FactSheet

BERTELSMANN STIFTUNG | JULY 2021

Carbon Pricing

Executive Summary – Five takeaways

1. By setting ambitious climate goals, the European Union (EU) is sending an important signal in the fight against climate change. Yet according to a simulation done by the Kiel Institute for the World Economy on behalf of the Bertelsmann Stiftung, the higher carbon prices that would result would only reduce greenhouse gas emissions to a limited extent over the long term – namely by just 2.5 percent, if carbon prices in the EU rise by an additional $50. That would be the equivalent of 760 million tons of CO_2.

2. The reasons for this modest outcome are Europe's small share of global emissions and the international division of labor. Higher carbon prices in Europe cause emissions to leak to countries where carbon prices are lower. In addition, European companies initially become less competitive. Countries with less efficient industries that are highly dependent on fossil fuels are particularly hard hit.

3. Transregional (the EU together with the US and/or China) or even global initiatives for carbon pricing (climate clubs) would have a much greater environmental impact compared to Europe's going it alone. A global increase in the carbon price of €50 would lead to a long-term reduction in global emissions of 38.6 percent, or 11.5 billion tons. Were the resulting tax revenues to be redistributed on a per capita basis, the income effects would be moderate: just 0.5 percent of GDP per country on average.

4. The carbon border adjustments planned by the EU would help reduce the shift in emissions to other countries, should Europe act on its own. Moreover, they would reduce the economic costs within Europe. Yet they would have very little impact on global CO_2 emissions: Instead of 2.5 percent, long-term emissions would be reduced by only 2.7 percent.

5. In terms of implementing an effective global climate policy, the EU, as an open economy with a high volume of emissions, should focus more in the future on its consumption-based emissions (carbon footprint) rather than looking only at production-related (territorial) emissions. It should view carbon border adjustments as an interim response and redouble its efforts to find a solution involving a transregional or, over the long term, even a global climate club. In implementing this solution, it should also take into account the social and economic costs for lower-income households and developing countries.

1 Why are prices increasingly being put on CO_2 emissions?

Reducing the amount of CO_2 emissions caused by humans is urgently necessary if **climate change is to be slowed**. One of the most **effective measures** for achieving this goal is charging higher prices for carbon-intensive goods, such as gasoline, steel and cement. This creates a financial incentive to produce and consume fewer emissions-generating products or services, to switch to lower-carbon alternatives and to invest in new climate-friendly technologies.

Two instruments can be used to set these prices: a **direct carbon tax** that stipulates the emission price; or a **cap-and-trade system**, i.e. a system for trading emissions certificates that sets a limit on emissions. The state can use the resulting revenue to provide financial support to households or industries that are particularly hard hit by the higher prices and to accelerate the transition to a lower-carbon economy, e.g. through additional spending on research or the expansion of infrastructure for renewable energies.

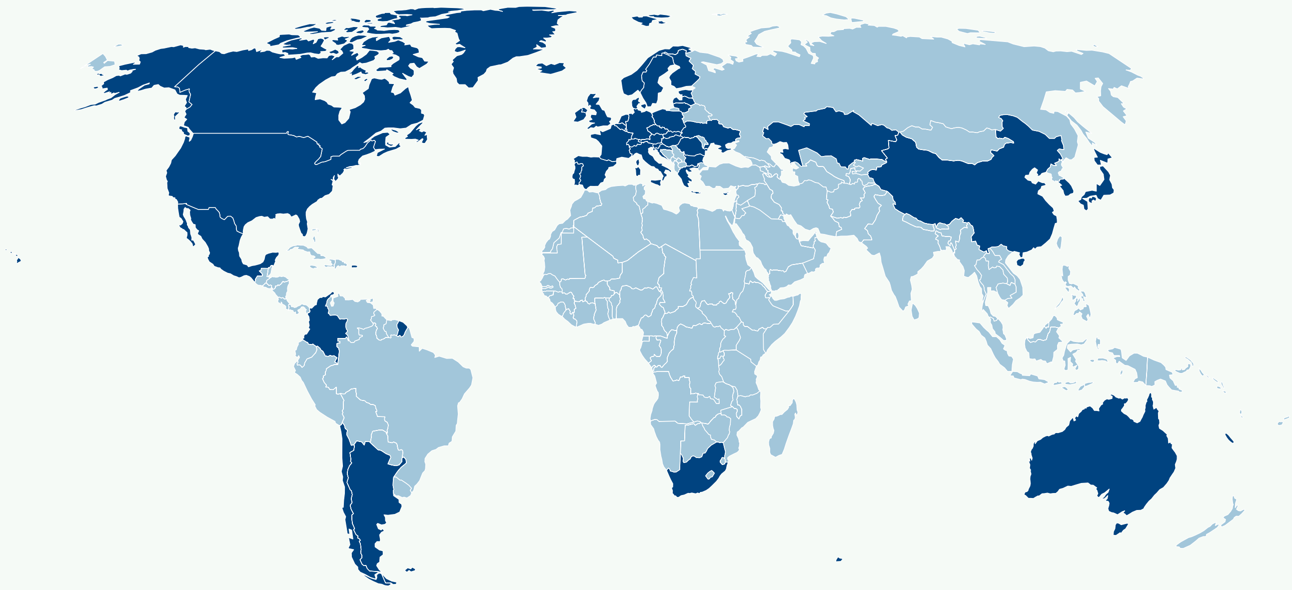
2 Which CO_2 price is charged in which country?

Finland and Poland were the first countries to charge moderate prices for selected carbon-intensive products in the early the 1990s. Other European countries gradually followed suit, and by 2005 all EU member states were participating in the EU Emissions Trading System (EU ETS). According to World Bank statistics, there are now **64 planned or realized initiatives** worldwide at the subnational, national or regional level (see Fig. 1). However, they account for only **21.5 percent of global CO_2 emissions**.

Prices vary significantly from country to country (see Fig. 2). The highest carbon price by far is charged by **Sweden**, at over **$130 per ton**. Next are Switzerland and Liechtenstein at about $100, followed by Finland and Norway at about $70 (as of April 2021).

What's more, all EU member states, along with Liechtenstein, Norway and Iceland, must also pay for the certificates traded in the **EU ETS**, the price of which is determined at auction and which fluctuates as a result. The certificates cover certain industrial goods, energy sources and air travel. After

FIGURE 1 **More and more countries are introducing carbon pricing.**



Source: World Bank. Carbon Dashboard (as of June 1, 2021)

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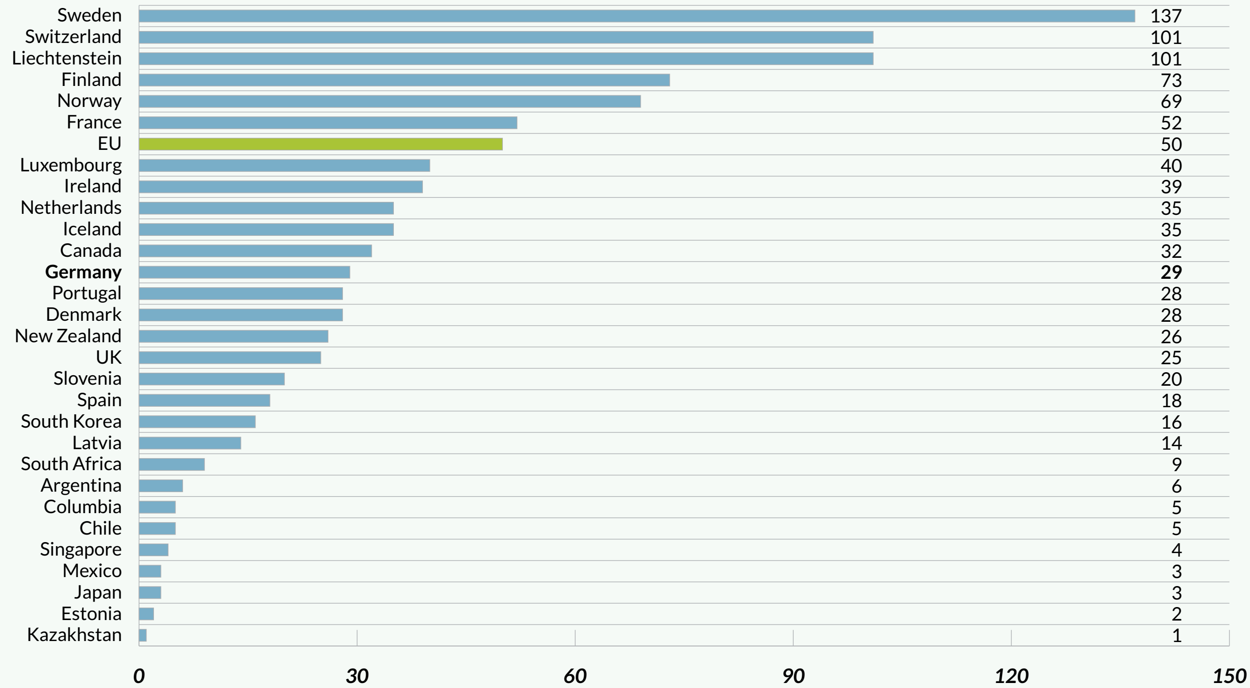
FIGURE 2 **Carbon prices vary significantly from country to country.**



Source: World Bank. State and Trends of Carbon Pricing (nominal prices in US dollars, as of April 1, 2021) | Bertelsmann**Stiftung**

FIGURE 3 **The price of EU ETS certificates has risen significantly over the last year.**

Source: Ember. Daily Carbon Prices (in euros, as of June 14, 2021) | Bertelsmann**Stiftung** a steep decline due to the Covid-19 pandemic, prices for the certificates climbed to **over €50 in May 2021 for the first time** (see Fig. 3).

In contrast, the prices charged in many non-European countries have been more symbolic – **just a few dollars or euros**.

3 How does carbon pricing work?

Carbon pricing has a series of **economic and environmental consequences** that, due to the international division of labor, affect not only countries that charge for CO_2 emissions, but the entire world. Since the EU imposes high carbon prices, **countries with a low carbon price** have a competitive advantage for emissions-generating products compared to companies in European states. This results in **two key impacts**:

1) **Emissions-generating products imported from abroad become more attractive for European consumers.** Countries with low carbon prices can thus increase their exports to the EU. That boosts production, gross domestic product (GDP) and employment in these countries – along with the amount of emissions they produce.

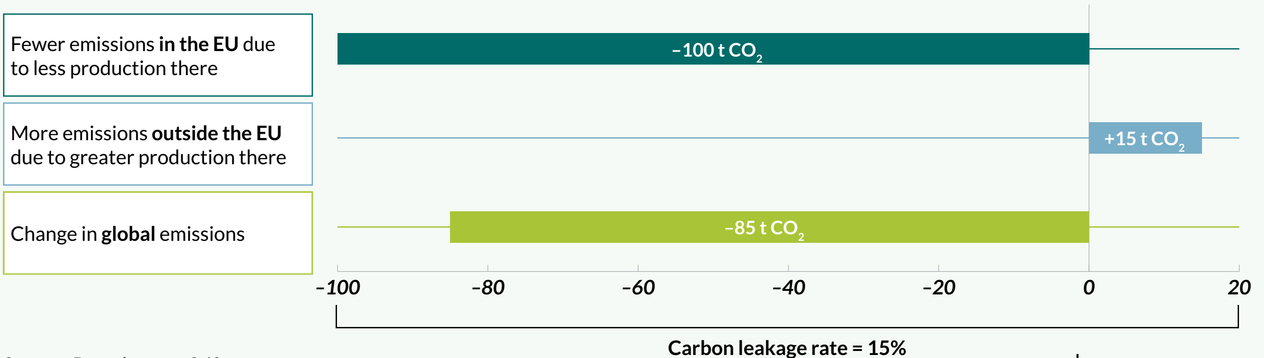
2) **Emissions-generating products imported from abroad also become more attractive for consumers in third markets** – i.e. in those countries that import goods from the EU and from countries with a lower carbon price. This means countries with less stringent environmental policies can export more, increasing their real GDP as a result. However, it also means that territorial emissions rise in countries with low carbon prices.

When higher carbon prices in one place lead to an increase in emissions in another – due to a shift in production or because of price effects on the international market for fossil fuels – it is called **carbon leakage**. Although the emissions produced on the territory of the EU decrease as a result of higher carbon prices, emissions on the territory of other countries rise as a result.

The indicator that quantifies the extent to which carbon leakage takes place is called the **carbon leakage rate**. It shows how many tons of greenhouse gas emissions are produced abroad when domestic climate policies lower emissions. The rate is expressed as a percentage. For example, when climate policies cause a reduction in greenhouse gas emissions in the EU of 100 tons, but result in an increase of 15 tons elsewhere in the world, the carbon leakage rate is 15 percent. It is therefore entirely possible that a particularly stringent climate policy in the EU will lower the EU's territorial emissions, but the policy's effectiveness in protecting the global climate will be reduced due to carbon leakage.

To better understand this dynamic, it is necessary to differentiate between a country's territorial emissions and its **carbon footprint**. The territorial CO_2 emissions used to assess whether national and international emissions goals – such as those laid out in the 2015 Paris Agreement – are actually achieved are the emissions generated by a country's **production**. The carbon footprint, conversely, measures the emissions resulting from a country's **consumption**.

FIGURE 4 **Impact of a higher carbon price in the EU on emissions in the EU and the rest of the world.**



Source: Bertelsmann Stiftung

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FIGURE 5 **Largest carbon exporters and importers in 1990 and 2017.**

Rank	1990				2017			
	Exports		Imports		Exports		Imports	
	Country	Mill. tons CO_2	Country	Mill. tons CO_2	Country	Mill. tons CO_2	Country	Mill. tons CO_2
1	Russia	486	EU	572	China	1,026	EU	610
2	Ukraine	201	Japan	163	India	204	USA	338
3	China	157	Germany	139	Russia	202	Japan	157
4	South Africa	94	Italy	125	South Africa	135	UK	148
5	USA	83	France	97	Iran	71	Italy	106
6	Poland	54	South Korea	71	Kazakhstan	68	France	101
7	Belarus	44	UK	68	Poland	40	Germany	84
8	Australia	33	Turkey	65	Qatar	34	Switzerland	81
9	Venezuela	28	Hong Kong	59	Australia	26	Belgium	73
10	Azerbaijan	23	Taiwan	52	Ukraine	20	Singapore	69

Source: Peterson et al. 2021

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The two figures vary due to the international division of labor, which often separates the site of production from the site of consumption. When the EU purchases goods from other countries, it imports the CO_2 emissions that went into producing those goods. Like other major developed economies, the EU is a net importer of CO_2 emissions, i.e. its carbon footprint is larger than its territorial emissions. Major newly industrialized countries (NICs) are generally net exporters. Much carbon-intensive production is thus already taking place in NICs, while consumption of the products made there often occurs in developed countries.

An analysis of national carbon pricing mechanisms to date (Peterson et al. 2021) shows that, while higher carbon prices discernibly reduce territorial carbon emissions, they are not effective in lowering a country's carbon footprint, in part because they increase carbon leakage.

4 What would happen if the EU raised its carbon prices further?

Until now, carbon pricing has not led to high leakage rates. However, as a result of the EU's ambitious climate goals, many member states will have to raise their carbon prices in the coming years and expand coverage to even more products. For example, a tax of €25 per ton of CO_2 came into effect in Germany on January 1, 2021. It applies to fuels for motor vehicles and buildings (above all, gasoline and diesel, along with heating oil, coal, natural gas and liquefied gas) and is set to gradually rise to €55 by 2025.

If these prices increase even further or if additional prices are imposed in coming years on other activities that are not dependent on their location, carbon leakage will become more attractive and the chances will increase that the gap between territorial emissions and carbon footprints will grow. In other words, **the EU will reach its goals for territorial emissions by shifting emissions to other states**. At the same time, carbon-intensive sectors in the EU will be subject to **greater competitive pressure**, threatening European companies and their employees with negative income effects.

We can estimate these emission and income effects with the help of a model developed by the Kiel Institute for the World Economy (for more on the methodology, see the box below). The model **tends to underestimate** the actual ecological effects of higher carbon prices, since it does not capture the medium- and long-term impacts, such as the adoption of more environmentally friendly technologies.

Figure 6 depicts what would happen if the **carbon price in the EU were increased by an additional $50**. As the chart clearly shows, the EU's territorial emissions would decline noticeably, especially in its Eastern European states, which still employ highly carbon-intensive production processes. At the same time, emissions would increase slightly in states outside the EU, since, with a carbon leakage rate of 14.9 percent, some emissions would shift to other countries. Overall, **global CO_2 emissions would fall** by 2.5 percent, or 760 million tons, due to the higher carbon price. Thus, if the EU were to take additional unilateral measures, they would benefit the globe's climate, **but only to a very limited extent**.

In Figure 7, we see the impact of this $50 price increase in the EU on **income development** in various states. **Those national economies are particularly affected in which the higher carbon prices lead to the greatest reductions in CO_2.** Above all, this applies to the economies in Eastern Europe that rely heavily on fossil fuels and that have imposed only modest prices on carbon, and countries that export fossil fuels to the EU, e.g. Norway, Kazakhstan and Libya. In contrast to the Eastern European states, however, the latter, not being members of the EU, do not benefit from the revenue generated by carbon taxes, which can be used to fund social policy measures. Even in countries that experience an overall benefit from carbon pricing, there are structural changes in the economy: The income and job losses in energy-intensive sectors, such as the chemicals or metalworking industries, are more than offset through growth in other sectors (e.g. financial or health services) and through additional tax revenues.

Simulation Methodology

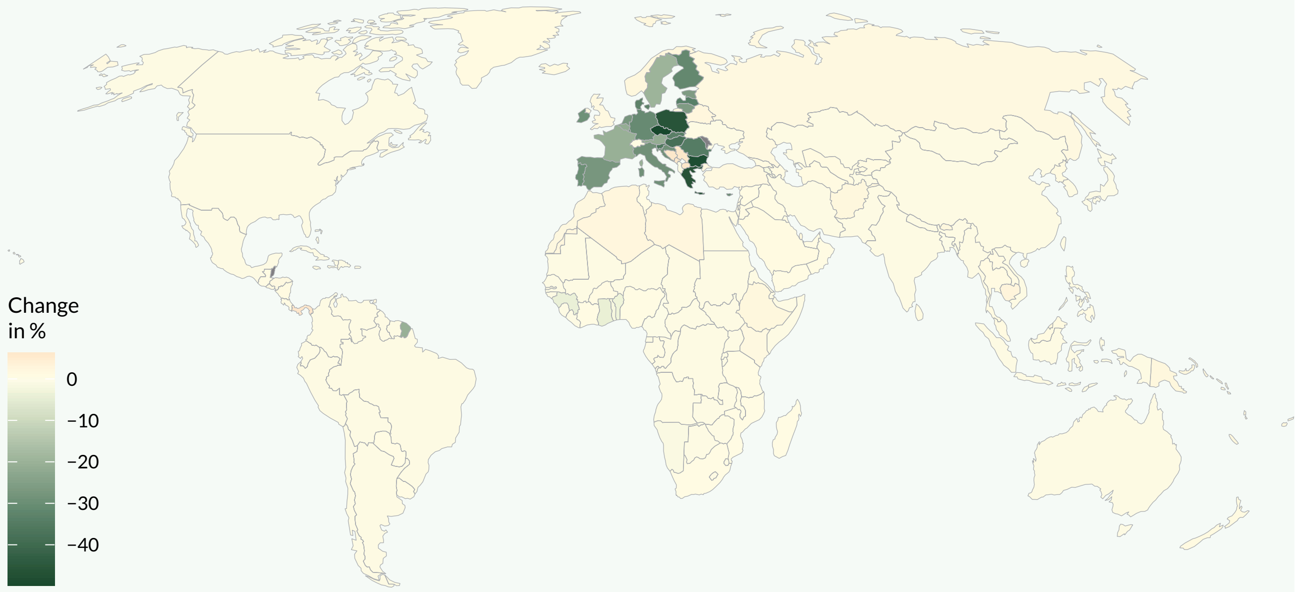
The simulations are based on a **foreign trade model**, the Kiel Institute Trade Policy Evaluation (KITE) model. The foreign trade flows of 141 countries captured by the model are supplemented with data on **CO_2 emissions**. To that end, fossil fuels are taken into account whose combustion produces CO_2 emissions. The fossil fuels are viewed as internationally traded products and as production inputs. A country's CO_2 emissions are measured by the consumption of these fuels. By examining 65 sectors, the level of emissions is calculated based on intermediate goods and the components in each product, allowing emissions to be quantified through to the end consumer.

The pricing of **fossil fuels** changes the international competitiveness of a country's individual sectors. Energy-intensive sectors become less competitive in countries with a carbon price that is relatively high internationally. This leads to a decline in production, GDP and employment in the affected sectors. It also makes it possible to quantify the carbon leakage effects outlined above.

The extensive data required for the model are currently available for the year **2014**. All calculated effects thus represent changes relative to the equilibrium in 2014 and reflect that year's sectoral production functions. To the extent that a country increases its carbon price, government revenues are redistributed on a per capita basis to the country's inhabitants. Since adjustments in foreign trade take time, the new equilibrium is reached only after a delay. Experience shows that this adjustment can take up to 10 years. Other short-term effects and effects impacting individual sectors are not modelled in the simulations.

A final note concerns the **modelling** of a higher **price for carbon**. When simulations are run to ascertain the impact of a global carbon price of $50, the prices valid in each individual country in 2014 are increased by $50. In terms of the EU, for example, this does not mean that this price replaces Europe's system for trading emissions certificates, but that a carbon tax of $50 is introduced in each country above and beyond the price of the certificates.

FIGURE 6 **Emission effects of an increase in the carbon price in the EU of $50**



Source: Felbermayr et al. 2021

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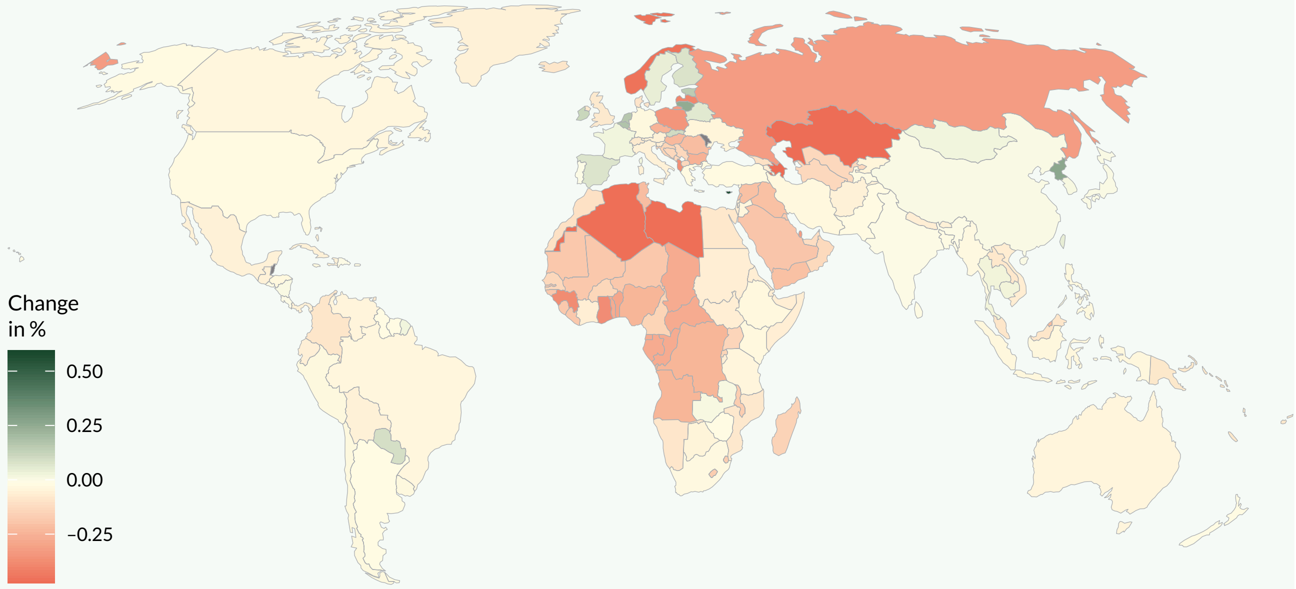
FIGURE 7 **Income effects of an increase in the carbon price in the EU of $50**



Source: Felbermayr et al. 2021

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5 What would happen if several countries came together to form an alliance that sets the same carbon price (climate club)?

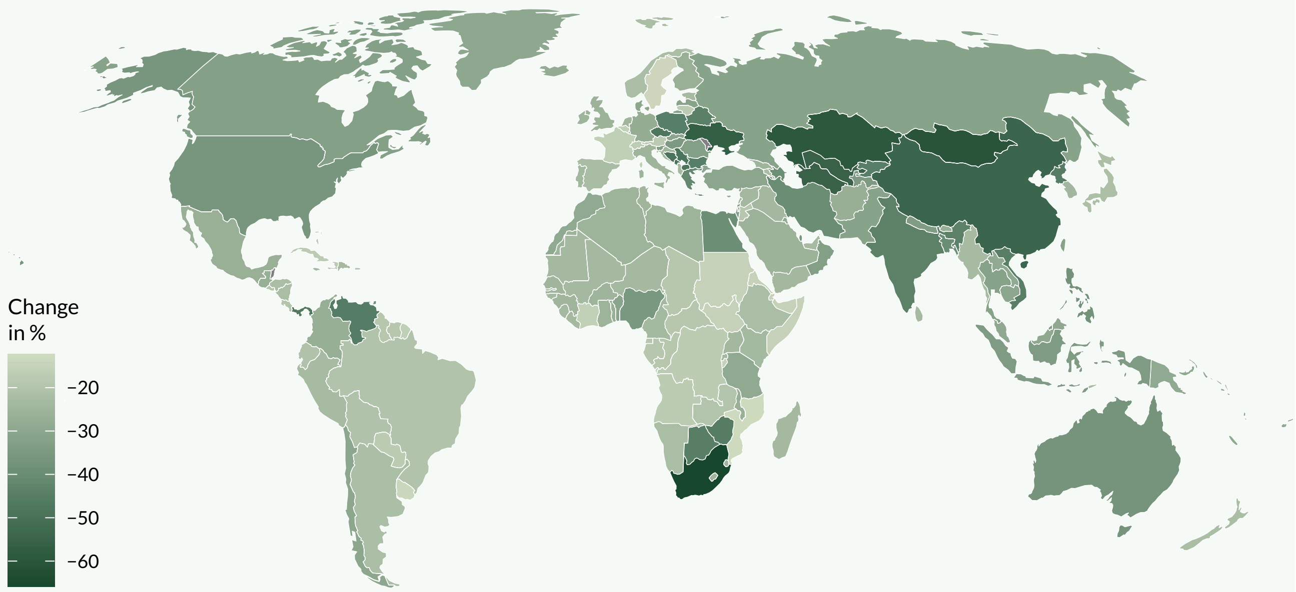
The **idea for a climate club** comes from William Nordhaus, recipient of the Nobel Prize in Economics. Countries with a similar position on the pricing of greenhouse gas emissions agree on a common emissions price, thus forming a climate club. Other countries can join the club, provided they are willing to abide by the predetermined price. A climate club offers its members an added incentive for participating: The countries that belong to the club can freely trade goods and services among themselves. Countries that are not members can only trade with the club if they pay a tariff. The import duty increases the costs that non-members must pay for their decision not to charge a high price for emissions. Climate clubs thus **punish the refusal to charge a high price for carbon** by reducing the advantages that the international division of labor offers non-members. The model used here, however, only considers the consequences of adopting a common carbon price. The simulation does not account for import duties imposed by climate clubs or the reduction of trade barriers between club members.

In a **global climate club**, i.e. when the price of carbon is uniformly increased by €50 worldwide, these effects are inconsequential, since no tariffs must be paid. This uniform increase results in very different outcomes (see Fig. 8). While economies with large service sectors reduce their emissions by a more limited amount, (e.g. Singapore, by 11.4 percent), countries that still rely heavily on coal experience an especially large decline in their emissions (e.g. South Africa, by 65.8 percent).

The income effects are also distributed differently. NICs and developing countries in Asia and Africa are particularly hard hit, with Mongolia having the largest fall in GDP, at 3.5 percent (see Fig. 9). Overall, however, **the income effects are moderate compared to the massive reduction in CO_2 emissions**. On average, they amount to 0.5 percent of GDP for all countries, and only 0.1 percent for EU member states (see Fig. 9).

As Figure 10 clearly shows, the **difference in global emissions is enormous when compared to Europe's going it alone**. Instead of 2.5 percent, emissions fall by 38.6 percent, or 11.5 billion tons. In this scenario, the carbon leakage problem disappears completely: Since all countries are club members, no CO_2 can escape. If only the major emitters collaborate,

FIGURE 8 **Emission effects of an increase in the carbon price worldwide of $50**



Source: Felbermayr et al. 2021

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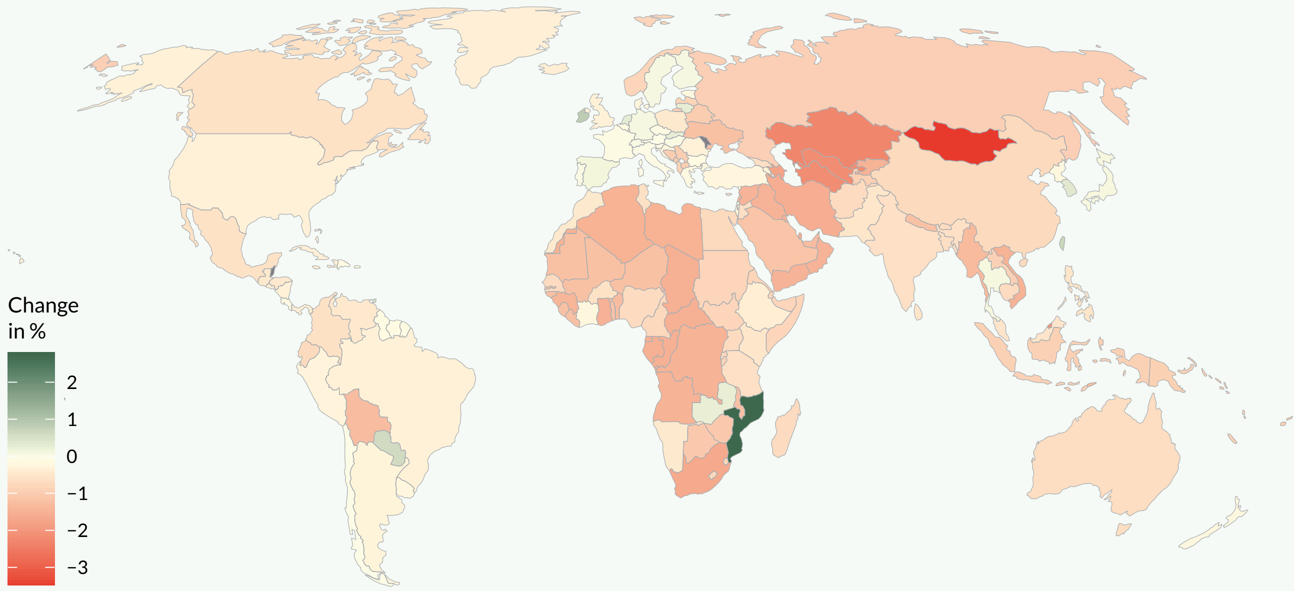
FIGURE 9 **Income effects of an increase in the carbon price worldwide of $50**



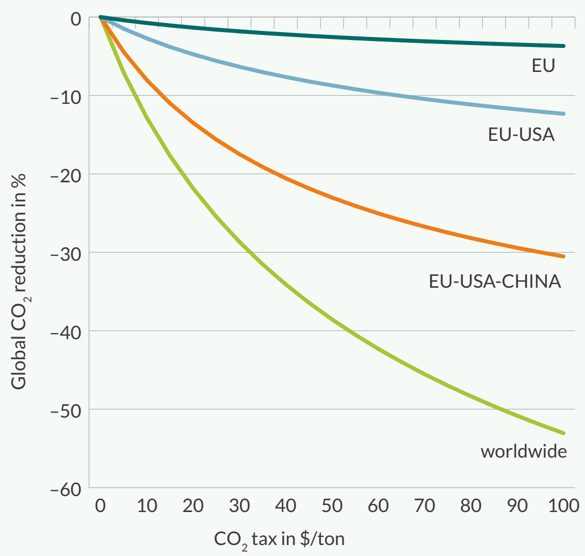
Source: Felbermayr et al. 2021 | BertelsmannStiftung

significant progress can still be made compared to Europe's taking unilateral action. A climate club consisting of the EU, US and China would generate a reduction in global emissions of 23 percent, or 6.9 billion tons, and carbon leakage would fall to well under 5 percent (see Fig. 10 and Fig. 11).

6 What would happen if the EU introduced a carbon border adjustment mechanism (CBAM)?

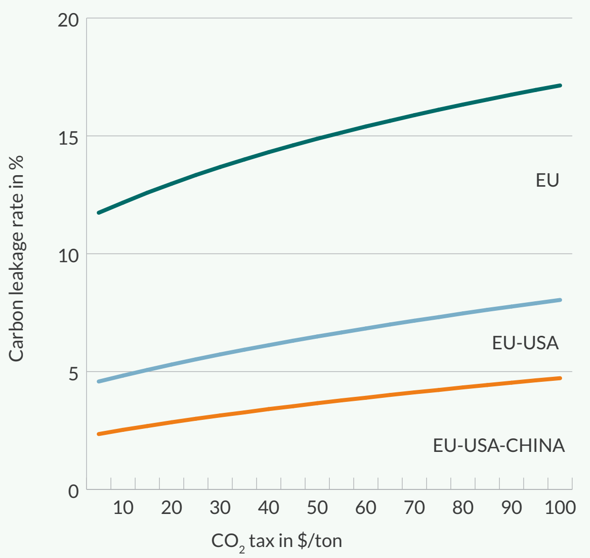
Currently, the type of policy cooperation described above seems highly unlikely, on both a global and trilateral level. That is why, as an alternative solution, the EU has chosen to focus on a different strategy for the time being: In July 2021, it will propose introducing a **carbon border adjustment mechanism (CBAM)**. The mechanism will **impose an emissions tax, or carbon tariff, on EU imports in especially energy-intensive sectors**. The size of the tariff will reflect the volume of emissions generated when the relevant product is produced abroad, and the carbon price will be

FIGURE 10 **Comparison of emission effects between different climate clubs and the EU acting alone**



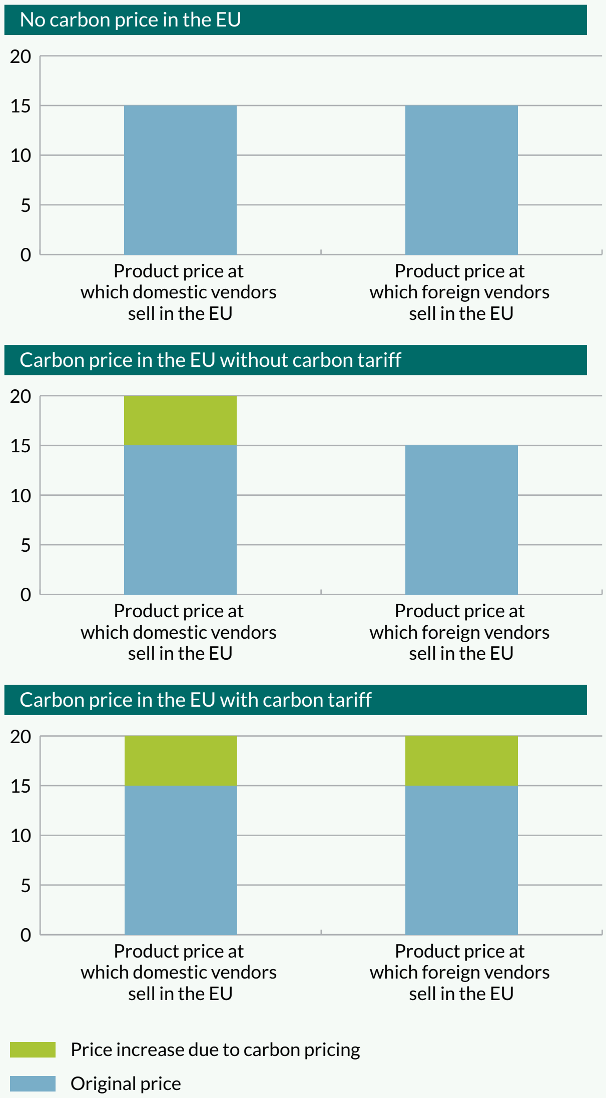
Source: Felbermayr et al. 2021 | BertelsmannStiftung

FIGURE 11 **Comparison of carbon leakage rates between different climate clubs and the EU acting alone**



Source: Felbermayr et al. 2021 | BertelsmannStiftung

FIGURE 12 **Impact of a higher carbon price in the EU on product prices**



Source: Bertelsmann Stiftung | BertelsmannStiftung

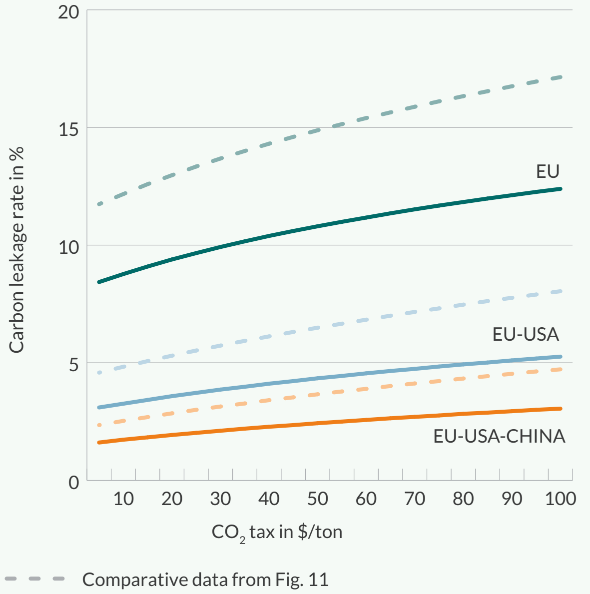
based on the carbon price in the EU ETS. All products sold in the EU will thus be subject to the emissions price charged in the EU – regardless of whether the product originates in the EU or abroad.

The impacts of the mechanism can be seen in Figure 12. The EU's carbon price increases costs for European producers, so that foreign producers have a competitive advantage both inside and outside the EU. By imposing a carbon tariff, the EU can level the playing field so that all market participants in the EU face the same conditions once again. In addition to greater competitiveness, the CBAM is meant to reduce carbon leakage and, as a result, global emissions.

Our simulation shows that **a border adjustment mechanism significantly reduces carbon leakage**. This is true if Europe goes it alone, and if it joins with the other major emitters to form a climate club (Fig. 13).

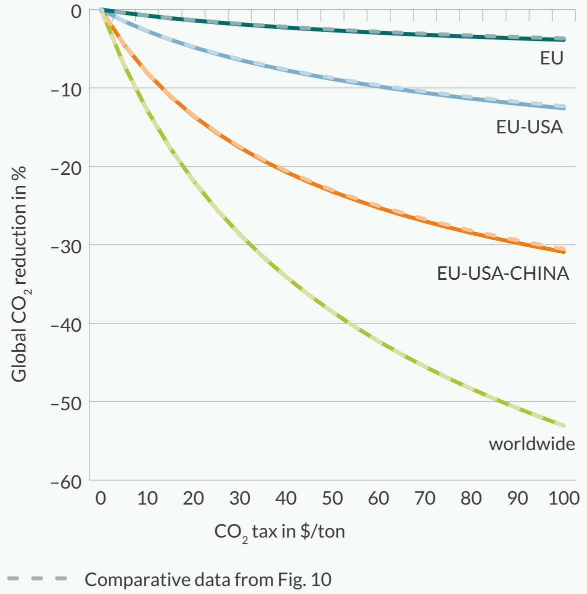
Border adjustments also improve the competitive position of European companies – even if this means that the reductions in emissions undertaken by foreign companies are partially offset by additional emissions in the EU. As a comparison of Figures 10 and 14 shows, the numbers are virtually identical in the scenarios with and without border adjustments. Global emissions fall by 2.7 percent instead of 2.5 percent. The CBAM thus makes **only a very limited direct contribution to protecting the globe's climate**.

FIGURE 13 **Comparison of how border adjustment mechanisms affect carbon leakage**



Source: Felbermayr et al. 2021 | Bertelsmann**Stiftung**

FIGURE 14 **Comparison of emission effects between different climate clubs and the EU acting alone, with border adjustment mechanism**



Source: Felbermayr et al. 2021 | Bertelsmann**Stiftung**

7 What does this mean for Germany and the European Union?

Differentiating between production-related emissions **(territorial emissions)** and emissions caused by a country's consumption **(carbon footprint)** is essential if climate policies are to be successful. This is particularly true for major economies, such as Germany or the EU, that are heavily involved in the international division of labor. If the goal is to reduce global emissions, **the most effective response is putting a price on consumption-related emissions**, since that avoids the problem of carbon leakage.

Pricing consumption, however, is **not realistic from a policy perspective**, since targets for reducing emissions are based on a country's territorial emissions, i.e. production-related emissions. **The CBAM** is a **compromise solution**: It combines a high national emissions price on production-related emissions with a fee for consumption-driven emissions by imposing a border tariff on imports causing emissions (both end products and intermediate goods).

Due to the **much greater effectiveness of a climate club**, the EU should at least combine its planned proposal for a CBAM with the offer to enter into **discussions with the United States**, which under the new Biden administration is more likely to cooperate once again in the area of climate and economic policy; better yet, it should strive for a trilateral exchange that includes China (see Fig. 15).

Even if, by providing incentives for research and investment, stringent climate policies offer long-term competitive advantages for national economies that lead the way, the short-term **economic and social impacts** of increasing carbon prices in these countries and for third states **should not be ignored**. Such impacts can worsen not only the social divisions within countries, but also between them, especially between the Eastern European states in the EU and its other members, and between developed and developing countries. That is why any initiative to form a climate club should be accompanied by social policy measures, e.g. through **temporary financial compensation for sectors and households that are particularly hard hit and though international burden-sharing**. The revenues generated by carbon taxes could be used to finance these responses.

FIGURE 15 **Overview of carbon-pricing scenarios**

Scenario	Global CO_2 reductions (share)	Global CO_2 reductions (absolute)	Carbon leakage rate (from the region imposing the tax)	Costs (average decline in GDP per country worldwide)
EU acts alone, w/o CO_2 tariff	2.50 %	0.76 bill. tons	14.90 %	0.07 %
EU acts alone, with CO_2 tariff	2.70 %	0.79 bill. tons	10.80 %	0.09 %
Climate Club EU/USA	8.70 %	2.6 bill. tons	6.50 %	0.10 %
Climate Club EU/USA/China	23.00 %	6.9 bill. tons	3.70 %	0.19 %
Global carbon pricing	38.60 %	11.5 bill. tons	0.00 %	0.50 %

Source: Bertelsmann Stiftung, data from Felbermayr et al. 2021

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8 Where can I find more information on this topic?

More detailed information can be found in the book **CO_2 zum Nulltarif? Warum Treibhausgasemissionen einen Preis haben müssen** by Thieß Petersen, which was recently published (in German) by the Bertelsmann Stiftung, and in the two studies conducted by the Kiel Institute for the World Economy on behalf of the Bertelsmann Stiftung, which are currently available (in German) as working papers:

Gabriel Felbermayr, Hendrik Mahlkow, Sonja Peterson, Joschka Wanner. EU-Klimapolitik, Klimaclubs und CO_2-Grenzausgleich. Working paper, Kiel Institute for the World Economy, 2021.

Sonja Peterson, Joschka Wanner, Gabriel Felbermayr. Der Effekt von klimapolitischen Maßnahmen auf CO_2-Emissionen und CO_2-Fußabdrücke. Working paper, Kiel Institute for the World Economy, 2021.

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