In Collaboration with PwC

WORLD ECONOMIC FORUM

Increasing Climate Ambition: Analysis of an International Carbon Price Floor

INSIGHT REPORT

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Foreword

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We know global warming, caused by the increased concentration of greenhouse gases (GHGs) in the atmosphere, is a serious threat to human health, ecosystems, infrastructure, and agriculture. We also know that we need to significantly accelerate global ambitions to safeguard the planet we live on, while ensuring a just transition so people aren't left behind.

If adopted systemically, carbon pricing has the potential to effectively reduce emissions. But today the cost of carbon dioxide and other GHG emissions is priced at anything from $0 to over $130 per tonne with varying sectoral coverage in different regions. This creates an uneven playing field across territories and industries, which means there is less incentive for some countries to reduce emissions.

In June, the International Monetary Fund (IMF) put forward a framework to introduce an international carbon price floor (ICPF) that proposes different price points for emissions for economies at different stages of development to incentivize greater participation. We have modelled this framework in order to explore how this approach would affect countries and specific sectors. The goal: to understand if this could become the starting point to bring about a more ambitious global agreement and inform discussions at the COP26 meeting in Glasgow, and to see how any adverse effects on the most disadvantaged could be mitigated.

We wanted to answer three key questions: could the ICPF reduce emissions significantly, could it be done without severe economic damage to livelihoods and businesses, and could it be done without shifting economic activity and emissions from one part of the planet to another.

The key messages from our analysis are positive: introducing an ICPF could make a significant contribution to tackling global warming by accelerating emissions reduction. This could be done without severe economic damage to livelihoods and business, although the effects would be uneven across the world. This underscores the need for global action on supporting a just transition to a net-zero world. The revenues generated by an ICPF could be used to support those most disadvantaged. In addition, it would not cause significant carbon leakage, the shifting of emissions from one place to another because of lower taxes.

We understand that these are conditional findings in a complex area where no single lever will be able to move the dial to where we need to be. We hope this research, however, will encourage countries to consider pricing carbon in such a way that it scales up effort to reach net zero in time to limit the worst effects of climate change on people and our planet. Ultimately, humanity's future survival and prosperity are at stake.

Executive summary

What would be the economic and political consequences across the globe of raising the price of carbon? The world needs energy to thrive and to protect and provide livelihoods. Yet over 83% of global primary energy consumption is attributable to fossil fuels, which are the main source of anthropogenic greenhouse gas (GHG) emissions.[1] How can countries that set high emission reduction ambitions, and introduce mechanisms to reach them, prevent the outflow of manufacturing and associated emissions to other countries with lower ambitions? And how can the cost of mitigation be shared across nations at different levels of development?

These tensions are at the heart of the debate leading up to the 26th Conference of Parties (COP26) of the United Nations Framework Convention on Climate Change (UNFCCC) in Glasgow.

Carbon pricing – which is a price paid on carbon dioxide (CO_2) and other GHG emissions – is generally agreed to be an effective method to reduce emissions.[2] The intent of this report is to analyse the impacts of international carbon pricing scenarios on economies and industries to provide information useful to governments, businesses and civil society in advance of COP26.

“ The cost in terms of economic activity of a carbon price floor is calculated to be less than 1% of GDP, and this could be offset by the redistribution of revenue.

Even if countries fulfil their emissions reduction pledges made under the terms of the Paris Agreement, this will not keep global warming below 2°C. The results of the economic modelling show a global price floor for GHG emissions could lead to further reductions and help bridge this gap. The cost in terms of economic activity of a carbon price floor is calculated to be less than 1% of gross domestic product (GDP), and this could be offset by the redistribution of revenues raised from the ICPF and the avoided costs associated with global warming.

The report analyses a proposal developed by the International Monetary Fund (IMF) to set an international carbon price floor (ICPF)[3] for GHGs that by 2030 would reach $75 per tonne for high-income countries, $50 per tonne for middle-income countries and $25 per tonne for low-income countries (in 2018 dollars). This structure is intended to mitigate the possibility that emissions will move to countries where the cost of GHG emissions is low – carbon leakage – while encouraging low-income countries to participate.

Scenarios modelled: To demonstrate the impact of a carbon price floor on different economies and industries, the analysis includes 10 scenarios that vary in scope based on the number of territories, sectors, and greenhouse gases covered (see section 3 for a full list of scenarios). Using a business-as-usual baseline, it is possible to calculate the impact of an ICPF and identify which regions and industries would be most affected. The core scenario assumes the ICPF includes all territories and major GHGs but is limited to electricity, high-emitting manufacturing industries (HEIs) and fossil fuel extraction and refining industries because of their proportionately higher impact on emissions. These industries collectively are referred to as “HEI+” and represent 51% of GHG emissions.

Three main questions are addressed in this report: (1) could the ICPF reduce emissions significantly, (2) could it be done without severe economic damage to livelihoods and businesses, and (3) could it be done without shifting economic activity and associated GHG emissions from one part of the planet to another.

The answer to all three questions is yes. That said, the landscape for introducing carbon pricing is complex and technical analyses are one part of a drive to find solutions to limit global warming. The results, therefore, are intended to provide preliminary, indicative quantitative information to help inform the global dialogue about the macroeconomic impacts of carbon pricing. There will be transition costs as the world moves away from fossil fuels and as employment and investment flow from high- to low-emission sectors and businesses and households adapt. International trade flows will need to readjust. A series of conversations with stakeholders in government, business and civil society helped to identify key challenges and gauge the impact of an ICPF from a variety of perspectives.

Key findings:

An international carbon price floor (ICPF) could significantly reduce emissions.

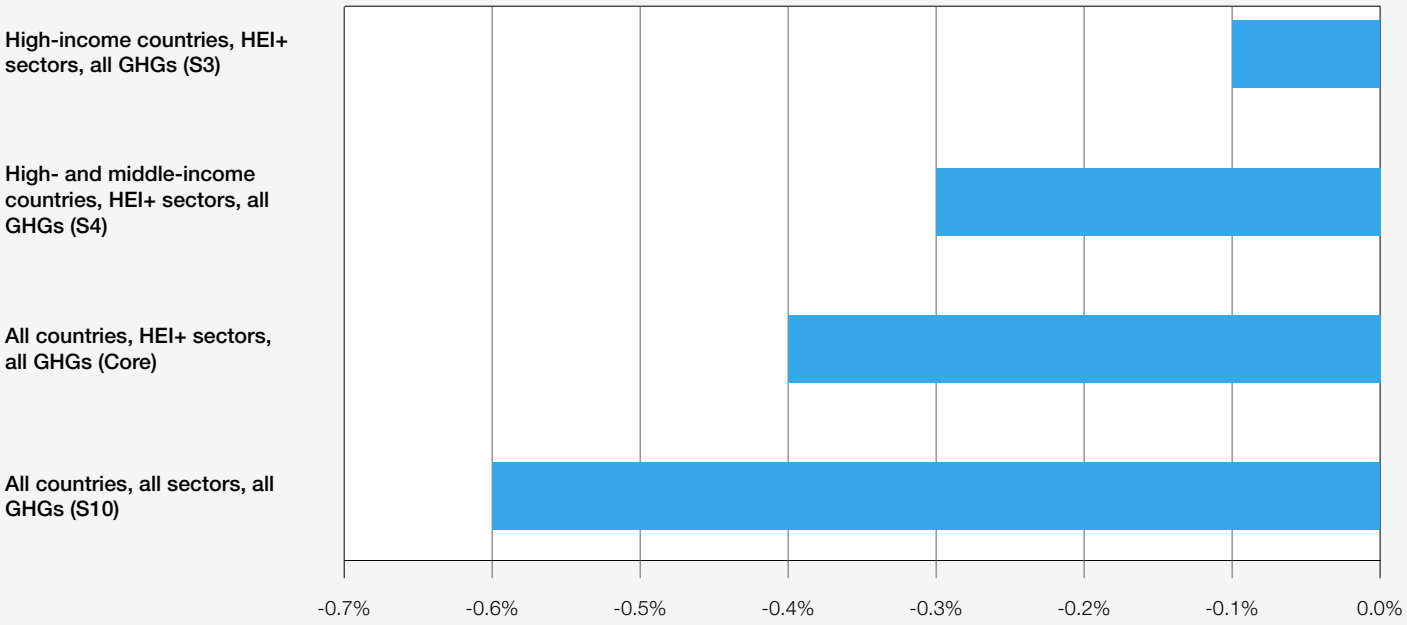
The effect of the carbon price floor on GHG emissions reductions relative to the business-as-usual baseline ranges from a 9.5% decrease in GHG emissions under the core scenario to a 12.3% decrease when all regions, sectors and gases are included in the ICPF.[4]

The reduction in emissions, together with revenues raised, could offset or eliminate adverse economic effects.

The global reduction in GDP caused by an ICPF would be less than 1%, depending on which industries, territories and GHGs are included.

The costs avoided by reducing GHG emissions, including from reduced agricultural productivity, sea level rises and other health effects of global warming, could offset much, if not all, of the direct GDP loss from the ICPF, even under a very conservative estimate.[5]

FIGURE 1 **The contraction of global GDP under four ICPF scenarios modelled ranges from 0.1% if only high-income countries and high emitting industries are included to 0.6% if all countries and all sectors are included.**



HEI+ = power generation, HEIs, fossil fuel extraction and refining industries

"Carbon dividends" could help lead to a just transition

The impacts of a carbon price floor would be uneven across territories and sectors, although the global contraction of GDP at less than 1% is relatively small. Lower-income countries that rely heavily on coal, for example, may be harder hit, which is why the use of carbon revenue to address differential impacts is key.

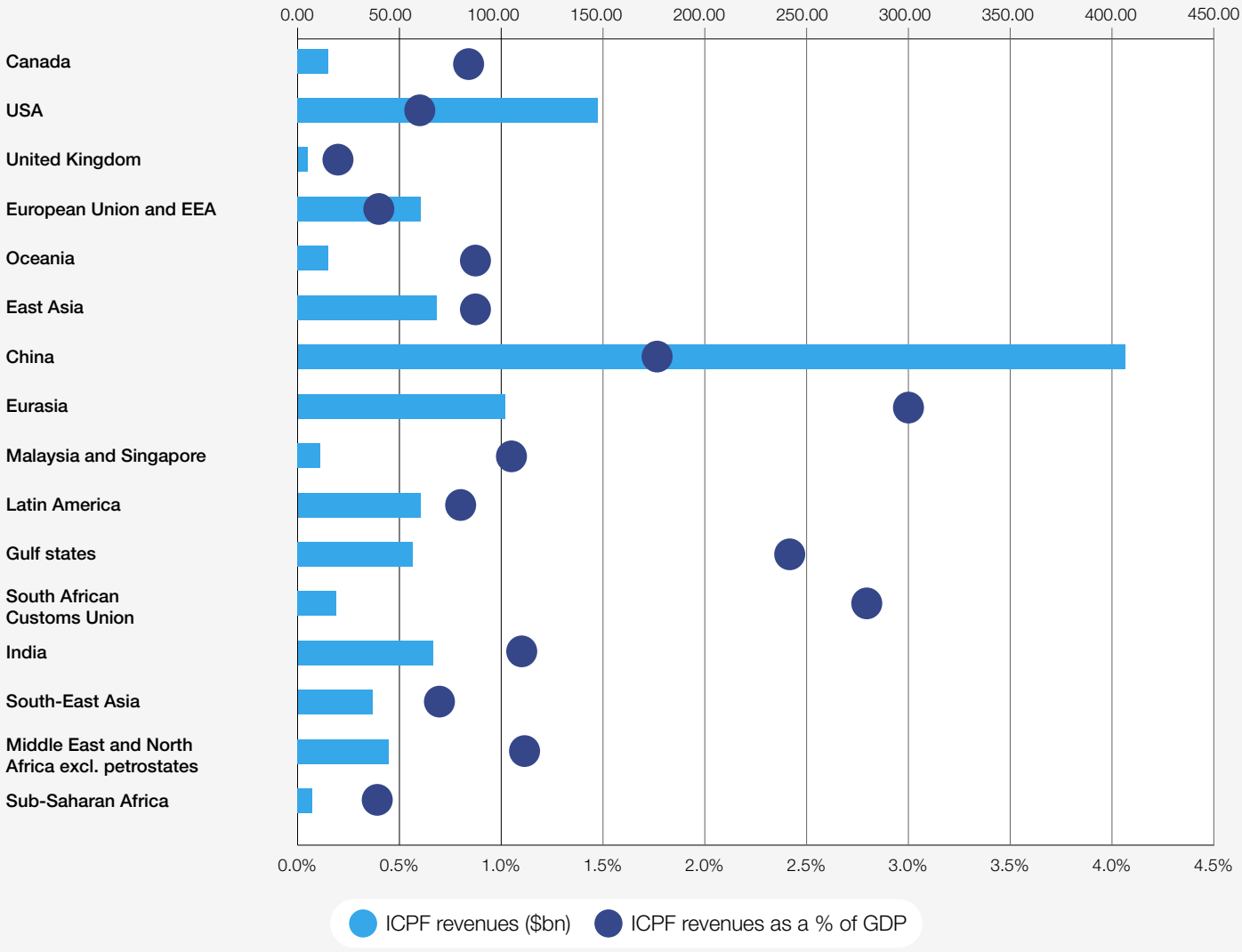
The revenues raised through carbon pricing would be significant and could be used to help manage the transition. Revenues from the ICPF could be as high as 3% of GDP in some regions modelled.

The model redistributes the additional ICPF revenues to all households in regions where revenues are collected and, in effect, is a "carbon dividend" that could help mitigate transition impacts for households. Revenues could also be used to reduce other taxes or fund incentives to support innovation, employment and investment during the transition.

The economic modelling suggests only 13% of the ICPF revenues from high-income economies would be needed to compensate low-income economies for lost GDP.

The regions most heavily affected by the ICPF, such as the South African Customs Union and China, could raise significant revenues from carbon pricing, which could be used to help affected households via a "carbon dividend". Revenues from carbon pricing in these regions could be 2.8% and 1.7% of GDP, respectively.

FIGURE 2 | **ICPF revenue by region under the core scenario (all regions, HEI+ sectors, all GHGs), 2030**



– **Including middle-income countries in an ICPF creates significant emissions reductions**

An ICPF that includes middle-income countries, particularly China, and high-income countries is most effective at reducing GHG emissions. If only high-income countries are included, the reduction in emissions is a modest 1.9% against the business-as-usual baseline by 2030. When middle-income countries are included, however, the emissions reductions increase to 8% compared to the business-as-usual baseline.

Under the core scenario, there would be significant decreases in all GHGs in the largest emitting countries: 7.7% (432 $MtCO_2e$ = millions of metric tonnes of carbon dioxide equivalent) in India, 11.1% (610 $MtCO_2e$) in the United States, and 16.8% (2,492 $MtCO_2e$) in China by 2030.

– **Under an ICPF that applies to all countries, carbon leakage is limited.**

Under the core scenario, there appears to be relatively little overall leakage of carbon across borders. Carbon leakage occurs when businesses move their operations to a country that has a lower cost of GHG emissions. Leakage shifts emissions rather than reducing them. The aggregate nature of the model and the assumptions used may not pick up all potential cases for leakages, although the initial findings are positive.

The economic analysis shows that an ICPF could help reduce emissions without significantly limiting economic growth and that it would not lead to major carbon leakage. It also shows that the effects would be uneven, which highlights the need for policy-makers to focus on ensuring a just transition to protect the disadvantaged. The results presented in this report can be a useful contribution to further discussions and galvanize ambitions at COP26.

This report and analysis, which PwC authored in collaboration with the World Economic Forum, seeks to provide an objective assessment of the ICPF proposal as a reference document for interested parties. PwC and its affiliates have not taken a position in favour of or against the ICPF.

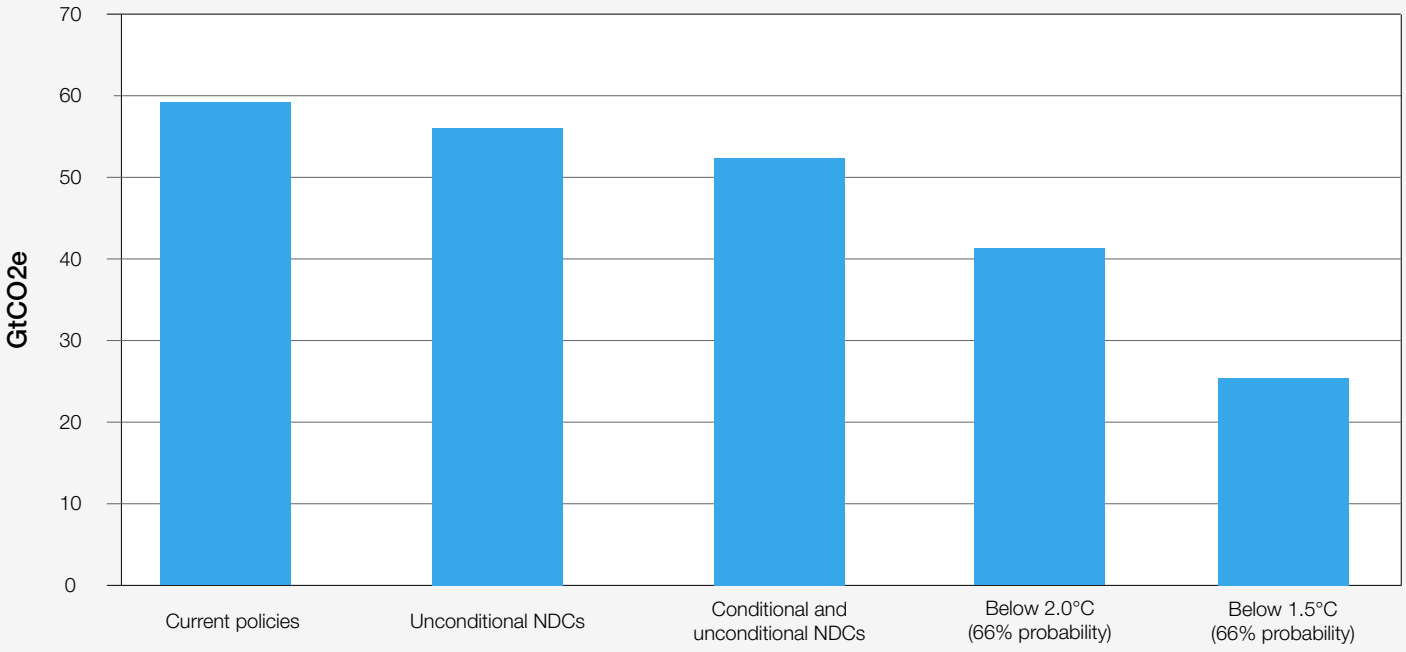
For a full explanation of the economic models used, please refer to the Technical Addendum.

1 Reaching net zero

There will need to be greater global collaboration to significantly reduce emissions and tackle global warming.

While the Paris Agreement of 2015 was an important advance in international environmental diplomacy, the nationally determined contributions (NDCs) commitments are insufficiently stringent to contain global warming to 2°C, let alone 1.5°C (**Figure 3**).[6] Although there is a groundswell in a broad range of industries to announce net-zero targets over the next decades, these too are non-binding, hard to assess and hard to measure.[7] But they indicate that reducing emissions is rising higher up the business agenda. Collaboration between governments and business in many areas, including ways to develop cost-effective green hydrogen and carbon capture, utilization and storage, are already happening. In the past decade, incentives and technological improvements have made renewable energy economically viable. But as the Intergovernmental Panel on Climate Change (IPCC) starkly laid out in its recent report, this progress is not enough.[8]

FIGURE 3 **Global total GHG emissions in 2030 in billion metric tonnes of carbon dioxide equivalent ($GtCO_2e$) under different scenarios (median estimates, based on pre-COVID-19 current policies baseline)**



Source: Author's representation, United Nations Environment Programme (UNEP) Emissions Gap Report (2020). The UNEP released its 2021 Emissions Gap Report on 26 October, 2021, too late to include in this report.

In view of the gap between the Paris Agreement goals and current emissions commitments and policies, the International Monetary Fund (IMF) has proposed the establishment of an international carbon price floor (ICPF). A carbon price floor – which is a minimum price paid on CO_2 and other GHG emissions – would create a platform for increasing international emissions reduction ambitions. While to date it has been challenging to agree on a collective price for carbon, there is precedent for global action on environmentally dangerous gases. The world has come together to act on other climate challenges before, although they are less complex issues compared to global pricing. For example, the 1987 Montreal Protocol was introduced to tackle substances that deplete the ozone layer and the 1983 Convention on Long-Range Transboundary Air Pollution addresses air pollutants that cause acid rain.[9]

More recently, 136 countries have endorsed the principle of an effective minimum tax rate for multinational groups.[10] The purpose of the minimum tax rate is to prevent countries from engaging in competitive tax reductions that cause the erosion of the income tax bases of other countries, a form of income "leakage" that is akin to carbon leakage. Carbon leakage is when businesses move their operations to a country that has a lower cost of CO_2 or other GHG emissions. Leakage shifts emissions rather than reducing them.

In section 2, the IMF ICPF Proposal is outlined and alternatives are considered. Section 3 describes the scenarios modelled. Section 4 looks at the economic modelling results, and section 5 outlines key challenges for governments and businesses.

2 The IMF ICPF Proposal

The carbon price floor is designed to be flexible and includes progressive pricing to encourage greater participation.

> To help ensure regions have time to adapt, price floors would be phased in between 2022 and 2030.

The IMF published its proposal for an ICPF in June 2021.[11] The framework initially recommends a minimum price on CO_2 emissions (to be expanded in the future to other GHGs) among a small group of large emitting countries.[12] The price floor could be implemented through carbon taxation, emissions trading, or equivalent measures. The IMF has proposed a progressive schedule of price floors, with a $75/metric tonnes of carbon dioxide equivalent ($mtCO_2e$) floor for high-income countries, $50/$mtCO_2e$ floor for middle-income countries and $25/$mtCO_2e$ floor for low-income countries (in 2018 dollars).

To help ensure regions have time to adapt, these price floors would be phased in between 2022 and 2030. With this three-tier ICPF, and participation by the "Big six" emitters – China, United States, India, the EU, Canada, and the UK – the IMF estimates global warming would be contained to 2°C (if countries also meet their NDC commitments). This is calculated by taking the NDC emission reduction in the UNEP's 2020 Emissions Gap Report under current policies and then applying the ICPF. The additional emissions reductions achieved are then added to the UNEP estimates of the effects of the conditional and non-binding NDCs.

The IMF recognizes that financial incentives may be needed to encourage and sustain participation by low-income countries and suggests that participation in the ICPF could be promoted through the establishment of a $10-billion-per-year fund complemented by the provision of technical assistance.[14]

The ICPF accommodates carbon pricing systems in countries with either a carbon tax or an emissions trading system (ETS). Currently, 64 jurisdictions have implemented carbon pricing, of which 35 have carbon taxes and 29 have emissions trading systems (ETSs).[14]

Due to political sensitivities or other factors, some countries rely exclusively on non-pricing approaches to reduce GHG emissions, such as facility and product regulations, incentives for renewable electricity and fuels, and incentives for carbon sequestration. According to the proposed IMF framework, an ICPF could also accommodate emissions-equivalent non-pricing approaches, i.e. approaches that seek to reduce GHG emissions through mechanisms other than a price. However, this would come at the expense of the simplicity and transparency of the proposal.

2.1 Advantages of the ICPF

An ICPF is one of a number of possible mechanisms to coordinate and accelerate GHG reductions through carbon pricing (see Box 1 for a short description of three others). Some potential advantages of an ICPF are set out below:

Flexibility: The ICPF proposal can accommodate existing carbon taxes and ETSs and potentially non-pricing regulatory approaches. Although carbon prices in ETSs vary daily based on market conditions, countries could comply with the ICPF by setting a minimum auction price, restricting the issuance of emission allowances (or repurchasing allowances) if the market price were to drop below the price floor, or combining a carbon tax set at or above the floor price with the ETS. Some ETS schemes already incorporate mechanisms to set a floor on the carbon price (e.g. the EU ETS).

Transparency: Carbon prices are publicly available and readily observable, whether implemented through carbon taxes or emissions allowance trading markets. As a result, compliance with a carbon price floor is relatively easy to monitor, and similarly, the actions required for a country to comply would be easier to enforce under an ICPF as compared to the NDCs.

Addressing carbon leakage without tariffs: The ICPF would address the carbon leakage problem (of industries switching to countries with low or no carbon taxes) by providing incentives to countries to reduce emissions rather than relying on a carbon border adjustment mechanism (CBAM), which is currently proposed by the European Union. Under the proposal set out by Parry et al. (2021), low-income countries would be encouraged to participate through two mechanisms: (1) a lower carbon price floor than the one that would apply to high-income countries, and (2) financial assistance from a global fund that would be financed by a percentage of the revenues from the carbon pricing systems of high-income countries.

BOX 1 | **Three alternatives to an ICPF**

Global linkage of ETSs: A uniform carbon price could be achieved if countries with existing ETS mechanisms allowed cross-system trading of emissions allowances, forming an expanded trading market, and other countries then joined this linked system. A linked ETS approach cannot accommodate countries that have adopted carbon taxes, which includes many jurisdictions that currently have implemented carbon pricing regimes. In addition, a linked ETS system sets a uniform price among participating ETS members rather than a minimum price, which prevents differentiated carbon prices for lower-income countries and restricts the flexibility of countries to set a higher carbon price if desired.

International carbon tax: A minimum carbon tax potentially would be a simpler approach to implementing a minimum carbon price.[15] The carbon price would be set by tax policy rather than markets and thus would be less volatile than under a linked ETS, but, given public opinion, it may be harder to garner political support for a tax.[16] Almost half the countries that have implemented carbon pricing have adopted ETS systems rather than carbon taxes.

Carbon club: Proposed by Nobel Prize winner William Nordhaus, a carbon club is intended to overcome the "free-rider" problem, i.e. countries that do not restrict GHG emissions benefit from the restrictions imposed by other countries.[17] A minimum carbon price (like the ICPF) would be combined with a broad-based tariff on imports from non-participating countries. Unlike the ICPF proposal, which envisions the use of financial incentives and differentiated minimum carbon pricing to encourage countries to participate, a carbon club relies on tariffs to create a more level playing field, i.e. a "stick" vs. a "carrot" approach.

3 Carbon price floor scenarios and economic models

Ten scenarios include different regions, gases and industries to illustrate the effects of the ICPF.

The economic results presented here are produced using PwC's international Computable General Equilibrium (CGE) model, which estimates how the global economy might react to policy changes or external shocks in a way that takes into account "general equilibrium effects", i.e. how prices, households and businesses may react due to direct and indirect effects. This is a tool that is widely used by international policy-makers to assess the consequences of policy changes.[18]

To determine how HEIs could be affected, an environmentally extended multi-regional input-out model (EE MRIO) was used to focus on the sectors that would be subject to the proposed EU CBAM. The initial CBAM sectors are cement, aluminium, iron and steel, fertilizers and electricity.[19] They are thought to be particularly prone to carbon leakage (see Technical Addendum).

In the CGE model, the world's countries are aggregated into 16 territories and characterized according to per-capita income as high-income, middle-income, and low-income[20] (**Figure 4**). All sectors are aggregated into 14 industry groupings (**Table 1**). As a result of this aggregation and a number of other simplifying assumptions, the model should be viewed as providing indicative results and a starting point for discussion.[21]

Using the CGE modelling, each scenario (**Table 2**) is compared against a business-as-usual case based on PwC estimates of GDP growth and historic rates of improvement in emissions intensity (i.e. GHG emissions per dollar of GDP) in each country. The difference between the model results under the tested scenario and the business-as-usual case is the incremental impact of the tested scenario.

FIGURE 4 **Categorization of territories by income level**

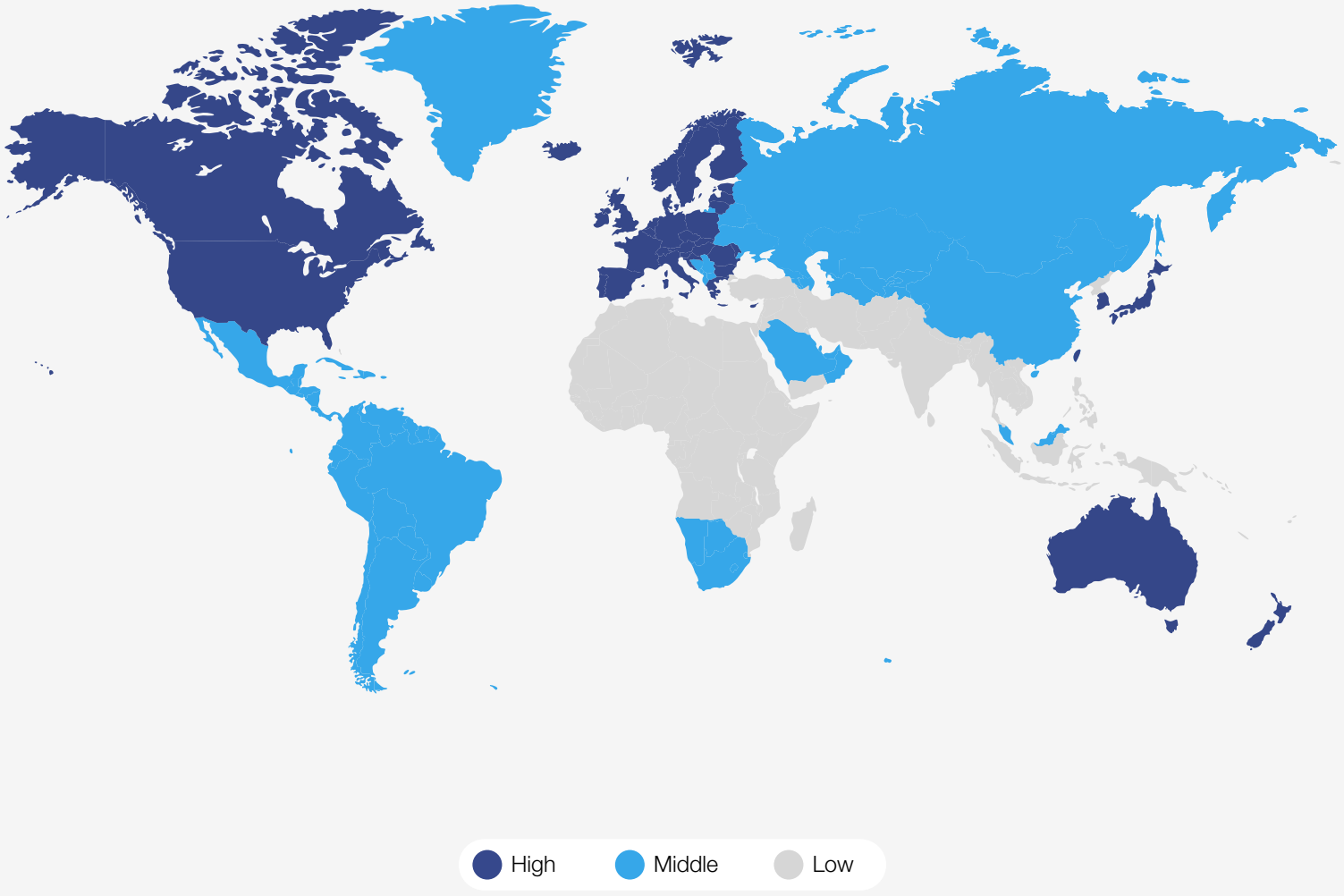


TABLE 1 | **Industry groupings used in the modelling**

Wide industry group	Narrow industry group	Detailed indusry (CGE) model
Primary industries	Primary industries	*Agriculture*
		Forestry and fisheries
Industry (Mining, manufacturing and utilities)	Fossil fuel extraction	*Coal mining*
		Oil
	Manufacturing activities of particular relevance	*High-emitting manufacturing industries (HEIs)**
		Oil & coal refining
	Power generation	*Electricity***
		Gas distribution
	Other industry	*Other industries*
Transport	Transport	*Air transport*
		Land transport
		Maritime transport
Services	Services	*Services*
Household	Household	*Household*
Government	Government	*Government*

* Sub-industries considered in the EE MRIO analysis: cement, steel, iron, aluminium, and fertilizers

** Sub-industries considered in the EE MRIO analysis: production of electricity by coal, gas, or petroleum and other oil derivatives

TABLE 2 | **Summary of the scenarios modelled**

	Business as usual (BAU)	Scenarios									
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
GHG coverage[1]											
All GHGs		X		X	X	X	X	X	X		X
CO_2 only			X							X	
Sector coverage[2]											
HEI+		X	X	X	X	X	X	X	X	X	X
Above plus other industrial sectors ex. AF&F[3]	Carbon pricing as in effect 1/1/21 (2019 $)					X	X	X	X	X	X
Above plus transport							X	X	X	X	X
Above plus household & government								X	X	X	X
All sectors ex. AF&F									X	X	X
Above plus AF&F										X	X
Country coverage/ ICPF price[4]											
High-income		$75	$75	$75	$75	$75	$75	$75	$75	$75	$75
Middle-income	NA	$50	$50	NA	$50	$50	$50	$50	$50	$50	$50
Low-income		$25	$25	NA	NA	$25	$25	$25	$25	$25	$25
Use of revenues											
Lump sum transfer to households		X	X	X	X	X	X	X	X	X	X

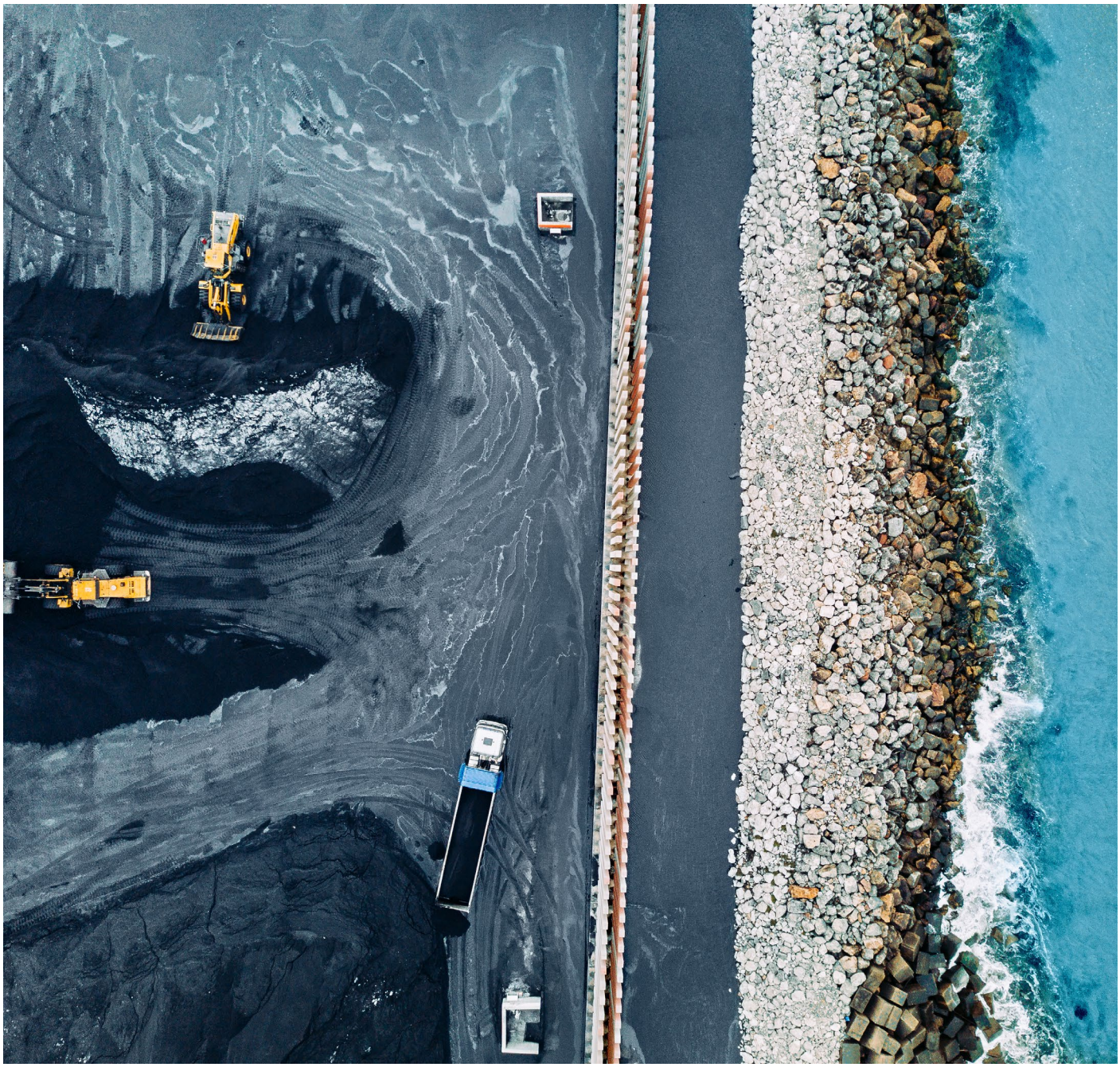
1 All GHGs = CO_2, N20, CH4, F-gases
2 HEI+ = Power generation, HEIs, fossil fuel extraction and refining industries
3 AF&F= Agriculture, forestry and fisheries
4 ICPF price in 2018 dollars per $mtCO_2e$

The IMF suggests that a small number of high-emitting countries establish the ICPF initially as this would make the negotiations easier. The IMF discussion paper points out that China, India, and the US account for 57% of baseline CO_2 emissions in 2030, and the Group of Twenty (G20) makes up 85% (including EU countries). Modelling a number of scenarios that include different regions, industries and gases is a way to show the incremental benefits of applying the ICPF broadly.

The modelling uses a core scenario (Scenario 1) for comparison. This extends the ICPF to all countries and all GHGs but is limited to the power generation, HEIs and fossil fuel extraction and refining industries. This is referred to as "HEI+". These results are then compared to other scenarios to understand the macroeconomic and emissions impacts of changes to the scope of the ICPF – by territory, sector and GHG (see Technical Addendum).

4 The impact of an international carbon price floor on economies and industries

The effects are uneven across economies and industries but redistribution of the revenues could help those worst hit.



> Over the longer term, much if not all of the GDP loss would be offset by avoided costs due to reduced global warming.

The results of modelling the impacts of ICPF scenarios on economies and industries are intended to provide information useful to various stakeholders as they seek consensus on how to reduce emissions. Three main questions are addressed: (1) could the ICPF reduce emissions significantly, (2) could it be done without severe economic damage to livelihoods and businesses, and (3) could it be done without shifting economic activity and associated GHG emissions from one part of the planet to another.

The results show that an ICPF could result in a reduction of emissions up to 12.3%, depending on the scenario analysed. Before considering the avoided economic costs associated with lower GHG levels, the loss of GDP from implementing an ICPF is under 1% in 2030 under all scenarios. Under the core scenario, which includes all countries, HEI+ industries, and all GHGs in the ICPF, the GDP contraction would be around 0.4% (Figure 1). The most limited impact is 0.1% when only high-income countries, HEI+ industries and all GHGs are covered. The greatest impact is a 0.6% contraction when all regions and sectors and all GHGs are included.

Although it is not possible to make a direct comparison with temporary economic shocks like COVID-19 or the financial crisis of 2009, it is interesting to note that the impact of an ICPF would be less than either of these recent challenging events.[22]

Over the longer term, much if not all of the GDP loss would be offset by avoided costs due to reduced global warming. These include health and environmental costs. According to the Organisation for Economic Co-operation and Development (OECD) and the IMF, the health and environmental benefits of a $50 per tonne price for carbon exceed the GDP costs.[23] Kompas et al. (2018) estimated the economic costs of loss of land due to rising sea levels, losses in labour and agricultural productivity, and damage to human health due to global warming.[24] Applying this analysis to the ICPF scenarios suggests that by 2100, the GDP benefits from avoided emissions under all scenarios would largely offset, and in some cases, outweigh the GDP costs. Accounting for other benefits (e.g. reduced natural disasters, reduced air pollution, tourism flow changes, etc.) would further offset the loss of GDP.

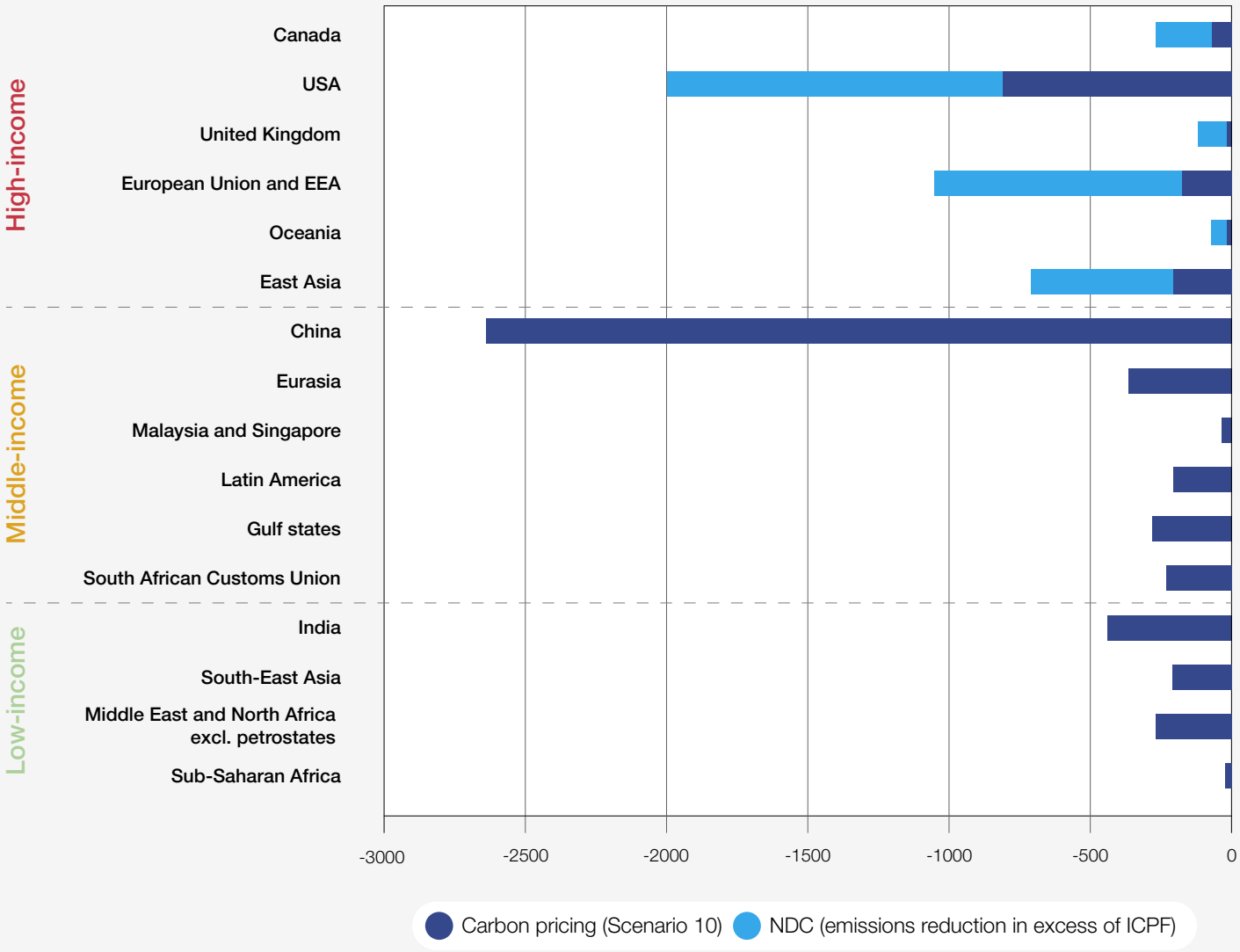
4.1 Global emissions impact

The overall effect of the carbon price floor on GHG emissions relative to the business-as-usual baseline ranges from a 9.5% decrease in GHG emissions under the core scenario (12.2% reduction in CO_2 emissions) to a 12.3% decrease (14.9% reduction in CO_2 emissions) when all sectors are covered. These ICPF scenarios equate to 2030 GHG emissions between 50.8 $GtCO_2e$ and 49.2 $GtCO_2e$, both of which exceed the upper limit the UNEP cites as compatible with limiting global warming to 2°C (39 to 46 $GtCO_2e$ levels).[25]

The ICPF scenarios do not reduce GHG emissions enough to contain global warming to 2°C above pre-industrial levels. However, if NDCs are fulfilled, the incremental reduction in emissions that is gained under an ICPF that covers all territories, sectors and GHGs is estimated to decrease CO_2 levels by 22% from the baseline by 2030. This finding is consistent with Parry et al. (2021), and it is at the upper limit of the 2°C range reported by the UNEP.[26] **Figure 3** shows that an additional 39% reduction in GHGs would be required in 2030 to go from the 2°C band to 1.5°C with 66% probability (from 41 to 25 $GtCO_2e$).

In Canada, East Asia, and the US, UK, and EU, over half of the CO_2 emissions reduction in 2030 would be attributable to NDCs (if fulfilled), with the minority attributable to the ICPF, even if the ICPF is applicable to all sectors and all GHGs. China is estimated to reduce CO_2 emission by 2.5 billion tonnes in 2030, which is the highest among all territories (all due to the ICPF). By contrast, the US is estimated to reduce CO_2 emission by 2 billion tonnes, of which only 40% is attributable to the ICPF, and the balance requires further actions to fulfil NDC commitments (**Figure 5**).

FIGURE 5 | **Absolute change in CO_2 emissions relative to the business-as-usual baseline under a scenario that includes all regions, all sectors and all gases, 2030**

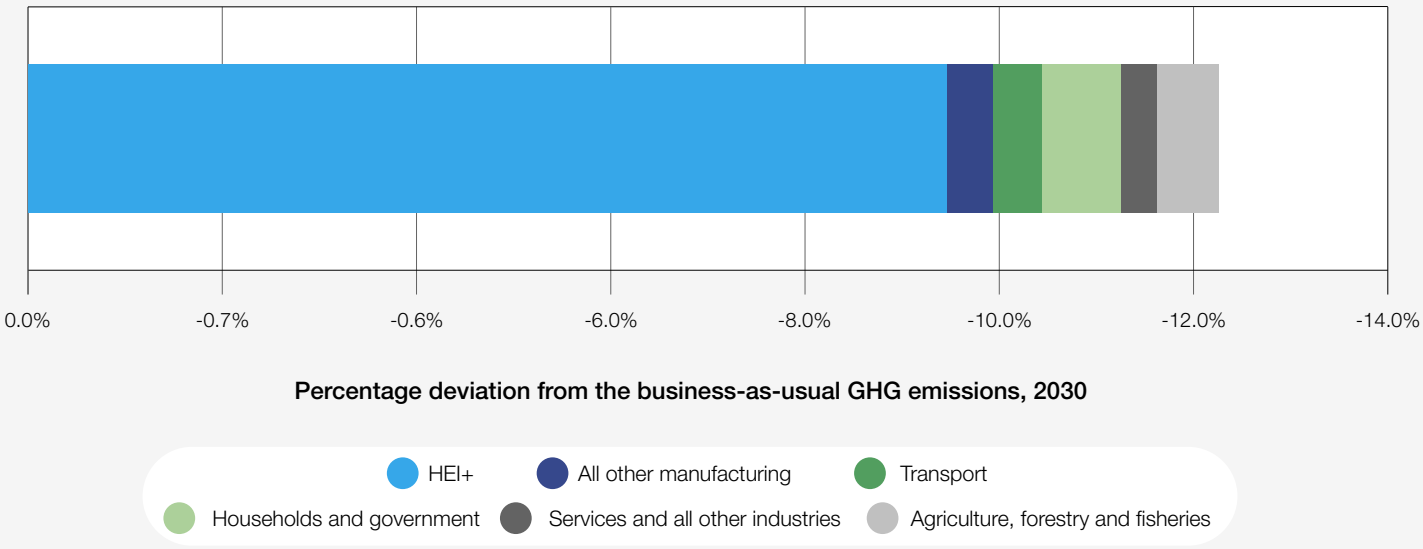


Source: Author's representation, PwC CGE modelling and Parry et al. (2021)

4.2 Share of emissions reduction by territory and sector

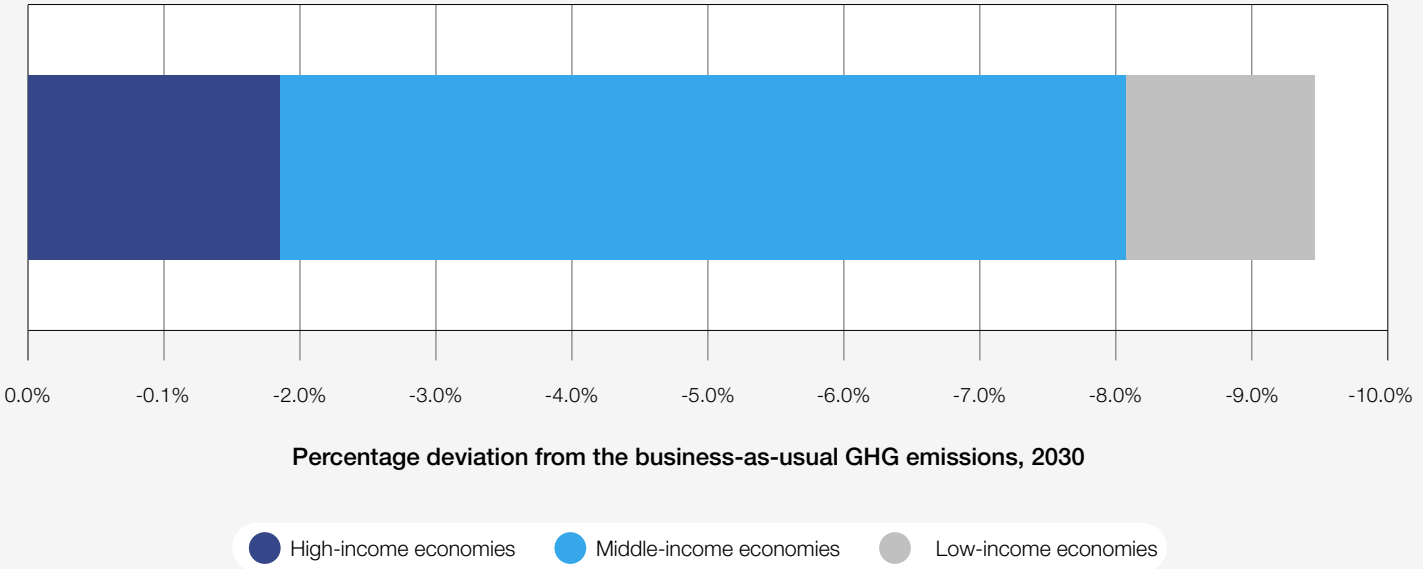
The lion's share of potential GHG emissions reductions under the ICPF is attributable to middle-income countries and to the HEI+ sectors. Under the scenario in which the ICPF applies to all territories, sectors and GHGs, HEI+ sectors would contribute 77% of the GHG emissions reductions (**Figure 6**).

FIGURE 6 **Percentage change from business-as-usual baseline in GHG emissions in 2030, incremental impacts as industry scope increases**



Under the core ICPF scenario, middle-income countries account for 84% of the emissions reductions from all territories (**Figure 7**). Much of this impact is driven by GHG reductions in China, which is estimated to account for 2.5 billion out of the 15 billion tonnes of GHG emissions reduction by 2030. This is the highest among all territories and a 17% reduction from its business-as-usual emissions.

FIGURE 7 **Percentage change from business-as-usual baseline in GHG emissions in 2030; incremental impacts as industry scope increases (ICPF scenarios including HEI+ sectors and all GHGs)**

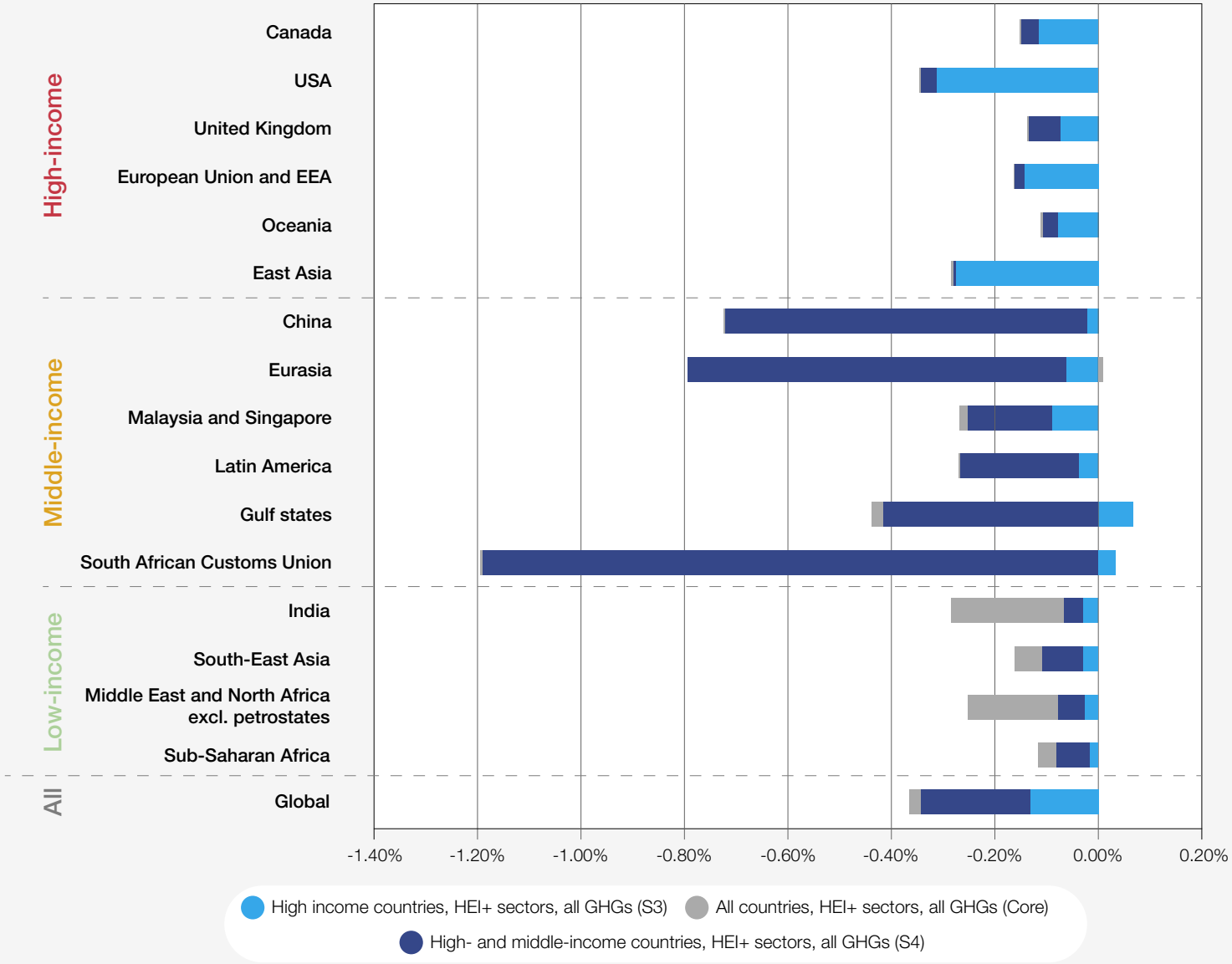


4.3 Regional impacts of the ICPF

The impacts of the ICPF across regions are not uniform and depend on the sectors, economies and GHGs included. Under the core scenario, GDP contractions are relatively lower in high- and low-income countries and more significant for middle-income countries (**Figure 8**). This may be due to greater reliance on emissions-intensive energy sources as well as low or nil pre-existing carbon pricing.[27] Coal is the dominant energy source in non-OECD Asian countries; for example, it accounts for half of all energy needs compared to 20% in OECD countries. The South African Customs Union experiences the largest GDP drop of any territory (1.2%), due in large part to a contraction in coal mining, which accounts for 2.6% of GDP in the 2030 business-as-usual scenario.[28]

When the ICPF is applied only to high-income countries, other regions experience smaller GDP reductions than in the core scenario. South Africa and the Gulf states experience a gain in GDP. In the case of South Africa, this effect is potentially driven by domestic increases in investment and consumption. The increase in the Gulf states' GDP may be driven by a reduction in imports and may reflect changes in real exchange rates.

FIGURE 8 **Incremental changes in GDP by scenario (as a percentage of 2030 business-as-usual)**



An ICPF that covers only high- and middle-income countries mitigates a substantial part of the losses seen in some low-income countries. In India and the Middle East (excluding the Gulf states), the |GDP drop is 70% lower when the ICPF does not include lower-income economies. However, the contraction is only approximately 20% lower in Sub-Saharan Africa (excluding the South African Customs Union), driven primarily by a fall in oil output, and in South-East Asia, driven by a fall in oil output as well as other manufacturing and services.

4.4 Sectoral impacts in a time of transition

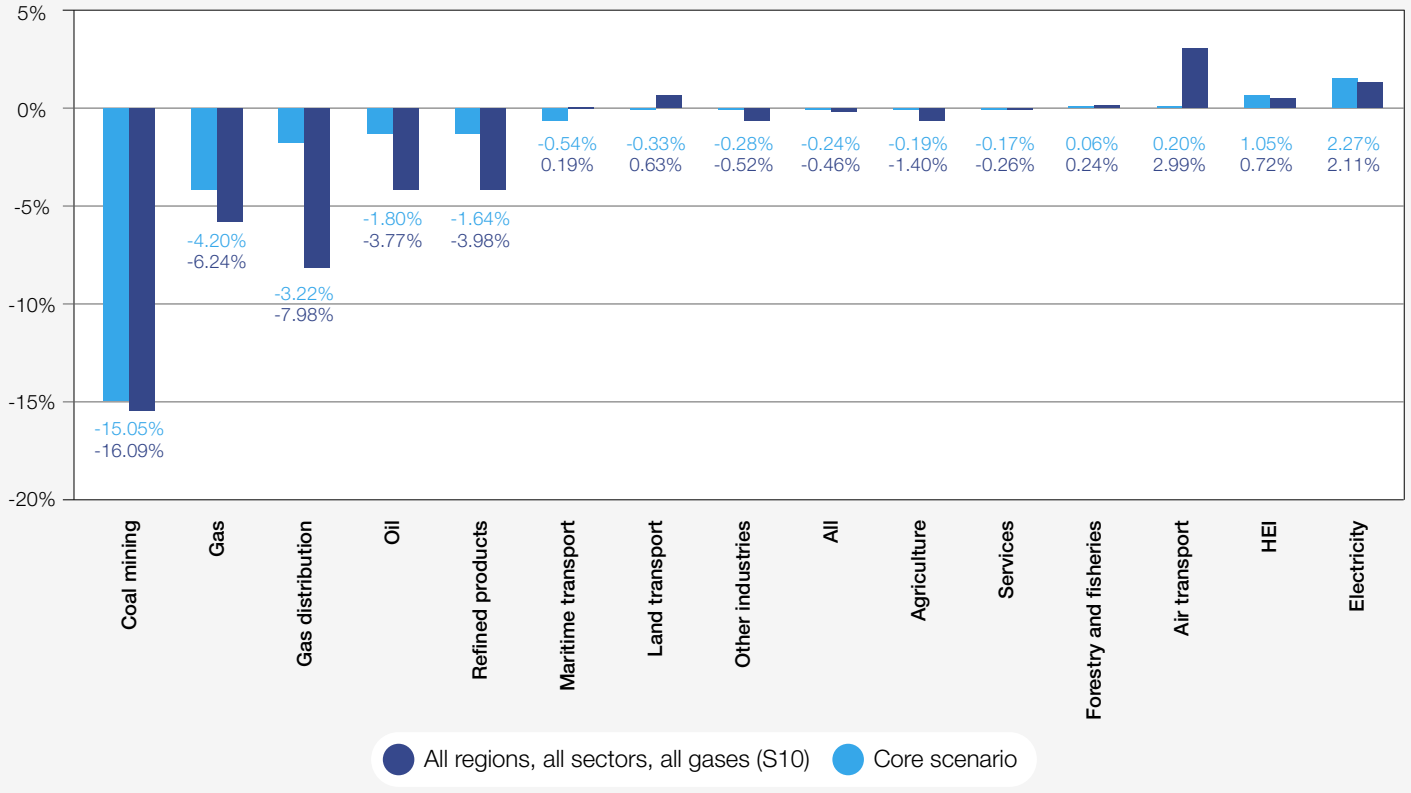
Extractives and energy production are the sectors hardest hit by an ICPF. Looking at gross output – the change in industry revenues (including carbon fees) – under the core ICPF scenario, global coal output declines by 22%, gas by 11.6%, and electricity by 7.3% in 2030.[29] The drop in electricity output reflects an overall decrease in energy demand by both businesses and consumers. From a regional perspective, countries that heavily rely on these sources of energy – e.g. China and South Africa – see a more significant fall in output, with the Gulf states also showing sharp drops in oil production. The output of HEIs drops in some regions but increases in others. Measured output can increase because the carbon fee increases revenues by more than production (net of carbon fees) declines.

Gross value added (GVA) is output net of purchased inputs and carbon fees.[30] To understand the unique value that each industry generates – excluding the value added in the supply chain and the cost of the ICPF itself – it is necessary to calculate the change in GVA (**Figure 9**).

Under the core ICPF scenario, across all territories, the sectors that experience the largest relative decreases in GVA are coal mining (-15% of GVA under the business-as-usual baseline) and gas and gas distribution (-4% and -3%, respectively). But GVA increases in electricity and HEIs – a surprising result that reflects a substitution of capital and labour for purchased fuels (e.g. utility investments in wind turbines replace coal purchases).

When the ICPF is extended from the HEI+ to all sectors, the gas distribution, extractive, and refinery sectors contract further. This may be explained by the supply chain effect – less demand for energy due to less demand for services and transport. Some changes may reflect geographic concentrations of certain industries. For instance, 80% of the coal GVA is located outside of high-income economies, and coal is mostly used for fuel outside of high-income economies.[31]

FIGURE 9 **Percentage relative to in GVA by sector — core scenario compared with ICPF applicable to all sectors (relative to business as usual, 2030)**



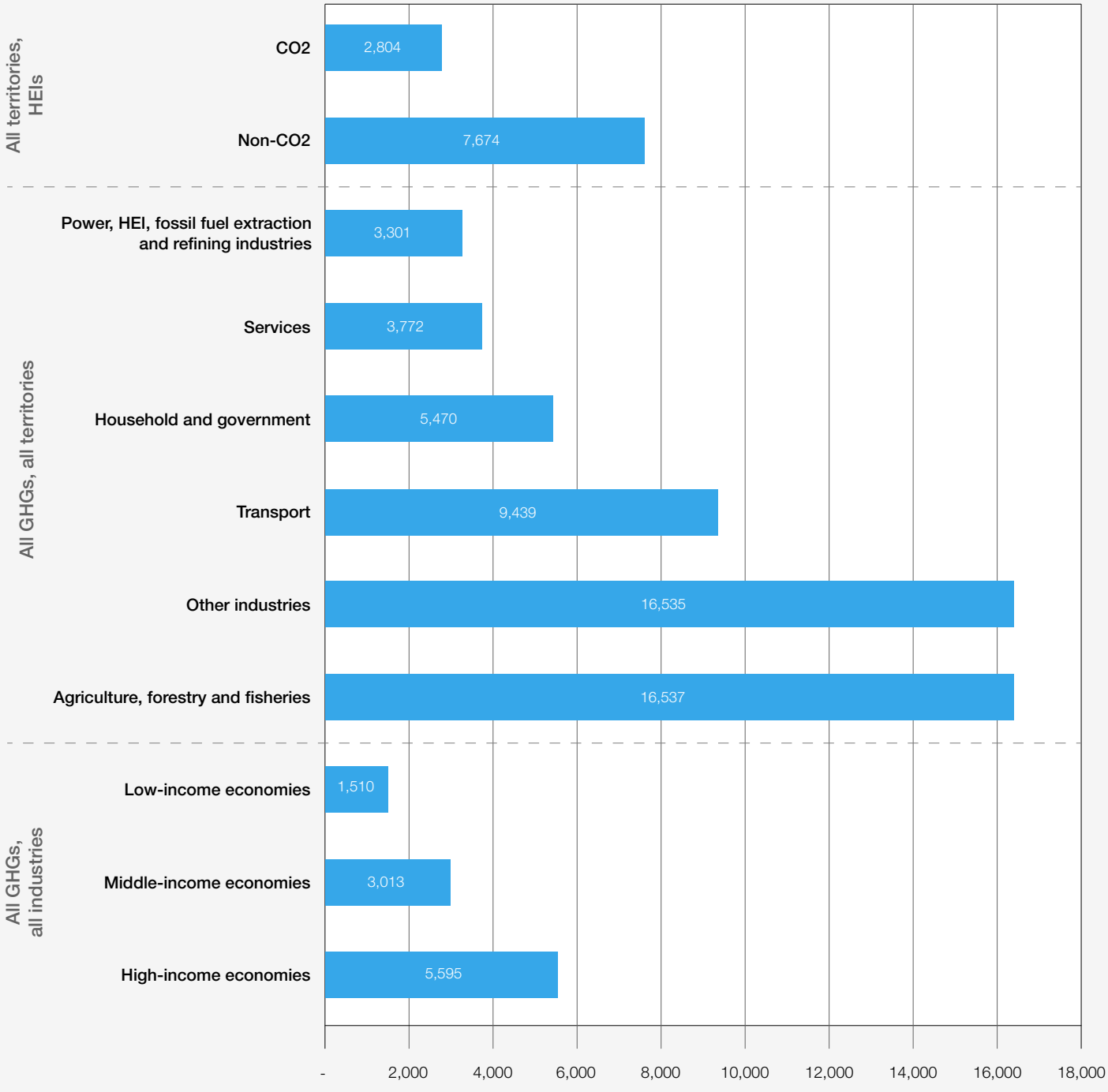
Under an ICPF that extends only to high-income economies, coal GVA decreases by 2% instead of 15% under the core scenario.

4.5 ICPF design: Reducing emissions at the lowest economic cost

To reduce emissions at the lowest GVA cost per tonne, governments may wish to start with a carbon pricing system limited to CO_2 emissions in the HEI+ sectors (**Figure 10**). An expansion of carbon pricing coverage by sector that minimizes economic costs would next include services, household and government, transport, and agriculture, forestry and fisheries, in that order.

On a global basis, emissions can be reduced at the least cost in low-income countries, followed by middle-income countries, and then high-income countries. This is one reason why it may be in the interest of high-income countries to assist low-income countries in financing the transition to a low-emissions economy.

FIGURE 10 **The cost in $ million of GVA using an ICPF to achieve a 1-percentage-point reduction in GHG emissions (compared to the business-as-usual baseline in 2030)**



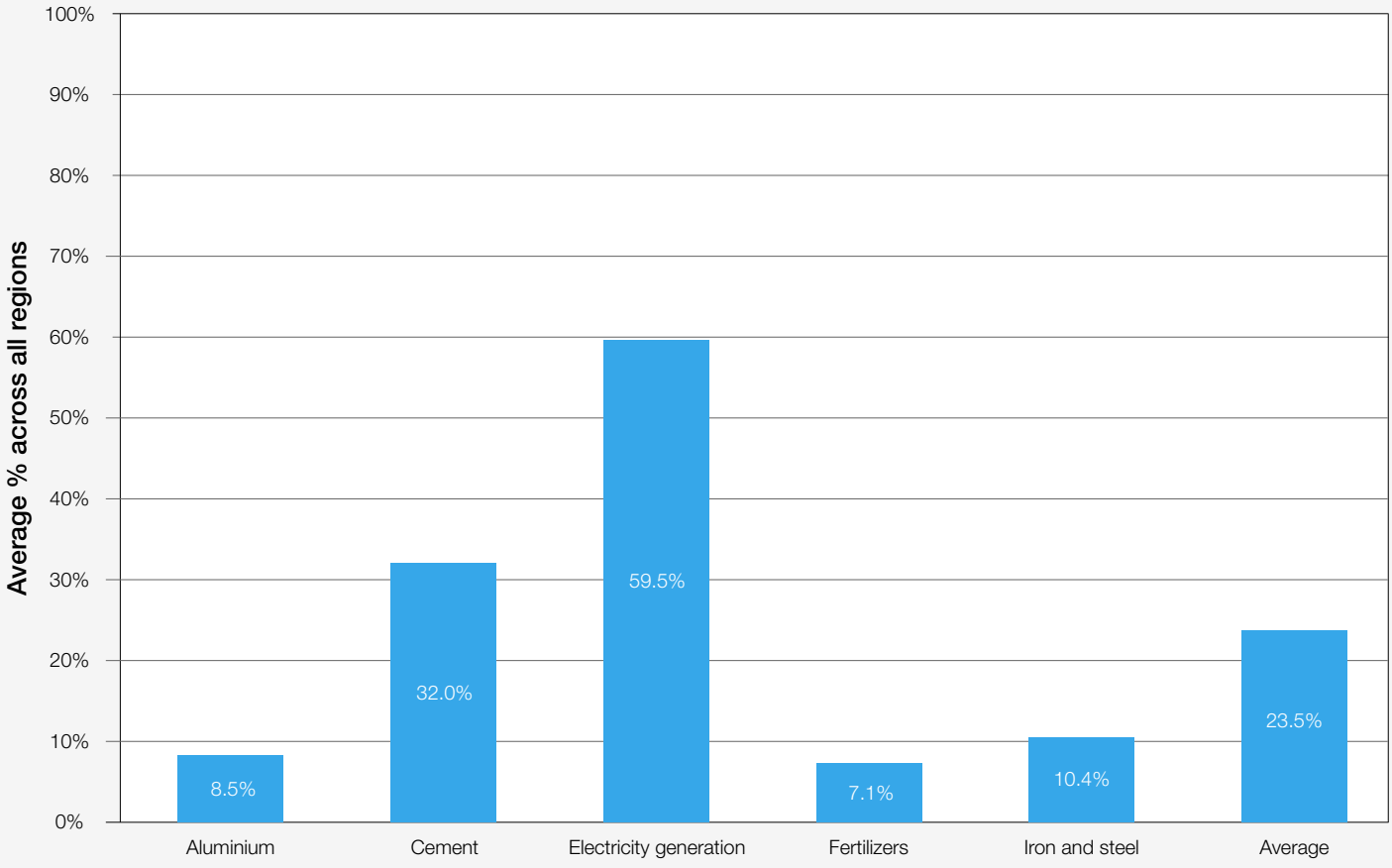
4.6 High-emitting manufacturing industries (HEIs)

To understand in more detail how HEIs could be impacted by an ICPF, a separate analysis was undertaken. These results are based on an environmentally-extended multi-regional input-output (EE MRIO) model and, unlike the preceding results, do not take into consideration business and individual responses to the ICPF.[32] As such, these results should be viewed as measures of the short-term impact before supply and demand adjustments take place.

The analysis captures the cost of carbon on own emissions as well as upstream emissions from purchased electricity (Scope 2) and the rest of the supply chain (Scope 3). This measure may be seen as a proxy for the potential increase in the price of goods and services due to the ICPF.

Under the core scenario, in 2030, the increase in the carbon price throughout the supply chain averages 23.5% of pre-ICPF revenues for the sectors considered, with highs of 59.5% in electricity generation and 32.0% in cement, and the rest of the industries below 11%[33] (**Figure 11**). On a regional basis, this ranges from 7.8% in the UK (averaged across all sectors) to 100.8% in the South Africa Customs Union (which is an outlier as most other regions are below 30%).

FIGURE 11 **Embedded ICPF carbon cost as a percentage of pre-ICPF revenues, 2030 for the core scenario that includes all regions.**



Expanding the scope of the ICPF to include all sectors increases the carbon price of emissions-intensive industry as a share of pre-ICPF revenues by one percentage point across all territories, from 23.5% to 24.4%.

4.7 Carbon leakage

If only high-income countries are included in an ICPF, there will be much higher levels of carbon leakage than under the core scenario (**Figure 12**), indicating the need to include as many economies and sectors as possible.

Carbon leakage occurs most directly when high carbon prices (on either direct emissions or embedded in the price of supplies) in one market shift business operations to places that are subject to lower carbon prices. Carbon leakage can also arise through indirect channels. For example, the pricing of GHG emissions can lower the net of carbon price cost of fossil fuels and lead to increased use of these fuels by firms in territories with low or no carbon pricing.[34]

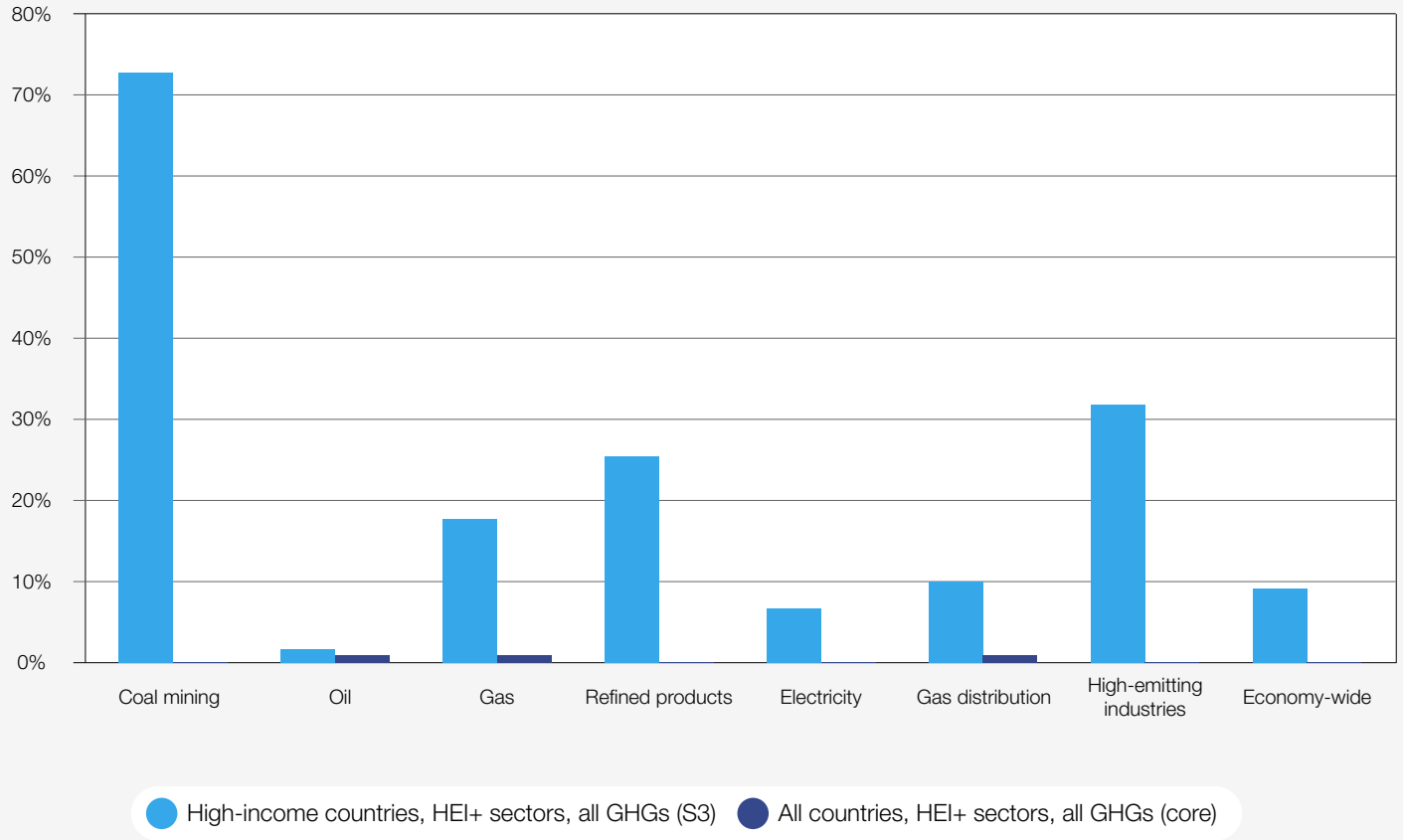
Carbon leakage can be measured as the increase in emissions in the low carbon price jurisdictions, expressed as a percentage of the decrease in emissions in higher carbon price jurisdictions.

For example, if carbon pricing results in an emissions decline of 100 tonnes in one territory and an increase in emissions of 15 tonnes in another territory, the carbon leakage rate is 15%.

Under the core scenario carbon leakage is 1% or less in all fossil fuel and HEIs. **Figure 12** compares imposing a price floor of $75 per $mtCO_2e$ on GHG emissions from HEI+ sectors only in high-income countries with the core scenario. If just high-income countries are included, there would be much higher leakage rates on average (9%) and in specific sectors: coal mining (73%), HEIs (32%), refined products (25%) and gas (18%).

If some countries choose not to participate in the ICPF, additional carbon leakage could occur. The model used here is highly aggregated, so the results are presented as indicative.

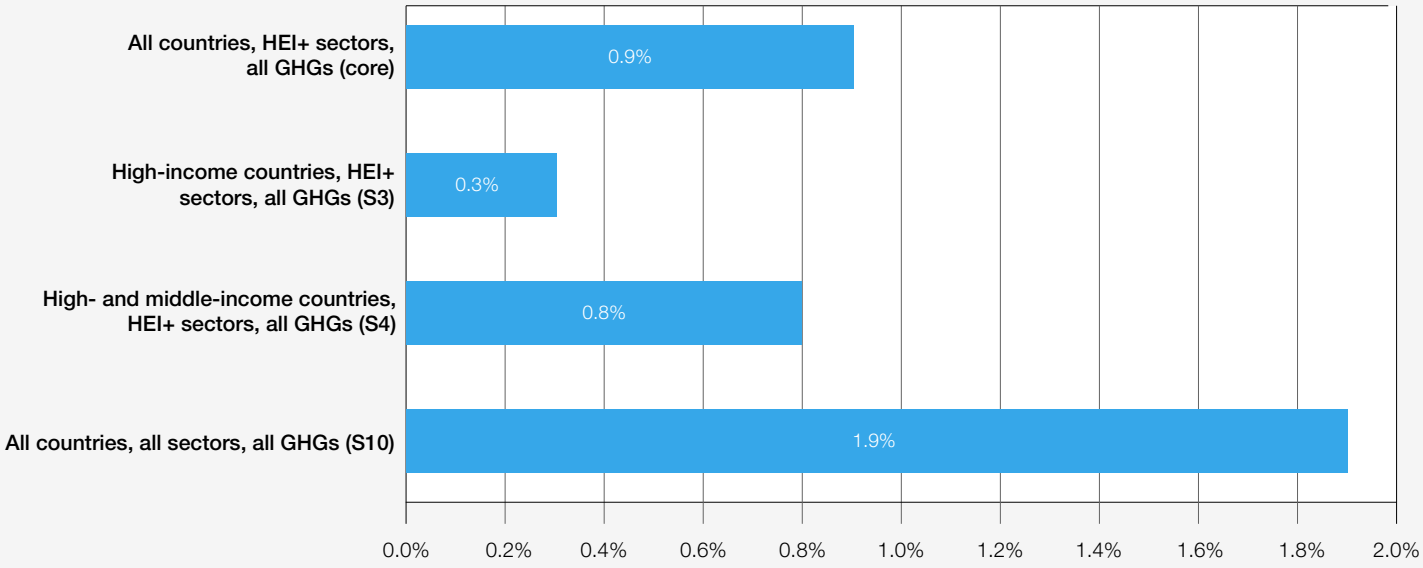
FIGURE 12 **Carbon leakage from high- to middle- and low-income countries: Scenario 3 ($75 carbon price in high-income countries only), and core scenario ($75 in high-, $50 in middle-, and $25 in low-income countries)**



4.8 Significant revenue generation from carbon taxes in the medium term

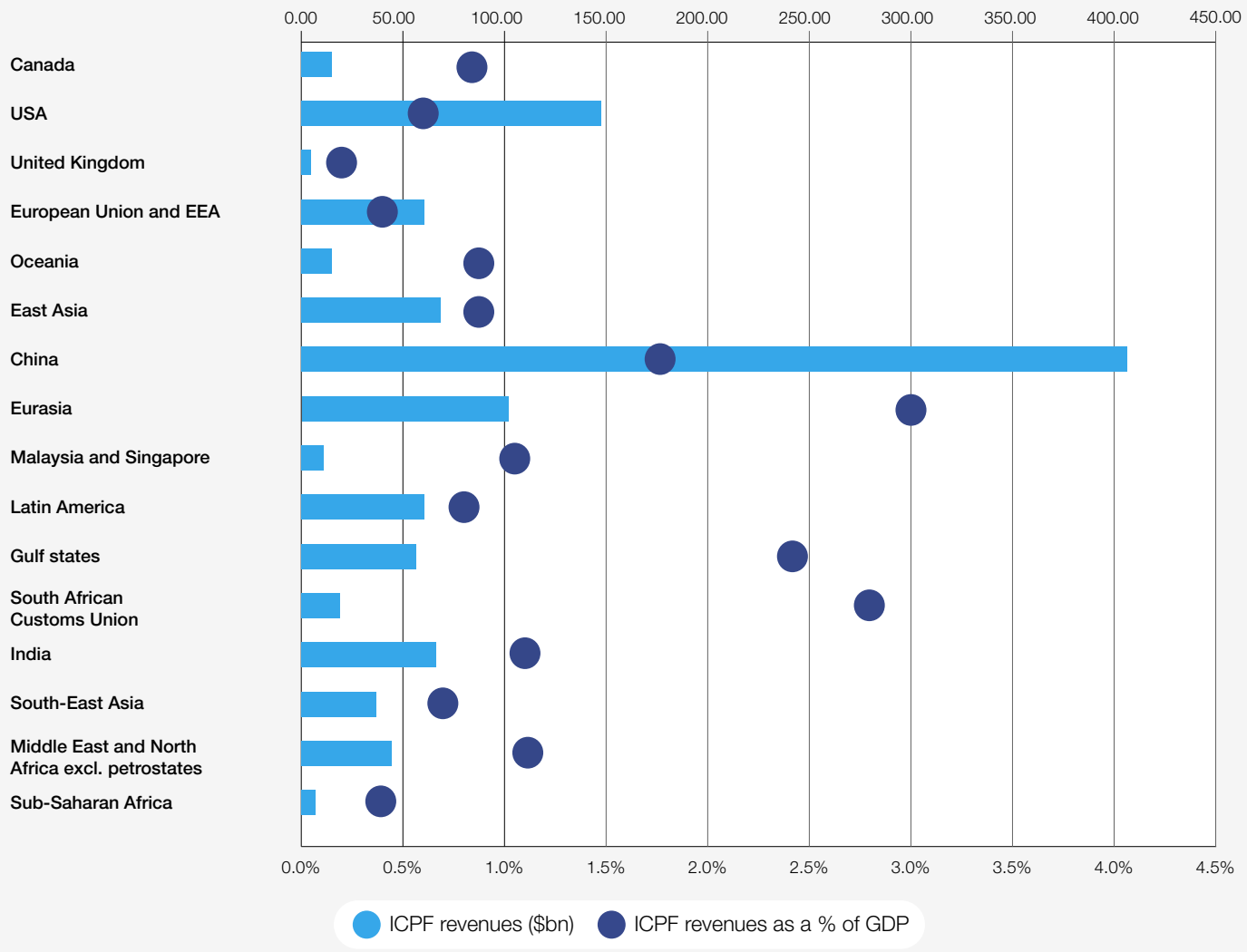
In the medium term, an ICPF could generate additional "carbon fee" revenues globally ranging from 0.3% to 1.9% of the business-as-usual GDP, depending on the sectors and economies covered in the next decade (**Figure 13**). This report assumes the carbon price is implemented as a tax or through the auction of emissions allowances, which not only incentivizes a reduction in the use of carbon or other GHGs but also generates significant revenues for governments in the medium term. If the ICPF is successful in reducing emissions, the amount of revenues raised will decrease over time for a given carbon price.

FIGURE 13 **Incremental ICPF revenue as a % of global GDP by scenario, 2030**



There is potential for significant revenue gains across all territories, as shown in Figure 14.

FIGURE 14 **Incremental ICPF revenue by region under the core scenario, 2030**



In the model, the revenues are redistributed as a carbon dividend, i.e. a lump sum transfer to households in the region affected by the ICPF. This assumption allows the analysis to isolate the impact of the ICPF alone, separate from the effects of any targeted use of the funds.

The IMF proposal suggests using a part of the revenues generated by the ICPF in high-income countries to mitigate adverse effects in some economies. This approach could be an important factor in gaining broad participation and in achieving a just transition to a low-emissions economy. Indicative analysis shows that it would take a fraction of the additional carbon revenue from implementation of the ICPF in the high-income countries to offset completely negative GDP impacts in low-income countries (without considering offsetting reductions in avoided costs). For example, the contraction in GDP in lower-income countries equates to 13% of the additional ICPF revenues generated in higher-income countries under both the core scenario and the scenario that covers all industries and all countries and GHGs.

Carbon taxes are moderately regressive as they often represent a higher fraction of income for lower earners as compared to higher earners.[35] To address this, a portion of ICPF revenues can be used to provide targeted carbon dividends to low-income families. A portion of ICPF revenues could also be used to provide income support and retraining for workers in industries that contract as a result of carbon pricing (e.g. coal mining).

ICPF revenues also may be used to reduce other distortive taxes. For example, Sweden reduced labour taxation when it introduced its carbon tax scheme in 1991.[36] After the financial crisis, Ireland used a carbon tax that allowed for a cut in taxes on labour to spur employment,[37] and in British Columbia, Canada, all carbon tax revenues are used to reduce other taxes.[38]

One of the challenges mentioned by businesses (see the case study of Dow Benelux in section 5) and in the literature is that carbon pricing is only effective if the technology to limit emissions is available and deployable.[39] Market forces alone do not generate the socially optimal level of funding for R&D, and this is particularly the case for non-market environmental benefits.[40] To spur R&D on decarbonization technologies, a portion of ICPF revenues could be used to fund basic research and demonstration projects.

5 The challenge agenda

Collaboration will be key to ensuring a just transition, consistent implementation, and economic restructuring.

Carbon pricing generally is agreed to be a powerful and efficient lever for reducing emissions: it corrects a market failure by putting a price on the social cost of carbon, it incentivizes positive behavioural change and innovation, and it leverages market forces to encourage the broad systems change required to move to a carbon-neutral economy. A carbon price floor could incentivize business investment and consumer choices that reduce emissions, with the potential to bring greater coordination, parity and momentum to the patchwork of international carbon pricing efforts.

Implementing carbon pricing brings significant challenges. No government wants to impose more tax, and in low-income countries, in particular, rising prices could hurt livelihoods and standards of living. "The reality is that, even if there is agreement in principle that pricing carbon reduces emissions, it can be hard to bring forward domestic and regional policy instruments to translate it into reality," says Ian Milborrow, Partner in Sustainability and Climate Change, PwC.

This "challenge agenda" aims to further the debate alongside COP26 about the role of carbon pricing and the effects that an international carbon price floor could have. Discussions with stakeholders from government, business and civil society have helped identify four key challenges to address on the road to implementing an ICPF.

Challenge One: Achieve a just transition and global buy-in

An international carbon price floor requires both national and international support and agreement. It has to be seen as helping everyone, including economies that rely heavily on fossil fuel for energy.

Given current geopolitical tensions, "it's a tough time for internationalism," says Andrew Mitchell, UK Member of Parliament and former UK Secretary of State for International Development.

As indicated in section 4, the revenues generated from a carbon tax could be used to gain greater acceptance nationally if used as a payment to households (carbon dividend), and internationally, if transfers are made from high-income countries to help mitigate the economic cost of an ICPF in lower-income countries. But inter-regional transfers would need to take into account existing climate finance and be transparent and secure. (Existing pledges by higher-income countries to help lower-income countries adapt to or mitigate the effects of climate change to the tune of $100 billion a year by 2030 have yet to be fully realized).

The US and China, as high-emitting countries, will need to play a significant role in attempts to curb emissions. China is moving quickly to introduce electric vehicles, but it will require coal-fired energy plants for years to come.[42] The US thus far has been unable to introduce a national carbon pricing system.[42]

Other countries, including India and China, have suggested that mechanisms like the EU Carbon Border Adjustment Mechanism (CBAM) are unfair.[33]

That said, the recent agreement among 136 countries to join an OECD framework to impose an effective minimum tax rate for multinational groups suggests that collective action on taxation is possible.[44] This process was built around developing an inclusive framework.

> **We need to think about the use of [carbon price] revenues to lower the tax burden on labour, to fight energy poverty, to increase equality.**
>
> Femke Groothius, President of The Ex'tax Project

> **The notion of climate negotiators setting an international price is a red line for most countries, not least the US… US federal intransigence on climate change turns into a political problem for other countries because the US is such a big economic player. If the US isn't doing a meaningful, comprehensive carbon pricing or carbon control programme, how can their competitors?**
>
> Dirk Forrister, President, International Emissions Trading Association

> **Bring together countries to agree a methodology and to agree common findings. This is a way to build common understanding.**
>
> Pascal Saint-Amans, Director of the OECD's Centre for Tax Policy and Administration

The flexibility of the ICPF approach might help. As noted in section 2, countries could effectively apply a carbon price floor through a variety of mechanisms, including explicit carbon pricing through emissions trading and carbon taxes (which already cover 21.7% of carbon emissions globally) or through price-equivalent process and product regulations. Public sentiment weighs in favour of emissions reduction alternatives to carbon taxes. A survey of residents from Germany, the UK and the US found that while people increasingly are looking to governments to find practical solutions, new regulations, incentives and disincentives, and subsidies are preferred to tax-based approaches.[45]

The downside of accommodating regulatory approaches is complexity. It is necessary to determine whether a regulatory regime attains a level of GHG reduction equivalent to what a carbon price floor would have achieved. Regulations' effects must be estimated through models. Deciding who does the estimating and the methodology used is challenging.

World leaders will need to be more direct with their citizens about the changes required to combat global warming and why pricing carbon will help. Mark Kenber, an expert in market-based mechanisms for environmental protection, commented that the main obstacle to climate action like carbon pricing is "political leaders not wanting to give unpleasant news to their citizens".

Challenge Two: Ensure internationally consistent implementation

By design, the ICPF would not prescribe the details of domestic carbon pricing schemes other than the price floor and the sectors covered. It also does not require agreement on how to measure embedded carbon (as in the case of CBAM). Instead, what is required is to agree on the sectors that will be covered by the ICPF (e.g. power, manufacturing, transportation, etc.). This flexibility should not be allowed to undermine the more level playing field that the ICPF is designed to create.

A common approach is needed to identify which measures count towards the floor to prevent future uncertainties or unintended competitive advantages. For instance, a common approach to exceptions, exemptions, subsidies and the treatment of carbon offsets (e.g. afforestation) would be required.

Challenge Three: Manage a major economic structural transition

Although the analysis in this report shows that the ICPF's overall impact on global GDP is modest, spurring the transition to a net-zero world would require a major transformation in the structure of global economies.

> **I don't think we will notice an effect on aggregate GDP or employment or consumption. What we will notice though are significant sectoral shifts. [For example, we need to] shut down the fossil fuel sector. That's the challenging political part. How do countries manage that transition?**
>
> Gilbert Metcalf, Professor of Economics at Tufts University, author of Paying for Pollution

Governments need to manage economic dislocation and disruption, including how to support a major redeployment of capital and labour with methods ranging from income support to job retraining. The scale of energy transformation is challenging, and it is uncertain how quickly the infrastructure and the technology could be developed. To help manage the economic impact on businesses of increasing energy costs, policy-makers need to consider how well business is able to adapt (see Dow Benelux case study on next page). For example, would businesses be able to pass through carbon costs through price increases? Do businesses have access to proven, economically viable technologies to support less carbon-intensive practices? What kind of subsidies would be needed to fund research and demonstration projects to develop these technologies?

BOX 2 | **Carbon price impacts on Dow Benelux**

In 2020, the Dutch Ministry of Economic Affairs asked PwC to assess the impacts on the competitive position of the Dutch industry of measures that would increase the price of carbon emissions over those prevailing in Europe. The analysis included case studies of companies that would be particularly affected by the measures, including Dow Benelux, a chemicals producer with global clients.[46]

The assessment suggested that the company would have minimum scope to pass on the increased costs due to competition in the international market. The necessary volume of emissions reduction through new technologies would not be economically feasible. Available subsidies would be insufficient to make the viable technical alternatives cost-effective.

Put together, these elements indicated that Dow Benelux would face a negative financial impact ranging from 16% to 48% of earnings before interest and taxes (EBIT) in 2030, depending on the design of the carbon price. As a consequence, the relative attractiveness of the Netherlands as a production location would decrease. This example shows that increasing carbon pricing and government support when making a major shift in production should go hand-in-hand.

Challenge Four: How to address innovation and additional policies to change behaviour

While carbon pricing is an important lever for reducing emissions, it is only one piece of the puzzle. Meeting climate ambitions requires deep behavioural and structural change and the development and deployment at scale of technologies that either do not exist or are in their infancy today. For this to occur, carbon pricing needs to work in concert with other elements such as financial support for innovation, infrastructure, process development, and in some cases, regulatory measures (e.g. transportation and building standards).

Carbon pricing is likely to incentivize some green technology R&D, but it is not clear that it would lead to the huge investments in early-stage R&D that are required.

> **Economics 101 is that research and development is a public good and therefore under-provided by the private sector. Government support of (early stage) R&D can help.**
>
> Gilbert Metcalf, author of Paying for Pollution

For a trickle of consumer behavioural change to become a flood, greener alternatives need to compete on aspects like convenience, reliability and cost. For example, most countries lack the charging station infrastructure for electric vehicles to be as conveniently refuelled as petrol ones.

For companies, transitioning to a low emissions business model is a complex process. It takes time, data, and analysis to rigorously track a company's emission sources (especially Scope 3 emissions generated by suppliers across a complex supply chain), prioritize where and how to reduce emissions, make a solid business case for the needed investment, and measure progress. Aspects of the business can be "sticky" – long term contracts, sunk capital expenditures and other transition costs may bind companies to locations or productive processes that are emissions-intensive. But a carbon price floor provides greater certainty that business investments in decarbonization will cover the cost of capital. As one senior executive said: "A lot of people are very aspirational [about decarbonizing the business], but they always have a CFO who talks about affordability, or shareholders or short-term goals versus longer-term goals. So, without carbon pricing, [reducing emissions fast enough] will not work at all."

> **It may seem surprising that leading businesses support a tax, but many companies we work with support carbon pricing as a key instrument to raise climate ambition. It will give investors and business clarity, and level the playing field.**
>
> Karl Vella, We Mean Business Coalition

Conclusion

An international carbon price floor could help reduce emissions and increase global ambitions to tackle climate change. The reduction in GDP from pricing carbon is estimated to be largely offset by the avoidance of costs associated with rising temperatures. That is a positive message. The challenges, however, are real and present. COP26 provides a platform for leaders to discuss the various options available to reduce global warming. This report provides a detailed analysis of one possible piece of the puzzle. An ICPF that is phased in and takes into account differentiated responsibilities and varying national approaches to GHG reduction could help spur greater ambition and international cooperation, two ingredients that will be needed in the decades ahead.

Glossary

CBAM: Carbon Border Adjustment Mechanism

CGE: Computable general equilibrium

EBIT: Earnings before interest and taxes

EE MRIO: Environmentally-extended multi-regional input-output

ETS: Emissions trading system

GHG: Greenhouse gas

GDP: Gross domestic product

$GtCO_2e$: Giga tonnes of carbon dioxide equivalent

GVA: Gross value added

HEIs: High-emitting manufacturing industries

HEI+: Power generation, HEI, fossil fuel extraction and refining industries

ICPF: International carbon price floor

IMF: International Monetary Fund

IPCC: Intergovernmental Panel on Climate Change

$mtCO_2e$: Metric tonnes of carbon dioxide equivalent

$MtCO_2e$: Millions of metric tonnes of carbon dioxide equivalent

NDCs: Nationally determined contributions

OECD: Organisation for Economic Co-operation and Development

R&D: Research and development

UNEP: United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

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Further resources

Bertram, Christoph, Gunnar Luderer, Robert Pietzcker, Eva Schmid, Elmar Kriegler and Ottmar Edenhofer, "Complementing carbon prices with technology policies to keep climate targets within reach", Nature Climate Change, vol. 5, no. 1, 2015, pp. 235-239, https://www.nature.com/articles/nclimate2514.

Burniaux, Jean-Marc, and Truong Truong, GTAP-E: An Energy-Environmental Version of the GTAP Model, Global Trade Analysis Project, 2002, https://www.gtap.agecon.purdue.edu/resources/download/1203.pdf.

Convery, Frank, Louise Dunne and Deirdre Joyce, "Ireland's Carbon Tax and the Fiscal Crisis", OECD Library, 2013, https://www.oecd-ilibrary.org/environment-and-sustainable-development/ireland-s-carbon-tax-and-the-fiscal-crisis_5k3z11j3w0bw-en.

European Commission, Proposal for a Regulation of the European Parliament and of the Council, establishing a carbon border adjustment mechanism, 2021, https://ec.europa.eu/info/sites/default/files/carbon_border_adjustment_mechanism_0.pdf.

Grainger, Corbett and Charles Kolstad, "Who Pays a Price on Carbon?", Environmental and Resource Economics, vol. 46, no. 1, Springer Link, 2010, pp. 359-376, https://link.springer.com/article/10.1007/s10640-010-9345-x.

Hertel, Thomas, and Dominique van der Mensbrugghe, Chapter 14: Behavioral Parameters, Global Trade Analysis Project, 2016, https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5138.

Tax Policy and Climate Change: IMF/OECD Report for the G20 Finance Ministers and Central Bank Governors, OECD, 2021, https://www.oecd.org/tax/tax-policy/imf-oecd-g20-report-tax-policy-and-climate-change.htm.

Global Energy Review 2021, International Energy Agency, 2021, https://www.iea.org/reports/global-energy-review-2021.

Kompas, Tom, Pham Van Ha and Tuong Nhu Che, "The Effects of Climate Change on GDP by Country and the Global Economic Gains From Complying With the Paris Climate Accord", Earth's Future, vol. 6, no. 8, 2018, pp. 1153-1173, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018EF000922.

Metcalf, Gilbert and James Stock, The Macroeconomic Impact of Europe's Carbon Taxes, SSRN, 2020, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3644097#.

Nordhaus, William, "Climate Clubs: Overcoming Free-riding in International Climate Policy", American Economic Review, vol. 105, no. 4, 2015, pp. 1339-1370, https://www.jstor.org/stable/43495421.

Taxing Energy Use 2019: Country Note - Colombia, 2019, OECD, https://www.oecd.org/tax/tax-policy/taxing-energy-use-colombia.pdf.

Ohlendorf, Nils, Michael Jakob, Jan Christoph Minx, Carsten Schröder and Jan Christoph Steckel, "Distributional Impacts of Carbon Pricing: A Meta-Analysis", Environmental and Resource Economics, vol. 78, no. 1, Springer Link, 2020, pp. 1-42, https://link.springer.com/article/10.1007/s10640-020-00521-1.

Parry, Ian, Simon Black and James Roaf, "Proposal for an International Carbon Price Floor Among Large Emitters", IMF, 2021, https://www.elibrary.imf.org/view/journals/066/2021/001/066.2021.issue-001-en.xml.

Partnership for Market Readiness, Carbon Leakage: Theory, Evidence and Policy Design, Open Knowledge Repository, Working Paper, The World Bank, 2015, https://openknowledge.worldbank.org/handle/10986/22785.

PwC Netherlands, Speelveldtoets 2020, De impact van het voorgenomen klimaatbeleid op het speelveld van de Nederlandse industrie, Rijksoverheid, 2020, https://www.rijksoverheid.nl/documenten/rapporten/2020/09/15/eindrapport-pwc-speelveldtoets.

Emissions Gap Report 2020, UNEP, and UNEP DTU Partnership, 2020, https://www.unep.org/emissions-gap-report-2020.

Williams III, Roberton, Hal Gordon, Dallas Burtraw, Jared Carbone and Richard Morgenstern, "The Initial Incidence of a Carbon Tax across Income Groups", National Tax Journal, vol. 68, no. 1, University of Chicago Press Journals, 2015, pp. 190-214, https://www.journals.uchicago.edu/doi/abs/10.17310/ntj.2015.1.09.

For a full discussion of the ICPF model, the CGE and IEEO models see PwC Technical Addendum.

Endnotes

1. For a breakdown of energy use, see BP Statistical Review of World Energy, 70th edition, 2021, www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf.
2. For a discussion on the benefits of carbon pricing, see Grantham Institute, What is a carbon price and why do we need one?, London School of Economics, 2018, https://www.lse.ac.uk/granthaminstitute/explainers/what-is-a-carbon-price-and-why-do-we-need-one/.
3. For a full description, see Parry, Ian, Simon Black, and James Roaf, "Proposal for an International Carbon Price Floor among Large Emitters," IMF Staff Climate Notes 2021/001, IMF, June 2021, https://www.elibrary.imf.org/view/journals/066/2021/001/066.2021.issue-001-en.xml.
4. The carbon emissions impact of the ICPF is estimated independently of NDCs. The level of emissions is then compared to NDC emissions reductions, as calculated by the UNFCCC in its Emissions Gap report and as set out in Parry et al. (2021). ICPF emissions reductions plus NDC reductions (to the extent in excess of ICPF-only reductions) indicate the combined impact of both policies.
5. Based on an analysis using Kompas et al., (2018), in most scenarios modelled, the benefits from these factors alone would largely offset the GDP costs modelled by 2100. The Swiss Re Institute suggests inadequate action to reduce temperatures will result in declines of GDP between 4% and 18%, https://www.swissre.com/media/news-releases/nr-20210422-economics-of-climate-change-risks.html.
6. UNFCCC, Full NDC Synthesis Report: Some progress but still a big concern" [Press release], 17 September 2021, https://unfccc.int/news/full-ndc-synthesis-report-some-progress-but-still-a-big-concern; United Nations Environment Programme, Emissions Gap Report 2020, December 2020, p. 26; Energy and Climate Intelligence Unit, Taking stock: a global assessment of net zero targets, March 2021, https://eciu.net/analysis/reports/2021/taking-stock-assessment-net-zero-targets. See United Nations Environment Program Emissions Gap Report 2021 for latest figures that reflect the effect of COVID 19 on economic activity, https://www.unep.org/resources/emissions-gap-report-2021
7. For a discussion on how to measure net-zero commitments, see MSCI ESG Research, Breaking down corporate net-zero climate targets, May 2021, https://www.msci.com/documents/10199/9172b38f-5d67-4346-a15b-9b8233f81da0.
8. IPPC, Climate Change 2021: The Physical Science Basis, August 2021, https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/.
9. For descriptions of two previous international agreements on climate, see UN Environment Programme, About the Montreal Protocol, n.d., https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol and United Nations Economic Commission for Europe information on air pollution, n.d., https://unece.org/environment-policy/air.
10. OECD, Statement on a Two-Pillar Solution to Address the Tax Challenges Arising From the Digitalisation of the Economy, 1 July 2021, https://www.oecd.org/tax/beps/statement-on-a-two-pillar-solution-to-address-the-tax-challenges-arising-from-the-digitalisation-of-the-economy-july-2021.pdf.
11. Parry, Ian, Simon Black, and James Roaf, "Proposal for an International Carbon Price Floor among Large Emitters," IMF Staff Climate Notes 2021/001, IMF, June 2021, https://www.elibrary.imf.org/view/journals/066/2021/001/066.2021.issue-001-en.xml.
12. IMF, IMF Managing Director's intervention at the Leaders Summit on Climate, Session 2: Investing in Climate Solutions, 22 April 2021, https://www.imf.org/en/News/Articles/2021/04/22/sp042221-md-remarks-at-the-leaders-summit-on-climate.
13. The IMF estimates that 1% of revenues from a $50 per $mtCO_2e$ carbon price in the G20 countries would raise $10 billion per year.
14. See World Bank Carbon Pricing Dashboard, https://carbonpricingdashboard.worldbank.org/map_data.
15. Nordhaus, William, "After Kyoto: Alternative Mechanisms to Control Global Warming", American Economic Review, vol. 96, no. 2, 2006, pp. 31-34, http://www.jstor.org/stable/30034609.
16. Climate Policy & Strategy, 2021, Global Climate Policy & Strategy: Summary of baseline surveys For example, research in the US published by Climate Policy & Strategy, June 2021, showed that most people did not support carbon taxes. https://democracycorps.com/uncategorized/climate-policy-strategy-united-states-baseline-survey-june-2021/
17. Nordhaus, William, "Climate Clubs: Overcoming Free-riding in International Climate Policy," American Economic Review, vol. 105, no. 4, 2015, pp. 1339-1370, http://www.jstor.org/stable/43495421.
18. A review of CGE modelling by the World Bank in 2015 has shown a range of effects on GDP from a decline of less than 1% to 1.6%. These results presented are in the middle of that range. See The World Bank, Carbon Leakage Theory, Evidence and Policy Design, PMR Technical Note 11, October 2015, https://openknowledge.worldbank.org/handle/10986/22785.
19. See European Commission, Proposal for a Regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism, 564 final, July 14 2021, https://ec.europa.eu/info/sites/default/files/carbon_border_adjustment_mechanism_0.pdf.

20. For the purposes of levying ICPF based on income level, we have modified World Bank country definitions in line with the constraints of the CGE model. This leads to some anomalies. For example, though Israel is classified as high-income, the model considers it as part of Middle East and North Africa, which are low-income. Similarly Greenland is classified as high-income by the World Bank, but we consider it as part of Rest of North America (along with Bermuda and Saint Pierre and Miquelon), which is classified as middle-income. See https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2021-2022

21. See the Technical Addendum for how the modelling is aligned with the IMF proposals.

22. COVID-19 was associated with a contraction of 4.3% of global GDP in 2020, over three times more than during the global financial crisis of 2009, which resulted in a contraction of 0.1% of global GDP; UN DESA, World Economic Situation and Prospects, 2021, https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/Monthly_Briefing_146.pdf; IMF, The Great Lockdown: Worst Economic Downturn Since the Great Depression, 2020, https://blogs.imf.org/2020/04/14/the-great-lockdown-worst-economic-downturn-since-the-great-depression/.

23. OECD,Tax Policy and Climate Change: IMF/OECD Report for the G20 Finance Ministers and Central Bank Governors, April 2021, Italy, p. 17, https://www.oecd.org/tax/tax-policy/tax-policy-and-climate-change-imf-oecd-g20-report-april-2021.pdf.

24. Kompas, Tom, Pham Van Ha and Tuong Nhu Che, "The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord", Earth's Future, 6, 2018, pp. 1153–1173. This estimate does not capture any losses from more extreme weather and changes in tourism flows and energy demand. For example, an increase in winter temperature would lead to a lower consumption of heating, and an increase in summer temperature would lead to a higher consumption of cooling.

25. United Nations Environment Programme, Emissions Gap Report 2020, p. xx, https://www.actu-environnement.com/media/pdf/news-36675-emissions-gap-report-2020-pnue.pdf.

26. If the estimates in Parry et al. are used. The baseline business-as-usual case used in this report's modelling is higher than the one used by Parry et al., which takes into account the impacts of COVID-19. See Annex 1 for further details.

27. For a discussion on the costs of energy transitions see European Bank for Reconstruction and Development report on middle-income countries in transition, April 2019, https://www.ebrd.com/news/publications/transition-report/ebrd-middle-income-transitions-.html.

28. For a breakdown on coal usage by region, see: International Energy Agency, World Energy Balances: Overview, August, 2021, https://www.iea.org/reports/world-energy-balances-overview/oecd#abstract

29. See table in Technical Addendum. Note that oil is relatively less affected.

30. Output figures include the cost of the carbon "fee" associated with the ICPF.

31. IEA Global Energy Review 2021, International Energy Agency, April 2021, https://www.iea.org/reports/global-energy-review-2021

32. See Technical Addendum for details of the model.

33. This is a simple unweighted average.

34. The World Bank, Carbon Leakage Theory, Evidence and Policy Design, PMR Technical Note 11, October 2015, https://openknowledge.worldbank.org/handle/10986/22785.

35. On factors affecting regressivity, see, for instance: Ohlendorf, Nils, Michael Jakob, Jan Christoph Minx, Carsten Schröder and Jan Christoph Steckel, "Distributional Impacts of Carbon Pricing: A Meta-Analysis", Environmental and Resource Economics, vol. 78, no. 1, 2020, pp. 1-42, https://link.springer.com/article/10.1007/s10640-020-00521-1; Grainger, Corbett and Charles Kolstad, "Who Pays a Price on Carbon?", Environmental and Resource Economics, vol. 46, 2010, pp. 359–376, https://doi.org/10.1007/s10640-010-9345-x; Williams III, Roberton, Hal Gordon, Dallas Burtraw, Jared Carbone and Richard Morgenstern, "The Initial Incidence of a Carbon Tax across Income Groups", National Tax Journal, vol. 68, no. 1, 2015, pp. 190-214, https://www.journals.uchicago.edu/doi/10.17310/ntj.2015.1.10.

36. Ministry of Finance, Government Offices of Sweden, Carbon Taxation in Sweden, 2021,https://www.government.se/48e407/contentassets/419eb2cafa93423c891c09cb9914801b/210111-carbon-tax-sweden---general-info.pdf.

37. OECD, Ireland's Carbon Tax and the Fiscal Crisis, 2013, https://www.oecd-ilibrary.org/environment-and-sustainable-development/ireland-s-carbon-tax-and-the-fiscal-crisis_5k3z11j3w0bw-en.

38. UNFCCC, Revenue-Neutral Carbon Tax: Canada, n.d., https://unfccc.int/climate-action/momentum-for-change/financing-for-climate-friendly/revenue-neutral-carbon-tax

39. Bertram, Christoph, Gunnar Luderer, Robert Pietzcker, Eva Schmid, Elmar Kriegler and Ottmar Edenhofer, "Complementing carbon prices with technology policies to keep climate targets within reach", Nature Climate Change, vol. 5, 2015, pp. 235–239, https://www.nature.com/articles/nclimate2514.

40. "Investing in U.S. Competitiveness: The Benefits of Enhancing the Research and Experimentation (R&E) Tax Credit," A Report from the Office of Tax Policy, US Department of the Treasury, 25 March 2011, https://home.treasury.gov/system/files/131/Report-Investing-in-US-Competitiveness-2011.pdf.

41. For more information on energy policy and usage in China, see: “Guide to Chinese Energy Policy”, Columbia University, 2021, https://chineseclimatepolicy.energypolicy.columbia.edu/en/electric-vehicles; Standaert, Michael, “Despite Pledges to Cut Emissions, China Goes on a Coal Spree”, Yale School of the Environment, March 2021,https://e360.yale.edu/features/despite-pledges-to-cut-emissions-china-goes-on-a-coal-spree.

42. California is linked to a cap-and-trade market with the province of Québec that covers power generation and distributors of fossil fuels, and 11 US states participate in the Regional Greenhouse Gas Initiative (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia), a cap-and-trade market for electric power generators.

43. See Politico, China’s Xi slams EU carbon border levy plans, April 2021, https://www.politico.eu/article/chinas-xi-seeks-macron-merkel-climate-change-co2-cop26-emisions/; “India says will oppose ‘regressive proposal’ by rich nations on carbon tax”, Business Standard, 29 June 2021, https://www.business-standard.com/article/economy-policy/india-to-oppose-regressive-proposal-by-rich-nations-on-carbon-tax-121062901291_1.html.

44. See OECD announcement on agreement on multinational tax deal: OECD, International community strikes a ground-breaking tax deal for the digital age, 8 October 2021, https://www.oecd.org/newsroom/international-community-strikes-a-ground-breaking-tax-deal-for-the-digital-age.htm.

45. See market research GQR report Climate Policy and Strategy, Global Climate Policy and Strategy: Summary of baseline surveys, 2021, https://www.gqrr.com/news/gqr-study-shows-europeans-are-ready-for-climate-action/.

46. See PwC report for the Dutch government (in Dutch): PwC Netherlands, Speelveldtoets 2020, De impact van het voorgenomen klimaatbeleid op het speelveld van de Nederlandse industrie, Rijksoverheid, 2020, https://www.rijksoverheid.nl/documenten/rapporten/2020/09/15/eindrapport-pwc-speelveldtoets.

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