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A JUST PATHWAY TO DECARBONIZATION IN GERMANY

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EXECUTIVE SUMMARY

This policy paper examines the macroeconomic and microeconomic implications of implementing a stringent carbon tax in Germany, alongside the consequences of various redistribution scenarios on welfare and energy poverty.

Macroeconomic Implications:

- Germany could reduce its dependency on natural gas imports by around 15% until the end of 2023.
- The carbon tax's impact on Germany's economic growth pathway is manageable, with most economic sectors being unaffected and the services sector experiencing a 0.4% decrease in value-added by 2032.
- The energy sector is expected to grow by around 0.4% in the same period, driven by the growing importance of renewable energy.
- Employment effects are minimal, with less than a 0.3% decrease in industry jobs by 2032 compared to the baseline scenario without a carbon tax.

Microeconomic Implications:

- Without revenue recycling, the tax displays mildly regressive effects, with welfare losses being greater for the poorest 10% of German households.
- Three redistribution scenarios (price subsidy, lump-sum, and double divided) show that aggregate social losses decrease substantially in all cases, confirming that carbon pricing has minimal impact on less affluent households when a redistributive policy is implemented.

Energy Poverty Concerns:

- While Germany is less affected by energy poverty compared to other European countries, the issue remains a grave concern, with almost 350,000 households at risk annually.
- The carbon tax would increase energy poverty rates by 42% before redistribution. All three redistribution scenarios reduce the share of energy-poor households, with the price subsidy scenario being the most effective in reducing the share by almost 20%.

BACKGROUND

Germany's macroeconomic situation

Since its reunification in 1990, Germany has consistently experienced robust economic growth, evident in both its GDP and GDP per capita. This progress has been particularly prominent in the last two decades, with Germany emerging as a primary driving force behind regional economic growth. The nation's growth pattern largely mirrors that of the European Union, with the few recessions it has encountered being linked to exogenous economic shocks impacting the entire Union, such as the Great Recession of 2008-2009. Furthermore, Germany has maintained a stable population, with modest overall increases in the past ten years, although this stability is partly due to higher life expectancy rates rather than rising birth rates.

The interplay between economic growth and population stability has resulted in greenhouse gas emissions remaining relatively unchanged compared to previous decades. However, Germany's emissions intensity has steadily decreased, albeit at a slower pace than the average European Union country. This reduction is attributable to the growth of employment in less energy-intensive industries and improvements in industrial production efficiency, particularly in sectors like automotive manufacturing.

From a policy standpoint, Germany is dedicated to one of the most ambitious energy transition strategies within the European Union. This plan includes a complete coal phase-out by 2038, with ongoing reviews potentially accelerating the timeline. Additionally, Germany has mandated that by 2030, 80% of its energy must be derived from renewable sources, incorporating 30 GW of offshore wind capacity by the end of the decade. Although these targets may appear ambitious, they are crucial for the coordinated efforts of the EU to achieve net-zero emissions by 2030, as mandated by the European Green Deal.

The German energy sector

In Germany's energy sector, the country's reliance on energy imports is noteworthy. Despite recent efforts to diversify due to geopolitical factors, Germany still depends on natural gas and oil imports. However, its energy mix includes various carriers: coal and gas are vital, while wind and solar PV have steadily grown and are becoming dominant. Specifically, wind makes up 18% and solar PV nearly 10%, akin to hydropower. Agriculture is closely tied to renewable energy advances, but the industry still relies on coal and other solid fossil fuels. As a federal state, Germany's regional differences impact emissions reduction rates, with pollution-heavy industries like chemicals affecting some areas more.

The German economy is service-oriented, with industry playing a significant role in specific regions (e.g., Bavaria's automotive sector). This structure implies that decarbonization strategies must consider diverse greenhouse gas sources and cater to each Bundesland's unique features. A one-size-fits-all approach would be sub-optimal and unpopular. Implementing a stringent carbon price requires considering local sensitivities and well-planned complementary social policies.

Energy poverty concerns

According to the latest data from Eurostat, Germany is among the countries least affected by energy poverty concerns in 2022 and 2023. Less than 2% of German households have been in arrears on their monthly utility bills, and approximately 1% have experienced disconnections due to financial hardship. Additionally, only 2.5% of German households, although not traditionally considered at risk of energy poverty, reported difficulties in keeping their homes adequately warm. While energy poverty risk may appear relatively mild compared to other countries in East-Central and Southern Europe, it remains a significant concern that nearly 350,000 households face energy poverty risks annually. This number has not declined over the past decade, and some years have even shown substantial increases in the number of affected individuals.

It is important to note that many households experiencing energy poverty do so transiently, meaning they face significant hardship only for a limited period. This suggests a certain level of resilience but also indicates that aggregate statistics may underestimate the actual scope of the problem. Thus, while Germany may have a less severe chronic energy poverty challenge, it faces a more widespread risk of temporary energy poverty. This is particularly concerning because experiencing energy poverty at some point has been shown to be a strong predictor of future energy poverty.

Recent research has identified specific socio-demographic and socio-economic characteristics that are likely associated with an increased risk of energy poverty, including low educational attainment, low labor intensity, rural household location, and housing conditions. These factors have become more significant in recent years due to the high prices of electricity and natural gas in Germany. For example, in 2021, German households paid the highest electricity prices in the European Union and some of the highest gas prices. Importantly, these high prices affected both household and non-household consumers, creating multiple channels through which energy poverty could impact vulnerable populations.

In recent years, concerns about energy poverty have gained prominence in the German political landscape due to several concurrent developments: the increased ambition and stringency of national climate policies, EU-wide objectives and policies (e.g., the EU ETS), as well as exogenous shocks like the COVID-19 public health crisis and geopolitical tensions in Eastern Europe (exacerbated by Russia's recent aggression in Ukraine).

Although German authorities have not yet implemented federal policy packages specifically addressing energy poverty, some argue that this is due to the limited number of households affected. However, German welfare provisions do include energy-related expenses within their broader scope, alleviating some pressure on vulnerable consumers. Notably, such measures typically cover heating expenses rather than electricity consumption. Additionally, more localized policy responses have been implemented, particularly regarding improved energy efficiency standards.

METHODOLOGY

To thoroughly evaluate the potential impacts of implementing economy-wide carbon pricing, interdisciplinary researchers from Bulgaria, Romania, Hungary, and Poland, in collaboration with *ideas into energy gGmbH*, utilized a comprehensive, data-driven approach that incorporates a wide range of factors to accurately predict macroeconomic and microeconomic consequences. The analysis begins by modelling individual carbon price levels for each country, aiming for a 40% reduction in CO2 emissions by 2032 compared to 2022, considering each nation's unique circumstances.

The model then calculates the necessary carbon price for each nation to achieve this emissions reduction target, considering factors such as the country's macroeconomic situation, carbon intensity, trade structure, energy mix, and the relative effectiveness of various mitigation strategies. Carbon prices are assumed to rise linearly over the modelled period, reaching approximately $22.58/tonne of CO2 for Germany by 2033. These predicted carbon price levels are then used to determine the potential deviations in macroeconomic indicators, such as GDP, employment, and sector-specific value added (including agriculture, manufacturing and services), from a baseline scenario without carbon pricing between 2023 and 2032.

To examine the effects of a carbon price of $22.58/tonne of CO2 in Germany by 2032 on households, the study measures changes in welfare across various income groups and energy poverty levels, which are important indicators of social equity. Utilizing national household budget survey data and a sophisticated microsimulation model, the analysis estimates the additional financial burden (welfare losses) on households by determining how much more each income group, from the poorest 10% to the wealthiest 10%, would need to earn on average to maintain their pre-carbon-price consumption levels. This assessment takes into account the carbon intensity of household consumption, the resulting cost increases due to carbon pricing, and the anticipated shifts in consumption patterns based on microsimulations that consider price changes, price elasticities of demand, and potential behavioural adjustments.

The analysis also models how different revenue redistribution mechanisms could alter welfare losses and energy poverty rates, considering various policy instruments and their effectiveness. The study assumes three main scenarios for redistribution: 1) a lump-sum scenario where each household receives an equal amount of funds, 2) a double-dividend scenario in which other distortionary taxes (such as labor or consumption taxes) are reduced, promoting economic efficiency, and 3) a price subsidy scenario where revenues are redistributed inversely proportional to household budgets, providing greater benefits to poorer households and ensuring a more equitable distribution of the carbon pricing burden.

MACROECONOMIC IMPLICATIONS

Currently, Germany has implemented a national carbon pricing policy that mainly applies to oil and natural gas, as the main sectors covered through this carbon market are heating and transportation. Therefore, at least conceptually, this system complements the European Union's Emissions Trading System. Nevertheless, the potential for developing a more stringent carbon price is evident, as both the scope and size of current measures are unlikely to be sufficient to align with the long-term objectives of the European Union.

Introducing such an encompassing carbon tax would have significant results related to Germany's decarbonization efforts. By increasing the costs of certain fossil fuels, our model predicts that until the end of 2023, Germany could reduce its dependency on natural gas imports by around 15%. It is crucial to note that such massive underpinning would be independent of other policies aimed at decreasing the role of gas, which could further reduce the level of emissions associated with Germany's economic activities through interaction with the carbon price. Moreover, the pace of reduction is similarly impressive, as Germany could rapidly reduce its need for natural gas by more than 5% by the end of next year. Given the current situation with the Russian invasion of Ukraine and the efforts of European countries to reduce their dependency on Russian fuels, this policy appears to be effective and timely.

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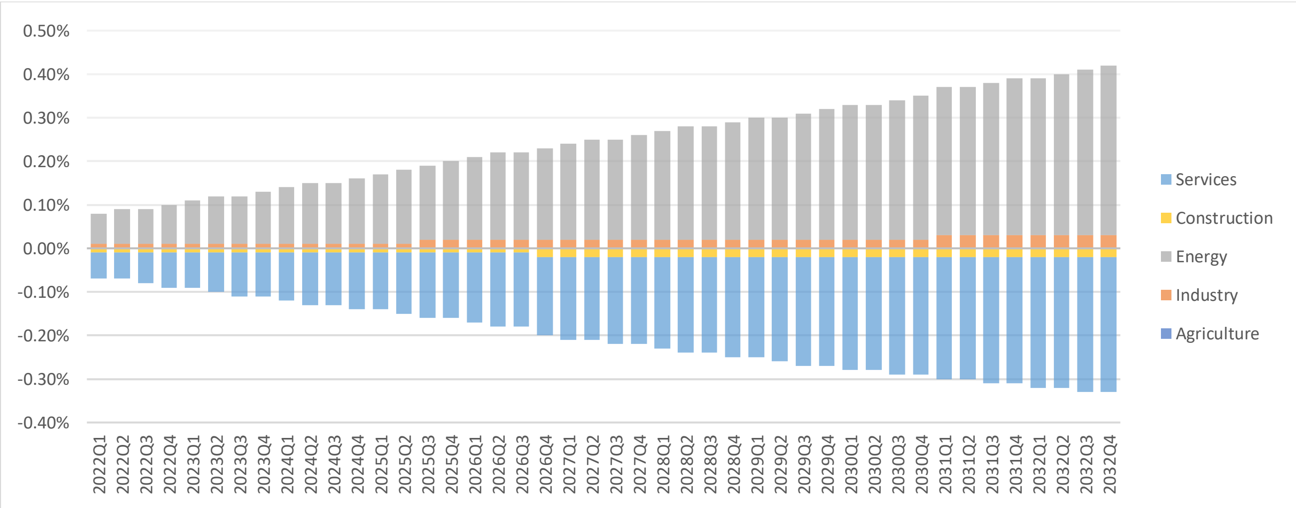

Figure 1. Carbon pricing effects on value-added by sector

Further, one of the more critical questions concerning the consequences of stringent carbon pricing mechanisms is the effect such a policy would have on Germany's economic growth pathway. While in the absence of any other measure, a carbon tax would have specific distortionary impacts like any other fiscal instrument, our model reveals this to be a manageable challenge. Figure 1 reveals a series of stylized facts that describes the direction and size of the effects induced by a carbon tax on the German economy. First, a series of economic sectors (including industrial branches) are likely to be unaffected by the introduction of the policy in terms of their value for the economy. Second, the only sector that appears to be affected by carbon pricing is the services sector. As a reminder, services were the main contributor to the German economy, both in terms of employment opportunities for the general population and of value-added. While this is an interesting development, possibly related to the reduced dependency on natural gas imports, it is essential to note that this sector is also the most resilient. Therefore, the 0.4% decrease in the value-added by services by 2032 is likely to be compensated either through market mechanism (i.e., a dynamic restructuring of where the investments in the services sector are directed) or through state-driven incentives.

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Finally, the energy sector is expected to grow by around 0.4% in the same period, driven most likely by the growing importance of regionally-located companies in the field of renewable energy. As Germany is committed to becoming carbon-neutral, the carbon tax would thereforecontribute to the process of directed technological change.

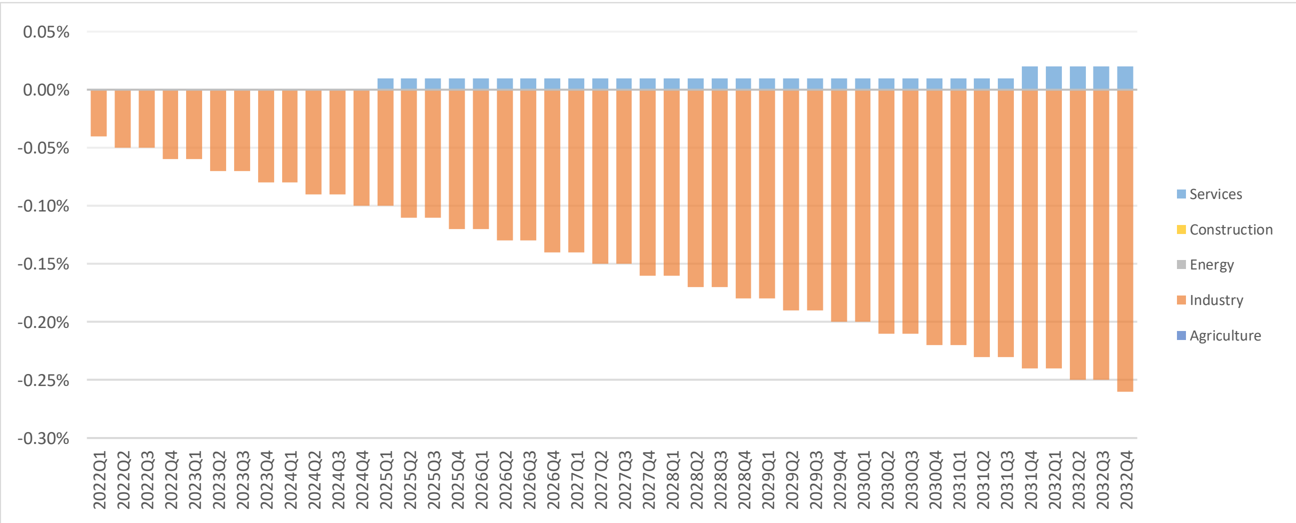

Figure 2. Carbon pricing effects on employment

Regarding the employment effects of carbon taxation in Germany, the overall impact appears to be minimal and concentrated in the industrial sector. However, by the end of 2032, the losses of industry jobs will be less than 0.3% compared to the baseline scenario where the new carbon tax is not implemented (Figure 2). While this is not negligible, as the people losing their job are likely to be concentrated in geographic hotspots, the ability of the German government to compensate them is not under question. Furthermore, referencing the German strategy of assisting workers affected by the coal phaseout as an example of targeted intervention, it would appear that the carbon tax would not require outstanding efforts from either the 16 Bundesländer or the national government. Additionally, while also small, the carbon tax is going to create new labour opportunities in the service sector. As stated before, this is correlated with the likely growth of the renewable energy firms in Germany over the next decade. While it is unclear whether a correspondence between services and industry could be established, work training programs could facilitate this endeavour. Therefore, the stringent carbon tax regime in Germany could be, in the optimistic scenario, an example of market self-adjustment.

The main challenge of Germany's energy transition is ensuring a cost-optimal abatement strategy that improves the ability of domestic firms to maintain their shares and profitability in the European and global markets. Given how decarbonizing industrial processes is central to achieving a net-zero economy in the timeframe set by the European Union, Germany will have to engage in a systematic process of directed technological change that prioritizes the introduction and development of new, market-ready low-intensity goods. This is essential for multiple industrial sectors, but one can immediately think of the chemical and automotive sectors as typical examples of where intervention needs to be well thought. In the case of Germany, an optimal transition pathway is not only important at the national level but also essential for the economic stability of the European Union. As shown through our macroeconomic modelling strategy, stringent nationwide carbon pricing mechanisms could contribute, sometimes in subtle manners, to addressing this challenge. The reason for which a carbon tax could be necessary is that, with minimal adverse effects on employment structures and sectorial value-added, it helps Germany to reduce its dependency on energy imports, which in recent months has proven to be one of the weaknesses of the German economy. Additionally, the carbon tax is expected to increase the value-added by the energy sector, thus contributing directly to internal diversification, which can only augment the country's technological potential.

MICROECONOMIC IMPLICATIONS

Figure 3 presents the primary results of the QUAIDS-based microsimulation, highlighting the welfare losses caused by a German nationwide carbon tax applied across all economic sectors from 2022 to 2033. Firstly, without revenue recycling, the tax displays mildly regressive effects. For perspective, the average loss for the poorest 10% of German households is over double that of the wealthiest 10% (i.e., a compensating variation of 0.025 vs. 0.011). The taxonomy of loss types reveals three categories: high payers (the first three expenditure deciles), medium payers (the following six deciles), and low payers (the top decile).

These adverse effects result from a relatively low tax level of 20.51 EUR/tCO2, suggesting that more ambitious carbon pricing mechanisms may produce a larger impact if applied similarly to the entire German economy. The low carbon tax level could also contribute to the variation in welfare losses between deciles, as the average German citizen is unlikely to struggle adapting to the new pricing regime induced by the tax. Secondly, the definition of welfare losses used in this report suggests that all households would need to earn between 1.1% and 2.5% more monthly to maintain their initial consumption levels before the carbon tax. Considering other sources of price inflation, this implies a significant effort for a sizable share of the population (at least the bottom 30%), indicating that government intervention targeting the less affluent may be politically and socially desirable. This is particularly relevant due to recent developments in 2022 that have increased inflationary pressure faced by the majority of citizens. However, our data only covers the period before 2020, which could result in a downward bias in our estimate.

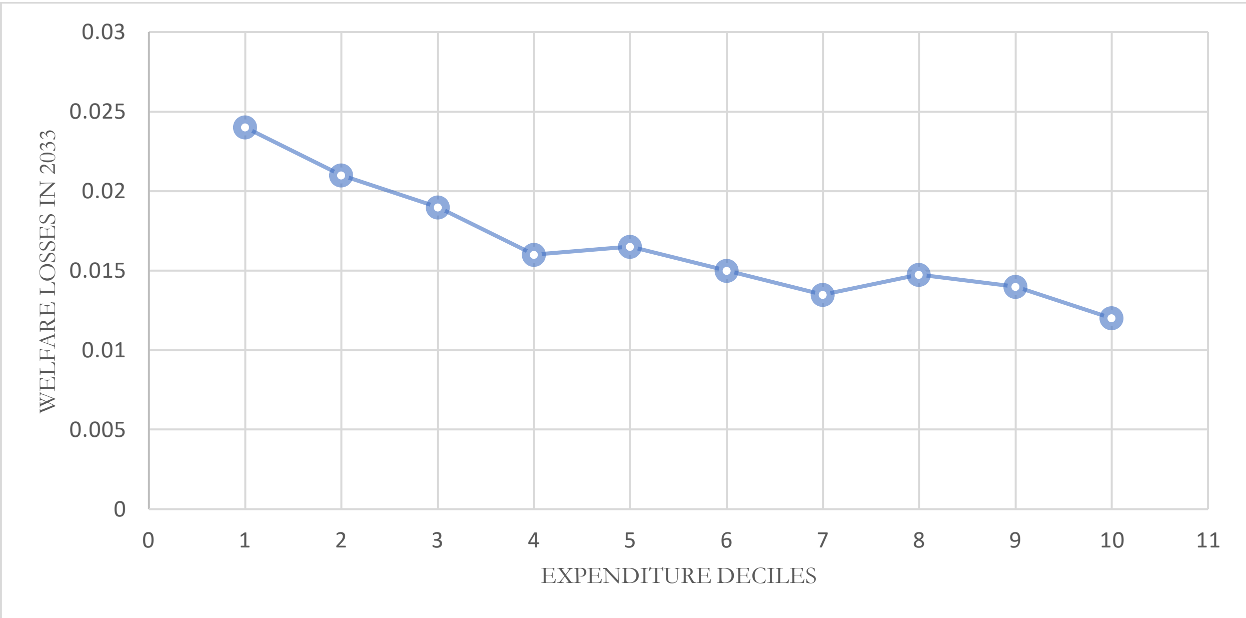

Figure 3. Welfare losses after the implementation of a carbon tax in Germany

Next, Figure 4 illustrates the welfare gains and losses across the German population under the carbon tax and three redistribution scenarios. Each scenario results in different winners and losers by 2033 compared to the baseline scenario before the carbon tax's introduction in 2022. Aggregate social losses decrease substantially in all three cases, confirming that carbon pricing in Germany has minimal impact on less affluent households when the government implements any redistributive policy. This holds true regardless of the policy's specific content.

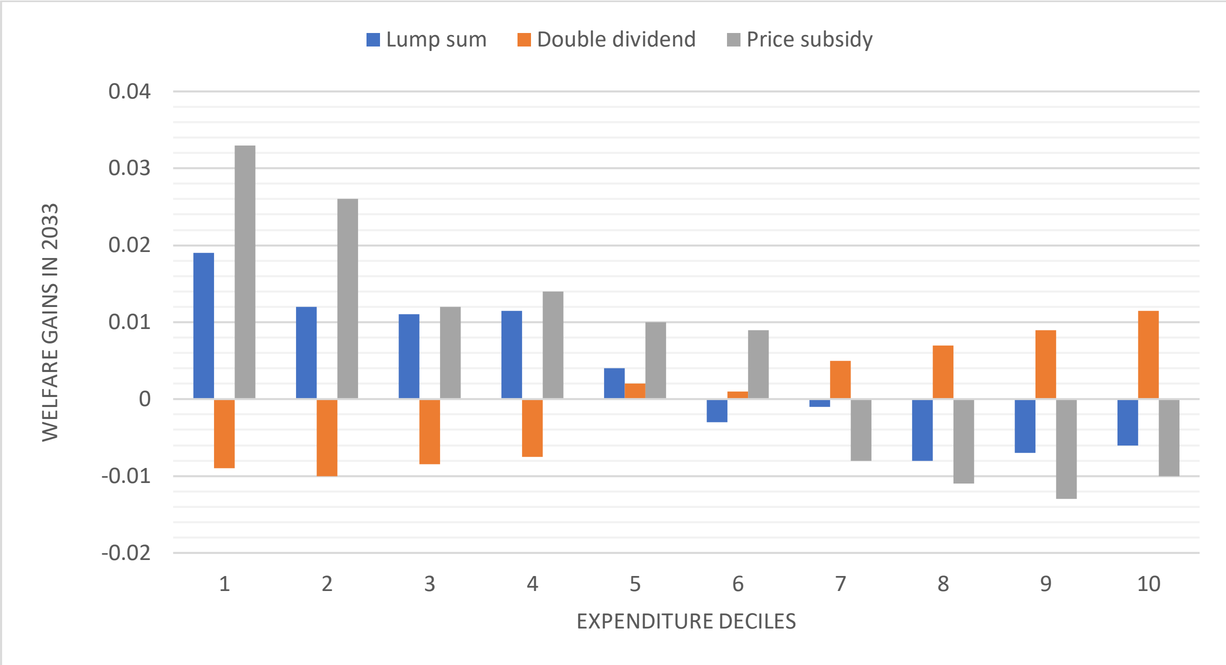

Figure 4. Post-redistribution gains and losses

• **The price subsidy scenario** is the most effective in reducing welfare losses for less affluent households, especially for the bottom 20%. Under this model of revenue recycling, households belonging to the first six deciles experience net welfare gains, with 60% of the population benefiting. This approach also has the potential to reduce overall inequality in the country. Although the wealthiest 40% become net payers (i.e., net losers), their losses are modest, with a maximum of 1.4% of their monthly income or about 66 EUR.

• **The lump-sum scenario** ensures that the bottom 50% of households incur no losses, becoming the net winners of this policy regime. However, under this redistribution scenario, the middle class is less protected from adverse effects, as people from the fifth and sixth deciles still incur minimal welfare losses. The net losers of the carbon tax regime are households in the top six deciles, but the total costs of carbon pricing are more evenly distributed. The simplicity of the lump-sum redistribution could be attractive for administrative ease in implementing and monitoring the policy across the German Bundesländer.

• **The double divided scenario** induces very different distributional and welfare effects compared to the other scenarios. In this case, the least affluent remain net losers, but the welfare effects are significantly less pronounced for the aggregate population. The net winners are the most affluent 60%, particularly the top three deciles. Politically, this could be seen as less feasible, as it increases within-country inequality and does not adequately address concerns like energy poverty. Nevertheless, further analysis on the broader effects of this scenario and the potential use of funds from the carbon tax to replace other distortionary taxes should be considered. Additionally, it would be relevant to study whether industry-specific measures would have a broader effect in generating large-scale welfare gains for those at the bottom of the expenditure distribution.

ENERGY POVERTY CONCERNS

Germany is one of the countries least affected by energy poverty concerns. Less than 2% of German households were in arrears on their monthly utility bills, and only ~1% had experienced disconnections due to financial hardship. Additionally, 2.5% of German households, despite not traditionally considered at-risk of energy poverty, have stated having financial difficulties maintaining the house warm. Nevertheless, while the risk of energy poverty might appear milder in relative terms, especially compared to other countries in East-Central and Southern Europe, it remains a grave concern that almost 350 000 households remain at risk of energy poverty annually. The number has not declined in the past decade despite the increased salience of this issue, and some years have displayed significant increases in the number of affected people.

Table 1. Carbon pricing and energy poverty

	Baseline scenario (2022)	**Post-tax scenario (2033)**	**Post-redistribution scenarios (2033)**		
			Lump-sum	Double divided	Price subsidy
Germany	8.25%	10.93%	8.34%	9.15%	6.02%

Table 1 presents our estimates for energy poverty in Germany, both in the baseline scenarios before carbon taxation in 2022, and at the end of the period studied in 2033. We see that in our baseline case, 8.25% of households are energy poor, a significant number but well below the average values for the European Union or, more specifically, Central and Eastern Europe. However, after implementing the carbon tax, before redistribution, the number increased by 32%, a dramatic situation if not well-managed by the authorities. This management first and foremost involves deciding which revenue recycling strategy is most well-suited for dealing with this societal challenge. The first observation from Table 2 is that all three redistribution scenarios reduce, even marginally, the share of energy poor German households. However, it is immediately observable that the price subsidy scenario is the most effective, reducing the impact on the share of affected households by almost 27%. The most attractive feature of this scenario is that all the funds required for reducing energy poverty come from the carbon tax, without the need to find other budgetary sources. In this sense, implementing a carbon tax complemented by a price subsidy scenario could reduce total emissions but also alleviate energy poverty within the country.

POLICY RECOMMENDATIONS

- **Implement a stringent nationwide carbon tax:** A carbon tax can help reduce Germany's dependency on natural gas imports, diversify the energy sector, and contribute to achieving the EU's long-term decarbonization objectives.
- **Couple carbon tax with a comprehensive revenue recycling strategy:** To address the regressive effects of a carbon tax and minimize welfare losses, revenue generated from the tax should be redistributed through well-designed policies targeting affected households.
- **Adopt a price subsidy approach to redistribution:** This scenario is most effective in reducing welfare losses for less affluent households, benefiting 60% of the population, and reducing overall inequality.
- **Develop targeted support programs for energy-poor households**: Given the significant increase in energy poverty rates following the carbon tax implementation, targeted support programs should be developed to alleviate energy poverty and ensure access to affordable energy for vulnerable households.
- **Encourage the development of renewable energy sources:** Support policies that promote the growth of regionally located renewable energy companies, as they contribute to the decarbonization of the energy sector and create new job opportunities.
- **Invest in retraining and workforce development programs:** To counteract job losses in the industrial sector and facilitate market self-adjustment, invest in retraining programs and workforce development initiatives that support workers in transitioning to jobs in the growing renewable energy and services sectors.
- **Support research and development in low-emission technologies:** Foster directed technological change by investing in R&D for low-emission technologies, especially in high-emission industries like chemicals and automotive sectors.

- **Monitor and evaluate the carbon tax's impact on various economic sectors**: Regularly assess the carbon tax's impact on economic growth, employment, and welfare to inform any necessary adjustments in tax rates or revenue redistribution strategies.
- **Enhance communication and stakeholder engagement:** Engage with stakeholders, including businesses and the public, to communicate the benefits of carbon pricing and revenue recycling mechanisms, addressing concerns, and building support for the policy.