a market-based **policy tool** for ensuring an **efficient, successful energy transition.**
- The modelling assessment of the macroeconomic and microeconomic effects of carbon pricing on national economies in Central Europe reveals a **limited negative impact** that can be successfully mitigated by smart policy measures.
- Carbon pricing can help countries in the region achieve a **40% reduction in CO2 emissions** over the next decade, while at the same time improving energy and climate security.
- Carbon pricing would incentivise a shift from loss-making and heavily subsidized fossil fuel industries to **higher value-added technologies.**
- With appropriate tax redistribution policies, carbon pricing could **reduce energy poverty and social inequalities,** whereas Central European countries having the most to gain in Europe from such redistribution policies.
- Lump-sum-based redistribution of carbon pricing revenues would be the **simplest-to-implement mechanism with a strong energy poverty reduction potential** across the region.

[1] Vladimirov, M., Rangelova, K., and Dimitrova, A., *The Great Energy and Climate Security Divide*, Sofia: Center for the Study of Democracy, 2022.

Federal Ministry for Economic Affairs and Climate Action

5 Years European Climate Initiative EUKI

The conclusion is that although some economic sectors may experience a slower growth in employment and economic output, other less carbon-intensive activities would benefit from carbon price-induced shifts in capital and labour. Introducing a carbon price will lead to welfare losses only without a redistribution mechanism. There are a number of fiscal mechanisms that could not only cut these losses, but improve welfare, especially for less affluent households. Thus, contrary to popular decarbonisation myths, carbon pricing could actually reduce energy poverty, while accelerating the low-carbon transition.

Assessing the Macroeconomic Impact of Carbon Pricing in Central Europe

The analysis of the macroeconomic effects of a carbon price is based on a multi-sector dynamic stochastic general equilibrium (DSGE) model covering Germany, Romania, Hungary, Bulgaria, and Poland. The tax is tailored and optimised by the macro-model for each country in view of reaching a 40% reduction of CO_2 emissions by 2033 vs 2022, taking into account the carbon intensity and energy mix of the national economy, as well as its general macroeconomic situation (Figure 1). The model results show that the introduction of a carbon price would slow economic growth only marginally. According to the OECD projections, economic growth between 2022 and 2032 will be significantly higher in Bulgaria, Romania, Hungary and Poland, compared to Germany, with the former growing by between 20 and 25%, whereas Germany's economy – by 9% during the same period.

In the cases of Germany, Bulgaria and Romania, the observed negative deviations (See Figure 2) from the OECD forecast are negligibly small, and even in Poland, which would see the largest fall in its GDP with around 1%, economic growth would still be in the double digits over the observed period, despite the carbon price. Interestingly, economic growth in Hungary would even accelerate if a carbon price were introduced, albeit only marginally. Consequently, all of the included countries could introduce a carbon price at levels that would reduce carbon emissions by 40% in the next 10 years without harming their economic development potential.

Box 1. Methodology for Assessing the Macroeconomic Impact of a Carbon Price

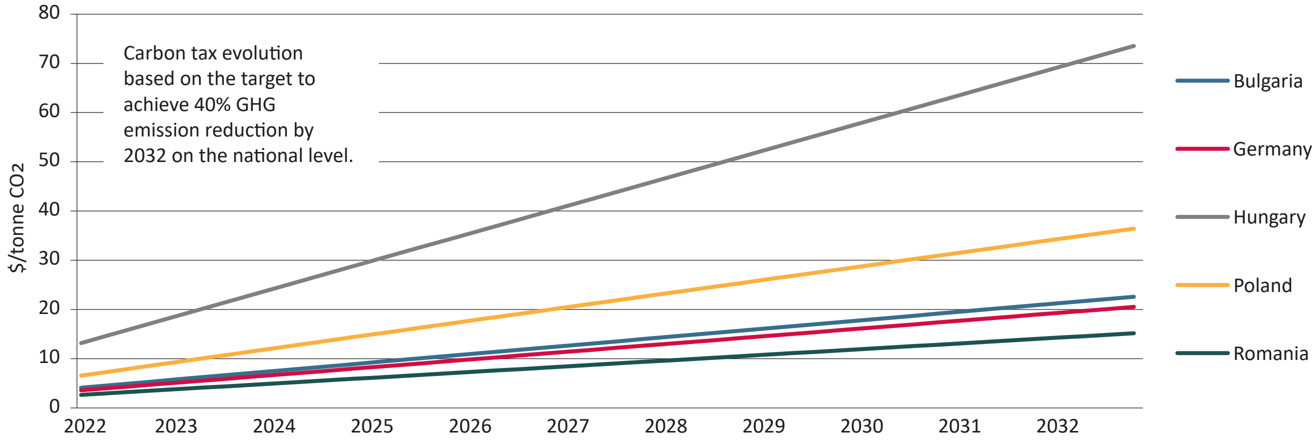
First, a CO_2 emissions reduction goal is set at 40% until 2032, compared to 2022 in all countries. Second, the carbon price (expressed in $ per tonne of CO_2 emissions) is adjusted by the model for each country in order to reduce the emissions by 40%. Hence, the carbon price value depends on the general macroeconomic situation of the country as well as its carbon intensity and energy mix. These modelled carbon prices are then used to compute how macroeconomic indicators (GDP growth, employment, value-added, fuel imports) will deviate from a 'no-tax scenario' between 2023 and 2032. The reference points for the no-tax scenario are formed by projections of these macroeconomic indicators done by the OECD. In the case of value-added and employment, separate percentage-based deviations are shown for 5 different economic sectors (agriculture, industry, energy, construction, services), whose carbon contents are derived from existing literature.

Another way of assessing the effects of a carbon price on the economy is to look at how the value-added[2] changes for the whole economy and individually for each sector. In Germany and Hungary, a carbon price leads to a slight increase in value-added (0.08% and 1.22%), whereas in Bulgaria (-0.9%), Poland (-1.2%) and Romania (-1.4%), value-added falls slightly by 2032.

However, breaking down the results by sector, it becomes apparent that the effects vary significantly. Most strikingly, introducing a carbon price would actually raise the value-added in the energy sector for all countries. The reason is that the tax would incentivise energy companies to switch from unprofitable but heavily-subsidised fossil fuel power plants to renewable energy, which generally have much lower marginal costs. Services would experience slightly negative deviations from a no-tax scenario across all countries ranging from -0.3% in Germany to -2.1% in Poland. Given the expected growth of these sectors on the back of the restructuring of Central European economies, the negative economic impact is likely to be manage-

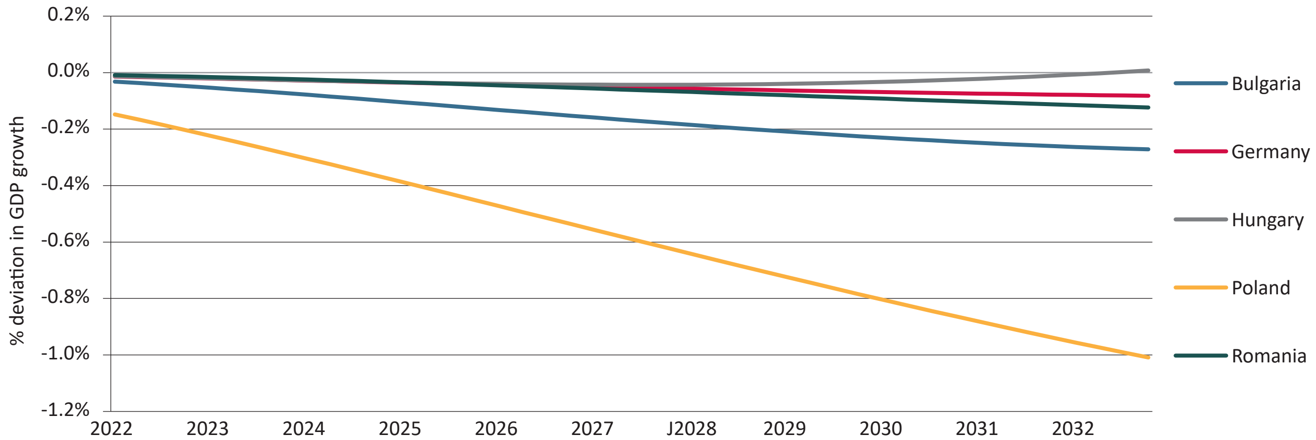
[2] Simply put, the value-added equals the difference between the value that is generated by producing goods and services and the costs for capital and labour.

Figure 1. Carbon Pricing Scenarios ($/tonne CO²)



Source: *CSD based on the MEMO model.*

Figure 2. Differences in GDP Growth (% Deviation from the No-carbon Price Scenario)



Source: *OECD Data (GDP Forecasts), CSD based on the MEMO Model (Carbon Price Effect).*

able. Moreover, the abundant EU funds available from the Just Transition Mechanism and the comprehensive regional strategies under the Territorial Just Transition Plans would further support a smooth low-carbon transition.[3]

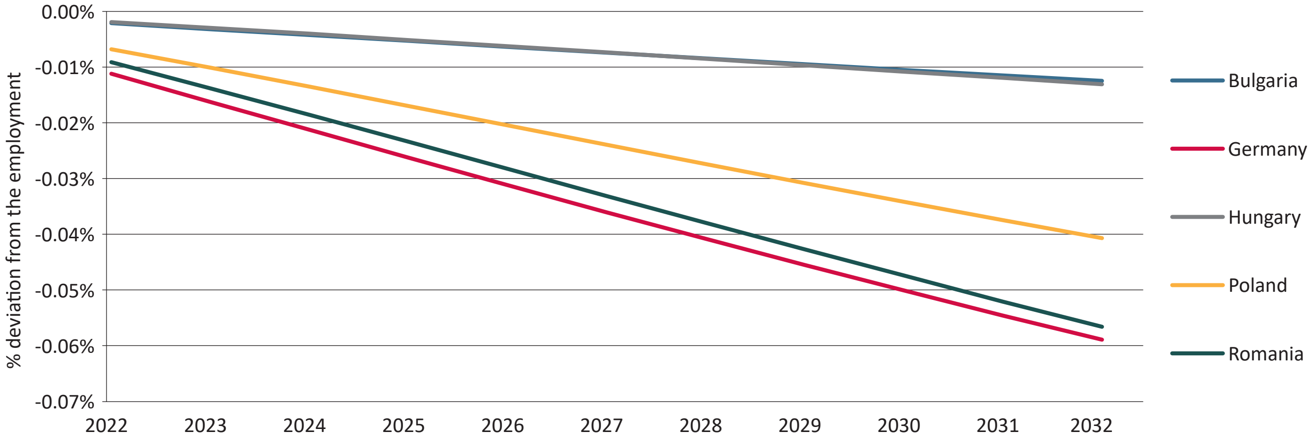
In the industrial sector, there is more variation of the regional performance the region, with Germany and Hungary showing positive impact from the carbon price, and negative in Bulgaria, Poland and Romania. The latter could be explained by the carbon intensity of the industry in those countries, as well as the inability of many companies to implement a swift transformation of their production processes, once a carbon price is introduced leading to higher production costs. However, these negative deviations could be tackled by decisive government action which facilitates investments in energy efficiency, the replacement of fossil fuel use with renewables and a general optimisation of business processes. The energy crisis in 2022 has shown how many manufacturing companies have been able to quickly and meaningfully reduce natural gas consumption in response to much higher prices.[4] With the right government support cushion to mitigate the immediate impact of skyrocketing costs, energy intensive businesses would be able to implement technology changes in energy use to restore competitiveness.[5]

[3] Primova, R., Vladimirov, M., and Trifonova, M., *Towards a Just Transition in Bulgaria*, Sofia: Center for the Study of Democracy, 2022.

[4] McWilliams, B., and Zachmann, G.,"European natural gas demand tracker", *Bruegel*, December 7, 2022.

[5] Rangelova, K. et al., *Switching the Gears of Decarbonisation*, Sofia: Center for the Study of Democracy, 2021.

Figure 3. Differences in Employment (% Deviation from the No-carbon Price Scenario)



Source: *CSD based on the MEMO model.*

In terms of the labour market, the carbon price barely affects employment rates as the model points to only small losses of employment growth by 2032 (see Figure 3). The expansion of low-carbon sectors would offset to a large extent the losses in employment in carbon-intensive sectors such as heavy industry and fossil fuel-powered energy production. This is also reflected in the expansion of employment in the service sector across all countries; a sector that is traditionally considered to be less carbon intensive.

As many energy companies are still mulling whether to double down on fossil fuel investments (e.g. new LNG import infrastructure) or to focus on renewables, a carbon price could be the push they need to encourage this transformational shift. Indeed, the results show that, compared to a no-tax scenario, fossil fuel imports would fall in all countries except foreign oil purchases in Germany. Natural gas imports will drop most sharply between 10% in Romania and 35% in Hungary. Hence, by reducing Europe's dependence on fossil fuel imports, especially from Russia, the positive impact of a carbon price would go beyond the acceleration of the decarbonisation process and will also include the strengthening of energy and climate security.

Carbon Pricing Impacts on Energy Behaviour

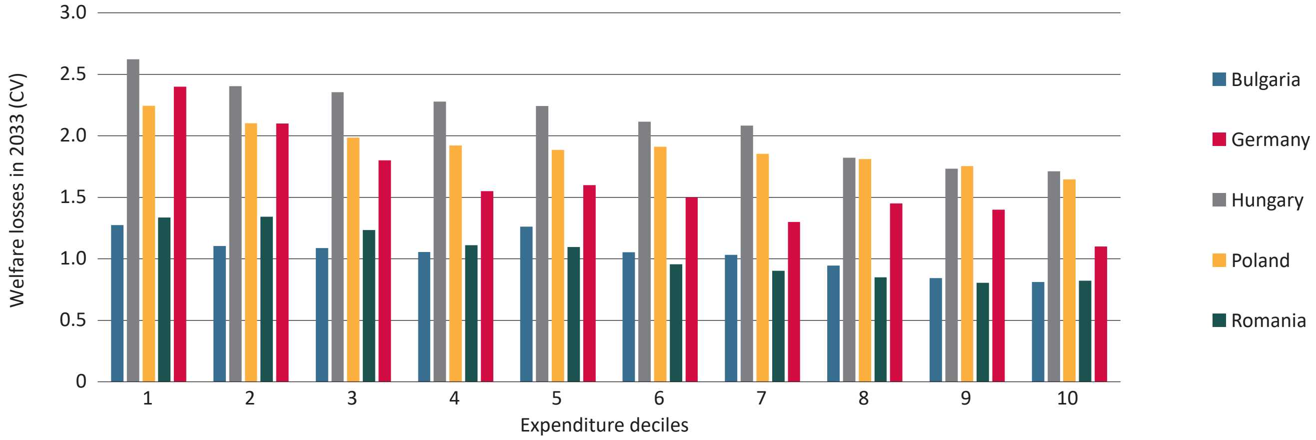
Aggregated welfare losses from the carbon price until 2033, distributed across the ten expenditure deciles, and even before the redistribution of the additional tax revenue to consumers, are minor (Figure 4) although the relative burden of the carbon price affects marginally more strongly lower-income segments of the society. Looking at the top 10% and the bottom 10% in terms of household expenditures, on average, Hungary has the highest welfare losses in 2033, as households would have to earn on average 2.2% more following the introduction of a carbon price to maintain their initial consumption levels, while Bulgarian consumers are the least vulnerable with welfare losses at around 1.1%.

Box 2. Methodology for Assessing the Impact on Households

For the microeconomic analysis, five distinct versions of a QUAIDS demand system model are employed (one for each country) to estimate the changes in household behaviour after the implementation of a carbon tax. The assumed carbon price levels used in the analysis are the same as for the macroeconomic analysis and the data comes from the Household Budget Surveys (HBSs) which analyse household expenditure patterns. The model calculates shifts in consumption behaviour resulting from carbon price-induced changes in relative prices for different expenditure categories, and then derives welfare losses for each expenditure decile, i.e. how much each household group (from the poorest 10% to the wealthiest 10%) would have to earn on average to maintain their pre-tax consumption level.

Germany is the country with the most pronounced adverse distributional effects, while Bulgaria exhibits the smallest differences between deciles.

Figure 4. % Welfare Losses in 2033 Prior to Redistribution in Central Europe



Source: *CSD based on the QUAIDS Demand System Model.*

A more interconnected energy sector within the CEE is likely to reduce the distributional effects of carbon prices, further improving the effectiveness of policy tool on GHG emissions cuts. Generally, distributional effects of policy tool depend on the scope of the pricing mechanism, with broader policies resulting in more evenly distributed costs[6]. As the expenditure patterns in the five countries are not identical, abatement incentives generated by any carbon price would follow the principle of cost-effectiveness, smoothing the immediate price changes and reducing short-term welfare losses. For example, in a well-integrated energy market, suppliers will import electricity from the most cost-competitive sources abroad (i.e. primarily renewables), instead of having to rely on more expensive domestic fossil fuel power plants. Hence, the improved coordination between Transmission System Operators (TSO) could allow for the optimization of the renewable energy trade on a regional level reducing power prices in all countries.

Although the distributional effects of carbon pricing in Central Europe are rather mild, even small welfare losses could be especially harmful for poorer households. They can also incite a social backlash against carbon pricing and decarbonisation policies in general. It is therefore up to national governments to redistribute the additional tax revenues as efficiently as possible as to target the most vulnerable communities with the goal of reducing energy poverty.

The study assumes three principal scenarios for redistribution: 1) a lump-sum cash transfer scenario where each household receives the same amount of money, 2) a double-dividend scenario where other taxes are reduced to offset the carbon price, 3) a price subsidy scenario in which tax revenues are redistributed inversely proportional to household budgets, so that poorer households benefit comparatively more.

The most significant reductions in energy poverty can be seen in the price subsidy scenario, with reduction rates of around one percentage point for all countries (Table 1). Slightly smaller energy poverty cuts are implied in the lump-sum scenario, as the poorest households receive the same monetary amount as the richest households, although relative to their budget the poorest households still receive greater support. In a double-dividend scenario, energy poverty rates would increase in all countries except in Germany. Given that the double-dividend scenario is comparable to an income tax cut, it is only logical that more affluent households will benefit disproportionally more in such a scenario, while poorer households would barely see any welfare gains.

A price subsidy is most effective at reducing energy poverty, as it will primarily benefit poorer households. However, such a policy might potentially generate a backlash from middle and high-income households, who would have to swallow higher welfare losses. In addition, the price subsidy distorts market signals to households that could otherwise invest in improving energy efficiency or be incentivized to save energy. Regulated prices have been the main strategy for reducing energy poverty in the CEE region, which has undermined the financial stability of state-owned utilities, public energy suppliers, and has, at the same time, contributed to wasteful consumption patterns.

6 Köppl, A., and Schratzenstaller, M., "Effects of environmental and carbon taxation: A literature review", – In: WIFO Working Papers No. 619, Austrian Institute of Economic Research (WIFO).

Table 1. Impact of Carbon Pricing and Tax Redistribution on Energy Poverty[7] Rates

	Baseline scenario (2022)	Post-tax scenario (2033)	Post-redistribution scenarios (2033)		
Country			Lump-sum	Double dividend	Price subsidy
Bulgaria	16.50%	18.05%	15.78%	17.01%	15.18%
Germany	6.26%	8.93%	5.34%	6.15%	5.03%
Hungary	11.45%	12.49%	10.65%	12.16%	10.57%
Poland	10.80%	12.52%	10.20%	11.55%	9.85%
Romania	13.83%	15.44%	13.66%	13.89%	12.59%

Source: *CSD based on the QUAIDS Demand System Model.*

In comparison, a simpler redistribution system like the lump-sum rebate comes with fewer administrative risks attached and will be more likely to gain the support of different societal groups. Lump-sum cash transfers do not distort market signals and allow households to directly support housing investments that improve their comfort and reduce energy demand. Cash transfers have to, however, be attached to strict spending requirements so that the financial support is used for energy efficiency investments and replacement of appliances rather than for supporting general spending.

Three general conclusions can be drawn from these results: First, carbon pricing can improve the welfare of less affluent households with an appropriate redistribution mechanism. As the CEE region is characterised by structural income and wealth inequalities, the findings from the modelling assessment would improve public backing for a carbon price, which in turn would facilitate its political implementation. Moreover, while households largely maintain the same level of spending due to the redistribution payments they receive, the emissions related to their consumption patterns will decrease as their spending behaviour is elastic to price changes between different expenditure categories.

Second, carbon price-induced welfare losses will be mitigated, in all three types of revenue redistribution approach considered in this study. Third, some revenue redistribution approaches produce second-order effects while reducing the distributional effects induced by the carbon price. Using the carbon price revenues to allow for other tax cuts, for example, will primarily benefit wealthier households, but still poorer households would receive welfare gains especially if the tax cuts are specifically tailored to changing their energy behaviour.

Box 3. The Weakest Link

Bulgaria is by far the most vulnerable country to energy poverty risks, although there has been significant improvement in key affordability factors, such as the share of oil and gas import costs in GDP and the energy expenditures per capita. Bulgaria still stands out as underperformer relative to other countries in Central Europe. In 2019, estimated energy expenditures in Bulgaria for every EUR 1000 of GDP stood at over EUR 65, 50% higher than the region's average. Meanwhile, Bulgaria's energy consumption per EUR 1000 GDP is three times higher than the EU average, contributing to high energy expenditures and fuel poverty among households, among which one quarter cannot adequately warm their homes.

Although considerable progress has been made over the last decade in reducing energy intensity, a large part of this success is the significant expansion of services at the expense of the industrial and agriculture sectors. CO2 emissions per capita,

[7] Due to data availability constraints, the present study uses an expenditure-based definition for energy poverty that takes into account households with expenditures that are below 50% of the national median. While this captures better energy poverty in the lower income deciles, it might miss energy poverty among the middle class living in energy inefficient dwellings and thus having relatively high energy expenditures. Tackling energy poverty requires a strategic, integrated approach that goes beyond the scope of this study, which focuses on carbon pricing mechanism that does not exacerbate but rather alleviates energy poverty.

on the other hand, have stagnated at a level s lightly below the EU average which is, however, not a result of effective decarbonisation policies, but rather of higher levels of energy poverty.

The long-term macroeconomic impact of introducing a carbon price would be minor in Bulgaria. The added value in the energy sector will see a slight positive deviation from the non-carbon-tax scenario, while other sectors will see a slightly negative deviation. The cumulative deviation in the size of the GDP relative to the non-carbon price scenario is smaller than in Romania and Poland, where coal and natural gas play a more central role in the economy. While a carbon price would contribute to the decarbonisation of the industrial sector, it is insufficient to bring about the kind of deep transformation of the sector which is needed to maintain its competitiveness in the long term. Thus, a carbon price needs to be flanked by additional government support that focuses not only on investments in energy efficiency but on a general transformation of production processes, the introduction of cutting-edge low-carbon technologies, as well as the shift to synthetic fuels and green hydrogen.

Countering Energy Affordability Risks in Central Europe after the Russian Invasion in Ukraine

In the present study, the effect of the carbon price on prices and consequently on households is isolated from other critical factors, such as commodity prices and overall inflation. This distinction has become critical for a fact-based public debate in light of the current energy crisis, to counter widespread misinformation narratives blaming the crisis on the European Green Deal and higher carbon prices.

The worsening of affordability risks across Europe since 2021 has largely been driven by the natural gas/electricity conundrum. Gas supply shortages, coupled with a strong economic recovery after the end of the COVID lockdowns, led to skyrocketing gas prices. Meanwhile, the reliance on gas power plants to meet peak demand makes them the market price-setter and their higher operational costs have pushed up electricity prices dramatically in the fall and winter of 2021, and they have remained very volatile ever since. The situation was exacerbated by the increase in crude oil, coal, and ETS quota prices that raised the overall energy import bill of European countries and the electricity production cost for all fossil-fuel-based plants.

This crisis has revealed how the overreliance on fossil fuels can significantly increase energy and climate security risks, and could undermine the viability of the energy transition. It has also bolstered voices urging for the revision or even the halting of the European Green Deal. This would be the wrong response. The European Green Deal is not the cause of the energy crisis, but the solution. It is also potentially the strongest instrument for reversing climate change and increasing the energy security of the EU and its members.

The Russian policy of squeezing European gas markets in order to worsen the stability of power markets has forced European governments to take drastic action to blunt the Russian attack and shield their energy markets and economies from the fallout. The total financial support in the form of direct subsidies and tax deductions across EU countries for households and businesses has reached EUR 350 billion, an amount deemed necessary to mitigate the impact of skyrocketing prices. The EU also unveiled a proposal to cap electricity prices at EUR 180/MWh for power producers not using natural gas, in addition to capping extra profits from oil and gas companies and using the revenues from sales above this price (estimated at EUR 150 billion) to finance support measures by member states. This emergency measure, which should remain in place through the end of March 2023, has been met by a wave of criticism that the Commission is undermining the foundations of European electricity markets.

Higher energy prices are, in theory, necessary to justify the economic viability of energy efficiency investments and more rapid deployment of cutting-edge renewable energy technologies. However, their short-term detrimental impact on industrial competitiveness and living standards have pushed governments to adopt market-distorting measures such as fuel subsidies and price caps, adopting a populist agenda that could undermine long-term energy and climate policy.

Energy poverty undermines the acceptability and feasibility of the deep decarbonization of the energy sector. The increase in CO_2 prices will raise energy poverty risks, and could cause a social backlash against renewable investments. However, carbon pricing is necessary for the decarbonization of the energy system as it disincentivizes fossil fuel-based power production. A critical policy conclusion is that sending the right market signals for the acceleration of decarbonisation policies is not the only prerequisite for a successful transition. Unless affordability is guaranteed, or basic support mechanisms are planned to avoid extreme outcomes, energy poverty would remain the primary barrier to structural changes.

National expenditures and the share of the household income taken up by energy costs are the key components of an energy affordability assessment. They are strongly affected not only by the price level of different energy sources, but also by the fuel mix, consumer choices, and energy efficiency. In this sense, high energy consumption and the use of more expensive fuels strongly influence affordability risks. This also significantly limits short-term solutions and measures that policymakers may take in order to reduce the effect of extreme prices on households and businesses. Improvements that structurally change the population's response to price shocks require a long-term commitment that five-year political cycles are insufficient to guarantee.

Related to this, the EU should show leadership by mandating that member states redirect the additional tax revenues from the rising ETS quota revenues, the power price caps on non-gas power producers towards strategic investments aimed at ensuring long-term supply security and diversification, the uptake of cutting edge low-carbon technologies, and the radical transformation of energy demand in transportation, industry, and buildings.

Distilling the modelling results through the **Energy and Climate Security Risk Index**, carbon pricing has the potential to significantly reduce energy and climate security risks on several fronts. The expected reduction of fossil energy intensity levels across Central Europe would significantly reduce the exposure of national economies to energy price fluctuations, while more of the value added will increasingly come from non-energy intensive sectors. Higher carbon costs would have a slight negative impact on overall affordability risks, but as the most recent experience from the energy crisis has demonstrated, the impact of carbon prices on energy costs pales in comparison to the volatility of natural gas and oil prices, which were the main factor driving up affordability risks ahead of the war in Ukraine.

The expected reduction of fossil fuel imports will also have a significant positive impact on geopolitical risks. With gas imports falling by between 10% (Romania) and 35% (Hungary) over the next decade, this could directly translate into lower reliance on Russian gas without the need to invest in new gas import infrastructure. Finally, a significant reduction of carbon emissions will bring down sustainability risks through lower CO_2 emissions per capita and per GDP produced, as well as increasing the share of low CO_2 electricity generation.

Introducing a carbon price signal that can meaningfully accelerate the low carbon transition is of critical importance for reducing energy and climate security risks. This can be done not only without hurting vulnerable households – it can be part of the solution to reduce energy poverty and inequality more generally. EU and national policymakers need well-designed carbon pricing and redistribution policies. These policies also need to be well communicated to the general public to counter disinformation narratives that seek to undermine and delay the low-carbon transition and to perpetuate the region's dependence on imported fossil fuels.