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GLOBAL CLIMATE PROTECTION: POLICY FRAMEWORK AND POTENTIAL COURSES OF ACTION

This is a translated version of the original German-language chapter "Globaler Klimaschutz: Rahmenbedingungen und Handlungsoptionen", which is the sole authoritative text. Please cite the original German-language chapter if any reference is made to this text.

KEY MESSAGES

↘ Climate protection is a global challenge. The risks posed by climate change and the economic opportunities offered by the transformation needed are unequally distributed around the world.

↘ Progress on global cooperation should be supported by burden sharing and technology collaborations. This is likely to boost private investment worldwide.

↘ Investment protection agreements and the formation of a climate club are key elements of international climate policy. Trade agreements should account for the close interdependencies between trade and climate. However, associated costs and benefits need to be balanced.

EXECUTIVE SUMMARY

Under the Paris Agreement the international community committed itself to limiting global warming to well below 2 °C and, if possible, to 1.5 °C compared with pre-industrial levels. The global measures taken to date, however, are not sufficient to meet this target. The task of intensifying global cooperation in climate protection is becoming increasingly urgent.

The wide heterogeneity of parties to the Paris Agreement poses a significant challenge. Long-term **direct climate risks** primarily affect developing and emerging economies, while the advanced economies in particular are facing **transition risks**. Decarbonisation means that countries with fossil fuel reserves will lose vital sources of revenue. At the same time, however, climate policy offers a number of opportunities. This will create **new markets** and profit opportunities for many firms. Switching to renewable energy will enable some countries to **diversify** their **energy dependence**, while others will have the chance to **export energy**. Climate negotiations are therefore strongly affected by diverse geopolitical and industrial policy interests.

For global climate cooperation to progress, the focus should be put on burden sharing (for example in the form of transfers from advanced economies to developing and emerging economies), technology collaborations and the joint creation of climate-friendly (global) value chains. If financial transfers and technological cooperation successfully facilitate the transformation for the developing countries and emerging economies, thereby opening new perspectives for them, global climate protection could be accelerated and the cost of emissions mitigation could be reduced. Bilateral **technology partnerships** can produce mutual benefits by providing domestic and foreign firms with the opportunity to test and scale up climate-friendly technologies at an early stage. This will require the **mobilisation of both public and private funding** from the advanced economies in particular. Public funding should be specifically used to improve the general framework in order to reduce political uncertainty for private investors. Large-scale private investment will be needed worldwide. Investment agreements will play a key role in unlocking this investment.

Further development of the Paris Agreement could strengthen countries' trust in global climate cooperation. In future this might win majority support for mechanisms capable of restricting free-riding more effectively. In addition to the global approach, a stronger focus should be placed on collaboration in smaller groups of countries. A **climate club** might be a possibility to achieve progress on climate protection and better embed international coordination of climate policy in an institutional framework. This could mitigate the risk of carbon leakage and of competitive distortions. Trade agreements should account for the close interdependencies between trade and climate.

I. SUCCESSFUL CLIMATE POLICY RELIES ON INTERNATIONAL COOPERATION

504. Climate protection is a **global challenge** that requires a global reponse (GCEE Special Report 2019 items 13 ff.). Only the broad involvement of the international community can mitigate climate change. Decisive steps to contain global warming are therefore taken under the auspices of the annual **Conferences of the Parties** (COPs). ↘ ITEMS 555 FF.

505. Finding a way to achieve ambitious emission reductions through the combined efforts of almost 200 countries is challenging. Both the **costs of climate change** ↘ ITEMS 512 FF. and the **transition cost of associated with mitigation** through reductions in greenhouse gas emissions ↘ ITEMS 521 FF. vary considerably across countries, resulting in highly divergent interests and differing negotiating positions. At the same time, climate negotiations are made more difficult by the fact that **climate protection is a global public good**: On the one hand, no country alone can – through its own efforts – achieve the Paris Agreement's goal of limiting global warming. On the other hand, no country can be excluded from the benefits created by reductions in emissions undertaken by other countries. This reduces the incentive for countries to undertake their own national mitigation efforts and increases the risk of **free-riding**. ↘ ITEMS 555 FF. National climate policy should therefore be embedded in multilateral climate policy.

506. Given the challenges of multilateral negotiations between all countries, the European Union (EU) and Germany are attempting to supplement multilateral climate policy by adopting bilateral and plurilateral approaches ↘ BACKGROUND INFO 12. These approaches can **support multilateral efforts** to cut emissions as well as improve a country's effectiveness of national **climate policies**. ↘ ITEMS 581 FF. Bilateral and plurilateral approaches are especially relevant in view of the **close interdependencies** between **national climate policy** and **international competitiveness**.

507. The international competitiveness of a country's industrial sectors can be jeopardised if the climate regulations raise domestic firms' production costs. In some industries the transition to climate-friendly processes is expected to bring about a **shift in locational benefits** and, consequently, in production locations. Moreover, unilateral climate protection measures can cause production to be relocated to less strictly regulated regions, which means that these measures ultimately achieve little or no reduction in emissions (**carbon leakage**; GCEE Special Report 2019 items 181 ff.).

On the other hand, climate policy can provide meaningful incentives for companies to **build competencies** in new technologies at an early stage and to **tap new markets** (GCEE Annual Report 2020 items 358 ff.). By creating an attractive environment for the development and scaling-up of climate-friendly technologies, it is possible to achieve market leadership in key technologies relevant for a climate-friendly economy. ↘ ITEMS 538 FF. Whether the national climate measures are net beneficial for the industrial competitiveness is determined not only by the choice of climate instruments used. The progress of international efforts, the climate policies of other countries and trade policy also have an impact here.

↘ BACKGROUND INFO 12

The distinction between multilateral measures and plurilateral measures

The measures that a country takes internationally can be classified according to the number of cooperation partners involved. In addition to unilateral and bilateral measures – in other words, measures undertaken either alone or in cooperation with one other country – a distinction is made between multilateral measures and plurilateral measures. The term '**plurilateral measures**' used below refers to agreements among small groups of countries, such as those signed as part of regional free trade agreements, for example. **Multilateral agreements**, on the other hand, cover larger groups of countries acting together within the framework of an international organisation. Measures taken under the auspices of the World Trade Organization or the United Nations are therefore referred to as multilateral.

508. In addition to the efforts undertaken to achieve multilateral agreement on climate protection measures and goals, **bilateral and plurilateral approaches to climate cooperation** can enable further progress on climate change. The most important approaches here include **technology and energy partnerships**, ↘ ITEMS 583 FF. which can present opportunities that go beyond the concerns of climate policy. ↘ ITEMS 547 F. Climate policy coordination through **trade policy** can also **provide major impetus** for climate protection↘ ITEMS 602 F. Bilateral and plurilateral climate cooperation can reduce global emissions, while improving the effectiveness and efficiency of national climate policy.

Strengthening efforts to achieve **technology and energy partnerships** in conjunction with a trade policy that is sensibly linked to climate policy might enable German and European firms to scale their climate-friendly products and solutions more quickly. ↘ GLOSSARY The resulting decline in costs can, in turn, reduce the national cost of climate policy. Moreover, it would also lower the technology costs of countries that do not participate in the relevant coordination mechanisms. ↘ ITEMS 537 FF.

509. **International investment agreements** play a key role within the context of German and European firms' global activities because they protect the firms' rights abroad, thereby unlocking investment in environmental technologies. These agreements can, however, increase the cost of climate policy measures if these measures reduce the value of investment already conducted in fossil technologies in a way that allows foreign companies to claim compensation. ↘ ITEMS 589 FF. Attempts to reduce the investment protection already established for fossil technologies are challenging to implement because adjustments to the agreements require unanimity among the parties concerned. There would moreover be a risk of eroding trust in investment protection in respect of future climate protection investment as well.

510. Finally, an alliance of countries that coordinate their climate policies with each other might be a starting point for stronger international climate cooperation ↘ GLOSSARY that helps to curb carbon leakage and other competitive distortions. A sufficiently large **climate club** – ideally including the European Union, the United States and China – could allow more ambitious climate policies in all countries involved. In terms of climate protection measures, this might create a more level playing field between economic regions enjoying close trade relations. Ideally, such coordination would take the form of joint pricing of greenhouse gas emissions or, alternatively, common emission mitigation paths in emission-intensive industries. A climate club could introduce a **carbon border adjustment mechanism** at its external borders. ↘ ITEMS 613 FF.

II. REGIONAL CHALLENGES AND CHANCES OF CLIMATE PROTECTION

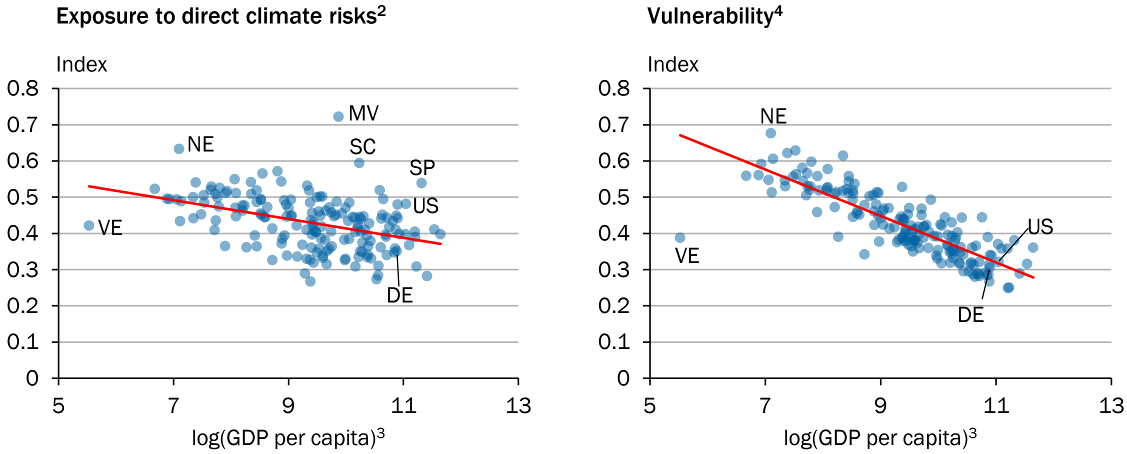
511. Many competing interests affect international climate negotiations. The negotiating positions adopted by the parties are shaped not only by **climate risks** that arise from global warming and that can vary considerably from one economy to another. ↘ ITEMS 512 FF. The **transition costs** ↘ GLOSSARY associated with the required **adjustment of the energy supply** and production locations and technologies also impact the climate policy positions taken. ↘ ITEMS 525 FF. Successful climate cooperation can mean a dramatic loss in value of natural resources, especially for those economies that export **fossil fuels**. ↘ ITEMS 530 FF.

At the same time, increasing climate ambitions create **economic and geopolitical opportunities**. ↘ ITEMS 583 FF. The substantial **investment required** to achieve carbon neutrality provides economies with new export opportunities as long as the local companies possess the necessary technology. ↘ ITEMS 538 FF. Renewables can help countries to change their energy dependence and to diversify their energy imports. ↘ ITEMS 547 F.

1. Regional differences in climate risk

512. **Climate change poses** significant **physical risks** to humanity along various dimensions such as changes in temperatures, in the levels of precipitation, and in the numbers of extreme weather events. The Intergovernmental Panel on Climate Change (IPCC) expects these changes to vary considerably from region to region (IPCC, 2013, 2021). It is forecasting lower temperature rises, for example, near the equator and in coastal regions and larger increases near the poles, especially in the northern hemisphere. Coastal regions would be particularly affected by rising sea levels. These climatic changes – in conjunction with the currently prevailing climatic conditions – are likely to produce **substantial regional heterogeneity in the consequences of climate change**, such as with respect to the availability of groundwater, food supplies or temperature-related mortality. The

↘ CHART 127
The climate threats arising from direct physical risks and vulnerability are negatively correlated with countries' economic output[1]



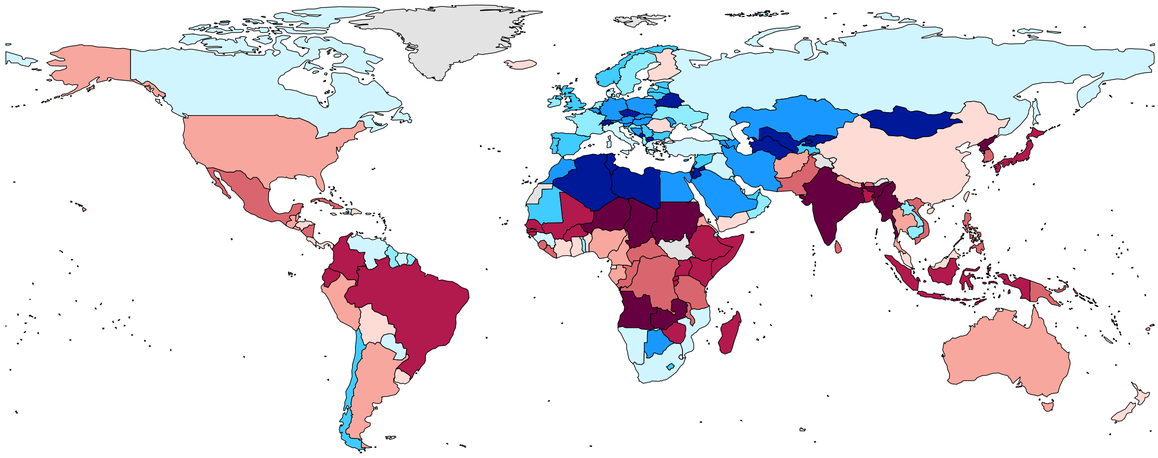
1 – DE-Germany, MV-Maldives, NE-Niger, SC-Seychelles, SP-Singapore, US-USA, VE-Venezuela. 2 – ND-GAIN Index 'Exposure' component for 2019. Describes the extent to which individual countries will be adversely affected by future changes in climate and covers the physical risks of climate change. The factors considered include the impacts of climate change on agricultural conditions, the availability of drinking water, changes in climate-related mortality, flood risks and changes in sea levels. 3 – Real per-capita GDP in 2019 adjusted for purchasing power parity measured in 2017 US dollars. 4 – ND-GAIN Index 'Vulnerability' component for 2019. Describes the extent to which individual countries will be damaged by future climate changes in climate. In addition to the 'Exposure' component this also includes the 'Sensitivity' and 'Adaptive Capacity' components, which measure the extent to which a country's population and economy rely on activities that are severely adversely affected by climate and the extent to which these activities can be adapted to climate change. these activities can be adapted to climate change.

Sources: Notre Dame Global Adaptation Initiative, Penn World Tables, own calculations

largest temperature rises, for example, are expected in regions that currently have low average temperatures and which could actually experience positive impacts in some areas such as agriculture (Moore et al., 2017; Nath, 2020). According to the IPCC (2014a, p. 510), for example, the yields for wheat, maize and soya in the boreal zone (parts of Russia, Scandinavia and Canada) could increase by between 34 per cent and 54 per cent. Temperature-related mortality in the regions near the equator is likely to increase particularly sharply because temperatures there are already very high, although the temperature rise will probably be comparatively small (Bressler et al., 2021).

513. In order to obtain an aggregate view of the risks resulting from climate change, various individual indicators at the regional level are combined in indices such as the Notre Dame Global Adaptation Initiative (ND-GAIN) Index (Chen et al., 2015). ↘ CHART 127 The climate-change-related risks to a country are captured here by the vulnerability index-component. This index-component consists of three sub-components which capture, firstly, the climate threats resulting from direct physical risks; secondly, the sensitivity of the economy and society to these physical risks; and, thirdly, countries' ability to adapt. The first index-component shows that the climate threats arising from direct physical risks are negatively correlated with gross domestic product (GDP) per capita. ↘ CHART 127 LEFT According to this component, the **advanced economies** are **exposed to direct physical risks as a result of climate change**. However, these risks are **generally**

↘ CHART 128
Direct climate threats particularly high near the equator[1]



1 – ND-GAIN Index 'Exposure' component for 2019. Describes the extent to which individual countries will be adversely affected by future changes in climate and covers the physical risks of climate change. The factors considered include the impacts of climate change on agricultural conditions, the availability of drinking water, changes in climate-related mortality, flood risks and changes in sea levels. Values can range from 0 (not adversely affected) to 1 (severely adversely affected).

Sources: EuroGeographics for the administrative boundaries, Notre Dame Global Adaptation Initiative

likely to be **lower than those in developing countries and emerging economies**. In addition, the negative correlation between the aggregate vulnerability index and per-capita GDP is much stronger. ↘ CHART 127 RIGHT This suggests that the advanced economies are better able to cope with the consequences of climate change – even if they are exposed to similar climate threats arising from direct physical risks – because, for example, they possess better infrastructure and they are less reliant on sectors that are adversely affected by climate change. However, this index does not allow any quantitative conclusions to be drawn about the expected economic effects of climate change, such as the evolution of GDP.

514. In order to quantify the **economic effects of climate change** and its regional heterogeneity, the relevant literature uses econometric methods to estimate the interrelation between prevailing climatic conditions, climate changes and welfare-relevant metrics such as mortality, agricultural productivity or economic growth (Auffhammer, 2018). These econometric estimates form the basis for the damage functions used in integrated assessment models (GCEE Special Report 2019 item 23), which are used to estimate the global economic effects of climate change. More recent models of this type contain coarse regional classifications and thus allows to evaluate the regional heterogeneity of economic effects of climate change. The most recent literature models regions at the sub-national level (Smith and Krusell, 2016; Conte et al., 2021; Cruz Álvarez and Rossi-Hansberg, 2021). In particular in geographically large countries such as Russia, Canada and the United States, which cover several climate zones, these models show that different regions within these countries are likely to be very differently affected.

The quantitative estimates of economic damages are subject to **considerable uncertainty** – particularly with respect to the **absolute amount of damage –** and are highly sensitive to the damage function used, the modelled interregional adjustments and the discount rate.

The damages caused by climate change could be much higher than assumed in the baseline scenarios, especially if certain tipping points are exceeded (GCEE Special Report 2019 item 25). However, the estimates draw a **qualitatively consistent picture** of the **relative regional distribution of these damages**. Several analyses show that the countries near the equator are likely to suffer especially adverse effects of climate change because temperatures there are already very high (IPCC, 2014a; Wing and Lanzi, 2014; Gazzotti et al., 2021). ↘ CHART 128

515. **Interregional adjustment mechanisms** can mitigate the global economic effects of climate change and reduce the regional heterogeneity of these economic effects. However, these mechanisms can also induce adverse indirect effects of climate change, for example due to violent conflict. ↘ ITEM 517 Two of the central mechanisms discussed in the literature are trade and migration. ↘ ITEM 516 **International trade** enables regions to align their production structures better with the economic environment altered by climate change without having to modify their consumption structures to the same extent. Higher trade barriers reduce the incentive to adjust sectoral specialisation and can reinforce the global economic effects of climate change (Conte et al., 2021).

516. **Migration** can mitigate the individual direct effects of climate change if people from regions that are severely adversely impacted by the direct effects of climate change migrate to less seriously affected regions. Cruz Álvarez and Rossi-Hansberg (2021) show in a quantitative model estimate that this could be an effective adjustment mechanism. This model suggests that welfare per capita in the target countries increases owing to the greater availability of labour as a factor of production, capital accumulation, and stronger incentives to innovate. However, the model does not take account of political and social barriers, the adjustment costs of integration, consequential economic costs, potentially necessary training and upskilling measures (GCEE Annual Report 2015 items 518 and 562) or, potentially, initially low labour force participation among immigrants (GCEE Annual Report 2015 items 524 and 528 ff.). The amount of welfare in the target countries might therefore be lower than that indicated by the model.

517. Despite the growing literature on **climate migration** there is still a **high degree of uncertainty** about the quantitative assessment of expected migration flows (Cattaneo et al., 2019; Ferris, 2020; Flavell et al., 2020; GCEE Special Report 2019 item 25). There is more agreement with respect to the assertion that a large proportion of climate migration – similarly to non-climate-related migration – is likely to take place regionally (Rigaud et al., 2018; Ferris, 2020; Flavell et al., 2020). The economic consequences of international climate migration in the target countries will largely depend on the level of education and skills among immigrants (Peri, 2016). Using a calibrated quantitative model Burzyński et al. (2021) estimate that among those individuals who migrate as a result of the direct

economic effects of climate change, the share of highly qualified individuals is likely to be higher than that among the general population in the country of origin.

There are, however, further risks in the form of an **increase in violent conflict**, which is promoted by climate change (Detges et al., 2020). In particular, regional migration resulting from climate change can cause a surge in conflicts, which are likely to raise the cost of climate change in the conflict regions (Burrows and Kinney, 2016; Ferris, 2020). Additionally, indirect risks emerge for the advanced economies that initially appear to be less vulnerable to direct physical risks. This might be the case, for example, if these conflicts give rise to failed states in the conflict region (Acemoglu and Robinson, 2012; Nay, 2013) or the advanced economies themselves are drawn into conflicts. Conflicts are also likely to trigger forced migration, which is structurally different from economic migration and will probably pose much greater challenges for the target countries concerned (Brell et al., 2020).

518. In addition to the **physical risks** arising directly from climate change there are **transition risks** that result from economic transformation in the pursuit of climate policy objectives. Transition risks emanate from the potential costs incurred by the process of adjustment towards a carbon-neutral economy. These two **types of risk** are **regionally unevenly distributed** (Ferrazzi et al., 2021, S. 15). Whereas physical risks are generally expected to be stronger in most developing countries and emerging economies, transition risks tend to dominate in the advanced economies and the oil-exporting nations. Nonetheless, physical risks are likely to become increasingly important in the advanced economies as well over the medium to long term.

519. Physical and transition climate risks can directly and indirectly create **risks for financial markets via** the **real economy**, which in turn can have a negative feedback effect on the real economy. ↘ BOX 30 For example, as a result of the global rise in average temperatures and sea levels renewable raw materials may no longer be able to cultivate in affected regions or only with considerable fluctuations. This could temporarily disrupt global supply chains and cause raw material prices to rise at least temporarily (Batten, 2018; Deutsche Bundesbank, 2019, p. 116). The extent and duration of the consequences likely depend on how quickly it is possible in each case to relocate affected production structures and to adjust supply chains. **Risk assessments on financial markets** therefore **vary** depending on **regional activity** and the **sector to which a company belongs**.

↘ BOX 30

Direct climate risks, transition risks of climate policy, and financial market stability

Financial markets play a key role in the transition to a carbon-neutral economy. They provide the financing for a large part of the investment needed ↘ ITEM 542 and they assess and price the potential risks. It is important that the adjustment processes accompanying climate change and climate policy do not pose risks to financial market stability.

Estimates for the euro area indicate that roughly 30 % of the **risk exposures held by**

European **banks** could relate to firms that are **exposed** to high or rising **physical risks** (ESRB, 2021, p. 15). This can give rise to **credit risk** if the damage to real assets causes borrowers to experience payment difficulties (Faiella and Natoli, 2018) or even entire regions and sectors of the economy are affected (Koetter et al., 2020). In addition, the increase in extreme weather events could reduce the **profitability of direct insurers and reinsurers** in the short term (ESRB, 2016, p. 7).

In addition to physical risks, **transition risks** play a key role resulting from the economic adjustment process and the political uncertainty about future decisions on mitigating climate change. These risks arise partly as a result of the phasing-out of fossil fuels and partly because of the adverse effects on the valuation of the capital stock following an increase in the production costs of emission-intensive firms due to the gradual increase in CO_2 prices (Deutsche Bundesbank, 2019, p. 122 f.). In addition, **assets may suddenly lose value** if investments already made are no longer compatible with politically motivated climate protection targets or with climate regulation and measures and therefore become unprofitable or are banned (stranded assets). Transition risks are therefore to be expected in particular for companies that operate in regions that place stringent requirements on the climate-related **transformation of the economic and energy systems.** Rising costs and falling demand for emission-intensive products will require many companies to totally reconfigure their business models. ↘ ITEMS 537 FF. This can impair their creditworthiness or, in extreme cases, cause them to default on loans. Both the financial system and the regulatory authorities are increasingly making preparations for these developments (BaFin, 2019). This will require the financial system to use an enhanced risk management system to differentiate between companies in terms of the future viability of their business models.. Consequently, lending criteria are being tightened even in the absence of concrete physical risks as environmental regulation continues to evolve.

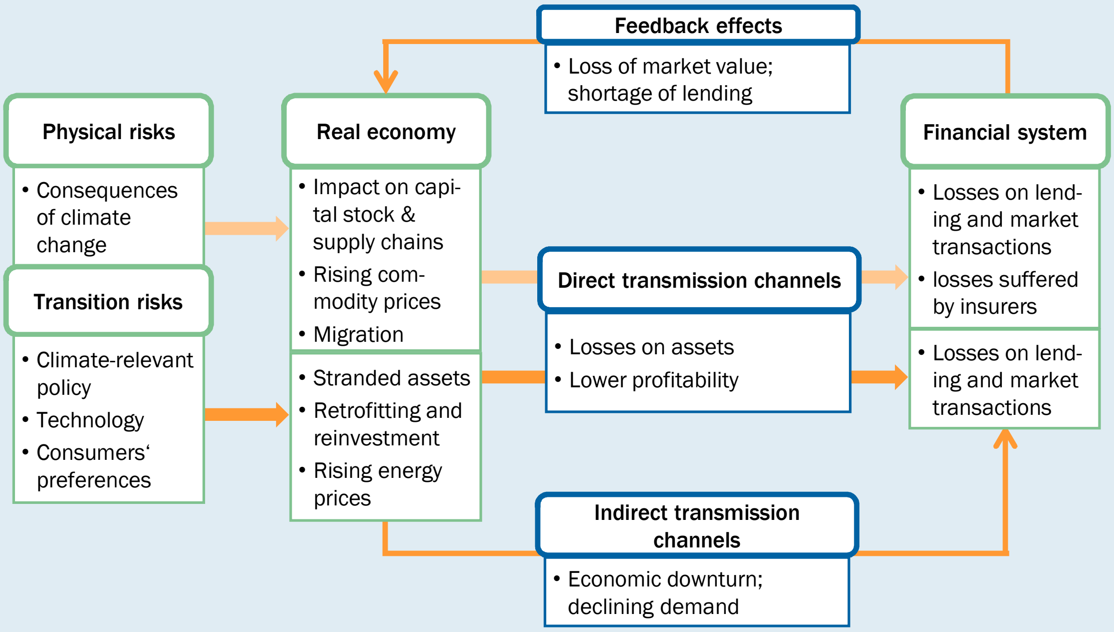
It is also important to consider **risks** that can arise **from excessive lending to finance green activities.** This could be the case if, for example, favourable lending terms have been provided for green investments purely because of their sustainable nature – such as through the loosening of regulatory requirements – and less attention has been paid to credit risks. If these investments then turn out to be largely unprofitable because, for example, the technology that they have helped to finance cannot find an adequate market, loan defaults could rise sharply, plunging financial institutions into financial difficulties. Similar risks could arise as a result of the overvaluation of green stocks if the price correction leads to a broad loss on assets and, in addition, to an unexpected loss on credit and market transactions. ↘ CHART 129 This risk can be mitigated if **lending standards are not relaxed for sustainable investments.**

At the same time, **banks** have an **important role** in providing the financial resources needed to **fund** investments aimed at **achieving climate policy objectives.** Even the announcement of international climate targets can create incentives for banks to finance more green investments and to reduce their funding of conventional projects and, consequently, the transition credit risk on their balance sheets (Reghezza et al., 2021). The effectiveness of other green financial instruments – such as 'green' government bonds, corporate bonds and equities that meet Environmental, Social and Governance (ESG ↘ GLOSSARY) criteria – is, however, controversial in terms of their achievement of climate policy goals. In the case of these forms of investment it has not been possible to establish a direct link between the allocation and application of funds (Advisory Board to Germany's Federal Ministry of Finance, 2021, p. 4 f.). By actively influencing companies' decisions, private investors and lenders can nonetheless achieve the desired impact on the real economy, thereby proactively supporting the implementation of climate policy objectives (Advisory Board to the BMF, 2021, p. 8 f.).

The **European Central Bank** (ECB) announced in its latest strategic review that it would as a first step **consider** the **impact of climate change on** overall **price stability** in its monetary policy framework. ↘ ITEM 168 In addition, it intends to establish disclosure requirements on sustainability aspects as a precondition for collateral and bond purchases, conduct climate stress tests

↘ CHART 129

Impact of physical and transition risks on the financial system



Sources: Deutsche Bundesbank, Network for Greening the Financial System

on the Eurosystem's balance sheet, and examine to what extent rating agencies take climate risk into consideration. It also wants to help ensure that the statistical basis used to analyse climate risks to financial markets is improved. Although more substantial adjustments to its corporate bond purchasing programmes are not planned for the time being, this situation is to be reviewed next year (ECB, 2021).

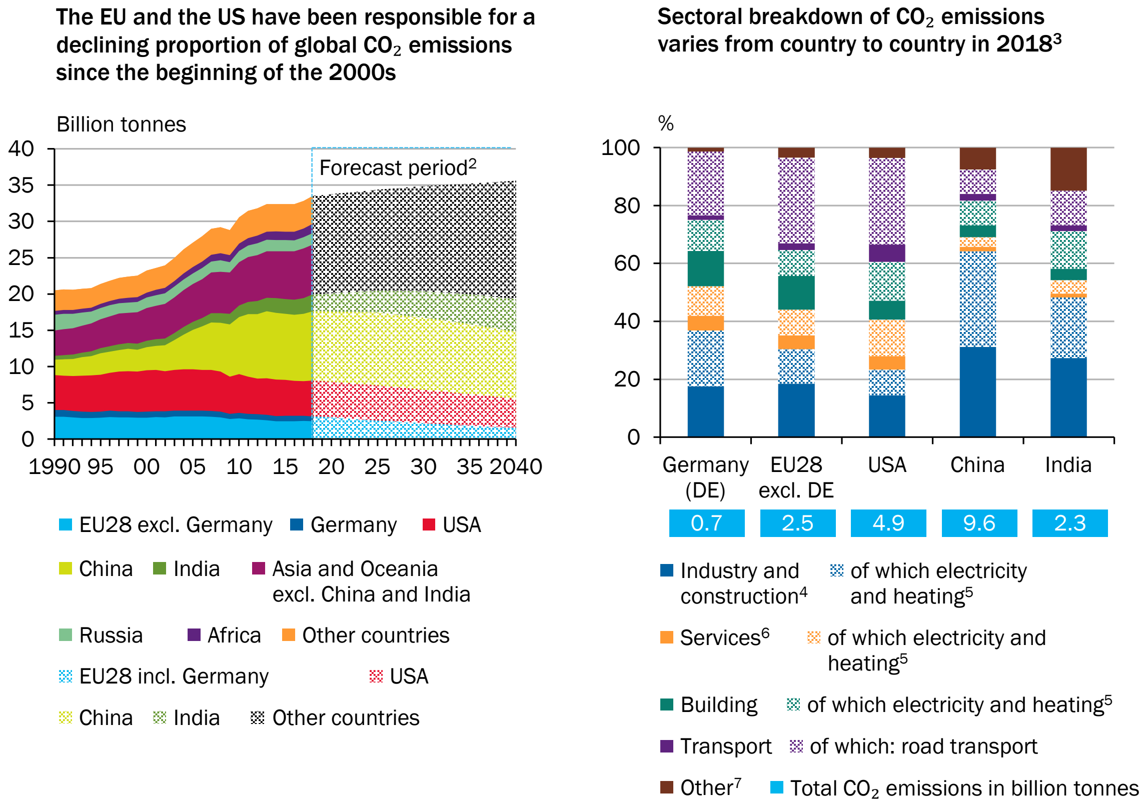
520. In summary, although a more ambitious **climate policy** creates greater **transition risks** for individual market actors, cutting emissions will more effectively **mitigate physical risks** and the associated costs from a macroeconomic perspective over the medium to long term. In addition, an effective and, above all, **long-term** and **multilaterally** coordinated **climate policy** will probably help to **reduce regulatory uncertainty**. Any multilateral coordination of climate policy measures should take account of the uneven distribution of physical and transition risks across different nations that negotiating partners represent. Countries that are exposed to especially significant physical risks might, for example, be more interested in adopting a timely and effective, multilaterally coordinated climate policy than countries facing greater transition risks, for whom such a policy would imply higher costs in the short term.

2. Challenges of decarbonisation

521. A carbon-neutral energy supply is essential for the decarbonisation ↘ GLOSSARY of global value added. According to the International Energy Agency (IEA), however, **global CO2 emissions** from the combustion of fossil fuels **increased strongly** from 20 billion tonnes per year in **1990** to almost 34 billion tonnes in **2018**. ↘ CHART 130 LEFT Whereas global carbon emissions fell by 5.8 per cent in 2020 in the wake of the COVID-19 pandemic, they are expected to rise by 4 per cent in 2021, which means that carbon emissions are then likely to be 2 per cent below the high points they reached in 2018 and 2019 (IEA, 2021a, p. 91).

A large part of the rise in carbon emissions between 1990 and 2018 took place after the year 2000. Whereas the share of global carbon emissions attributable to the EU and the United States has declined slightly and amounted to just under 11 per cent (3.2 billion tonnes of CO2) and 15 per cent (4.9 billion tonnes of CO2) respectively in 2018, the **share of total emissions accounted for by the**

↘ CHART 130
CO_2 emissions from the combustion of fossil fuels[1]



1 – CO_2 emissions from the combustion of fossil fuels only. CO_2 emissions from land use, land-use change and forestry (LULUCF) and from agriculture are not included. 2 – Forecast in the IEA's Stated Policies Scenario (2020b). 3 – These CO_2 emissions are carbon emissions from the combustion of fossil fuels in the sector concerned. The latter result from the electricity and heating used in the sector concerned. 4 – CO_2 emissions from the industry & construction sector as well as CO_2 emissions resulting from the production of fossil fuels, such as the refining of crude oil. 5 – CO_2 emissions from the electricity & heating sector, which are allocated to the relevant user sector according to the electricity and heating that it uses. 6 – Public and private services. 7 – CO_2 emissions that are not allocated to any of the use sectors in the data.

Sources: IEA (2020a, 2020b), own calculations

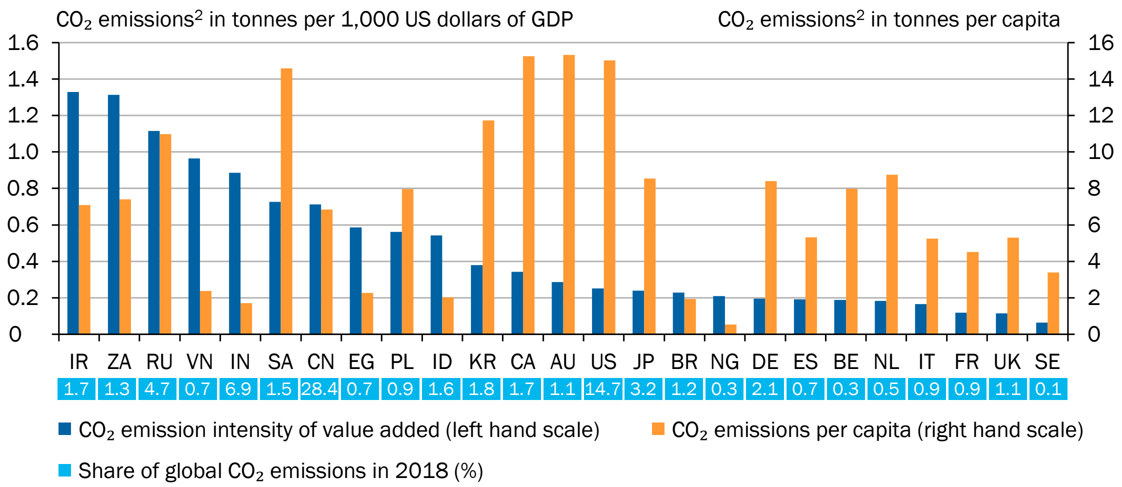
developing countries and emerging economies has increased. China was responsible for almost 30 per cent (9.6 billion tonnes of CO2) of global emissions in 2018, while India accounted for around 7 per cent (2.3 billion tonnes of CO2). The IEA's Stated Policies Scenario (2020a), which outlines the relevant emissions paths if currently prevailing conditions continue to apply and planned policy measures are implemented, states that the developing countries and emerging economies – and India in particular – will account for a growing share of global carbon emissions up to 2040. ↘ CHART 130 LEFT Carbon emissions in the developing countries and emerging economies are, however, comparatively low in relation to these countries' populations. ↘ CHART 131

522. The **increase in global carbon emissions** from the combustion of fossil fuels over the past three decades is closely connected with the **strong economic and population growth** in the developing countries and emerging economies.

A relatively large share of emissions in the large developing countries and emerging economies such as India and China is caused by their industrial and construction sectors. ↘ CHART 130 RIGHT This is likely to some extent attributable to the greater importance of the construction sector in these rapidly growing economies. The industrial and construction sectors in the advanced economies account for a much smaller share of total emissions, which is due not least to the lower carbon intensity of value added in these sectors. ↘ ITEM 524 The major challenges of decarbonisation in these countries lie in the areas of transport and buildings.

↘ CHART 131

Advanced economies have lower CO_2 emission intensity of value added but higher CO_2 emissions per capita[1]



1 – IR-Iran, ZA-South Africa, RU-Russia, VN-Vietnam, IN-India, SA-Saudi Arabia, CN-China, EG-Egypt, PL-Poland, ID-Indonesia, KR-South Korea, CA-Canada, AU-Australia, US-USA, JP-Japan, BR-Brazil, NG-Nigeria, DE-Germany, ES-Spain, BE-Belgium, NL-Netherlands, IT-Italy, FR-France, UK-United Kingdom, SE-Sweden. 2 – Territorial CO_2 emissions from the combustion of fossil fuels.

Sources: IEA, own calculations

Transition costs in energy supply and goods production

523. The increase in carbon emissions worldwide has been much lower than the growth in economic output, which means that the **carbon emission intensity of value added has fallen steadily over time** (IPCC, 2014b, p. 47). **Further reductions in the carbon emission intensity of value added are essential** in order to achieve the goal of decarbonisation while at the same time raising prosperity worldwide. There are three ways of achieving these **reductions**. First, innovation can create new low-emission production technologies. ↘ ITEMS 537 FF. Second, firms that are currently using emission-intensive production technologies can switch their processes to the less emission-intensive production technologies that are already available. ↘ ITEM 525 And, third, consumption habits can shift from emission-intensive products and services to low-emission ones. Which of these ways manages to reduce carbon emission intensity more efficiently will depend on factors such as the structure of value added and energy supply, technological progress and consumers' preferences.

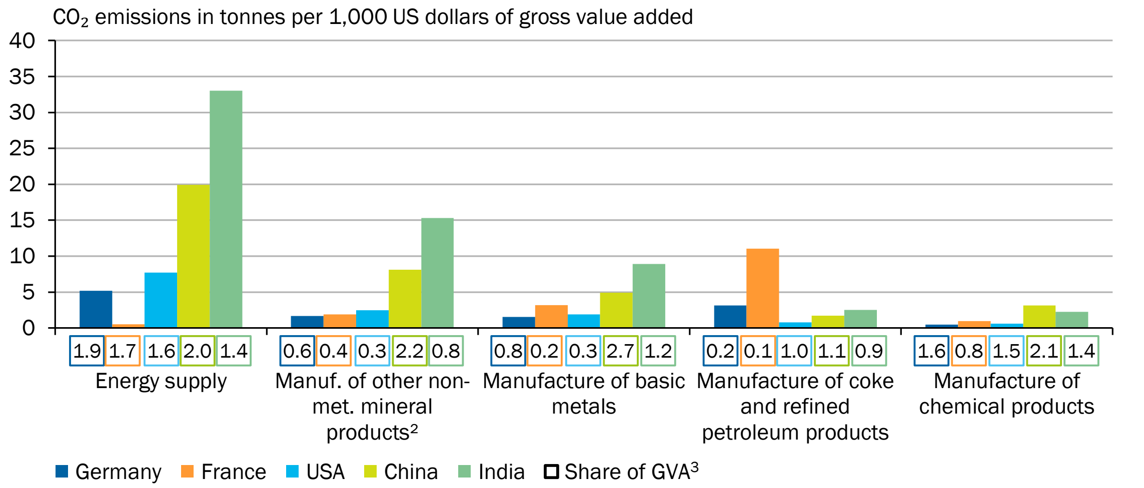
524. There are **considerable differences in the carbon intensity of value added and in carbon emissions per capita** across countries. ↘ CHART 131 Over the long term, therefore, countries will have to transform their value added to varying degrees in their efforts to decarbonise. The countries with relatively high levels of carbon emission intensity in 2014 included India, China and Russia, which emitted between 0.9 and 1.0 tonnes of CO2 for every 1,000 US dollars of value added. Many European economies such as France, Germany and the United Kingdom have relatively low carbon intensities of less than 0.2 tonnes of CO2 for every 1,000 US dollars of value added.

These differences can be partly attributed to **different industry composition** of the economies. Economies that derive a larger share of their value added from manufacturing or mining have higher carbon emission intensities than those that generate a larger proportion of their value added from services. There are also **differences** in the carbon emission intensity of value added **in the same industries across countries**, which could well be attributable to factors such as the use of production technologies and processes with varying levels of carbon emission intensity. ↘ CHART 132

525. Even just **switching production** to existing lower-emission technologies and processes could substantially cut carbon emissions **in developing countries and emerging economies**. If the carbon emission intensity of value added in each sector of the Chinese economy were at the same level as in the corresponding sector in Germany, the carbon emission intensity of the entire Chinese economy would – holding the current sectoral structure of the economy constant – be reduced by more than 60 per cent (6.2 billion tonnes of CO2). In India it would be possible to lower the carbon emission intensity by more than 70 per cent (1.5 billion tonnes of CO2). Various studies show that because the carbon emission intensity of value added is high in India and China, the **marginal abatement cost** ↘ GLOSSARY in these countries **is lower** than it is in countries with low carbon emission intensities such as the United States and the EU member states (Stern et al., 2012; Hof et al., 2017).

↘ CHART 132

Sector-specific CO_2 emission intensity of value added is lower in advanced economies



1 – According to the International Standard Industrial Classification of All Economic Activities (ISIC) Revision 4. 2 – Manufacture of other non-metallic mineral products. 3 – Share of gross value added in the countries concerned (%).

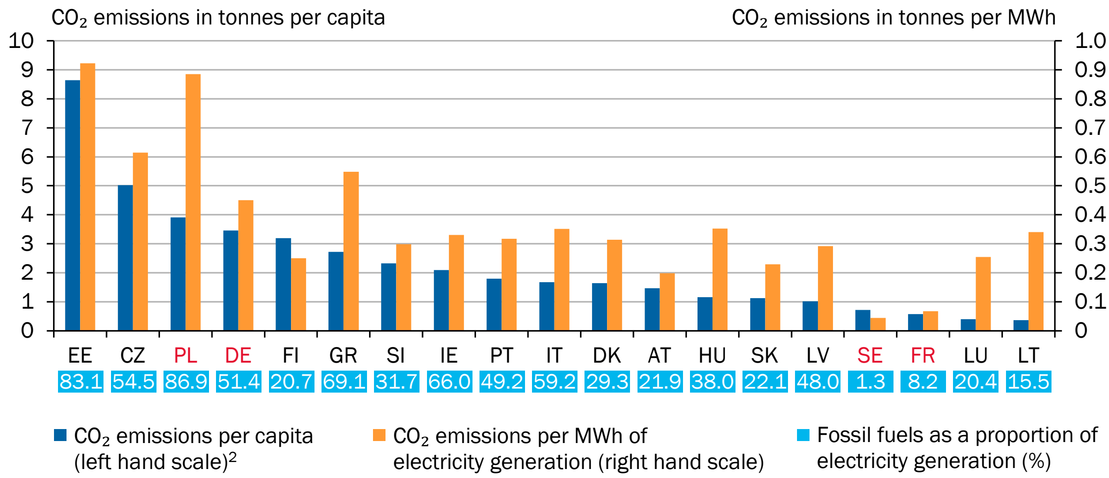
Sources: Corsatea et al. (2019), World Input-Output Database, own calculations

526. Nonetheless, this **transformation will incur substantial costs overall**, which will **pose significant challenges for many developing countries and emerging economies** . In contrast to the marginal abatement cost, the total cost of emission mitigation plans – such as those under the Paris Agreement – ↘ ITEM 556 can be high for emerging economies as well (Stern et al., 2012; Hof et al., 2017). In the process of meeting national climate targets, unfavourable socio-economic transformation paths could cause social inequality or adversely affect overall economic prosperity (Hof et al., 2017). For example, due to their financial strength, advanced economies should make a contribution to emission abatement. ↘ ITEM 560 Burden sharing between advanced and developing economies plays a key role in this context. ↘ ITEMS 561 FF.

A transition to what are currently state-of-the-art technologies, however, poses the risk that these will be outdated in a few years. Excessive support for the transition to today's low-emisson technologies can therefore delay the decarbonisation process by creating **lock-in effects** ↘ GLOSSARY (de Groot et al., 2003; Erickson et al., 2015; Haelg et al., 2018). Lock-in effects are especially likely to occur in the case of technologies that involve high investment costs, low operating costs and, consequently, long investment cycles (Erickson et al., 2015). Support schemes aimed at promoting investments therefore need to balance the relative benefits of higher carbon abatement in the short term versus, potentially, even higher carbon abatement over the long term. Technology-neutral support can help to mitigate such lock-in effects (Haelg et al., 2018).

527. Although the value added in the advanced economies is less emission intensive on average, within sectors there are also significant differences in the carbon emission intensity of individual companies (GCEE Special Report 2019 item 163). In these economies, therefore, the transformation of production processes to the currently lowest-emission alternatives also offers considerable potential for

↘ CHART 133
CO_2 emission intensity of electricity supply in 2018 especially high in countries with a large share of fossil fuels[1]



1 – EE-Estonia, CZ-Czech Republic, PL-Poland, DE-Germany, FI-Finland, GR-Greece, SI-Slovenia, IE-Ireland, PT-Portugal, IT-Italy, DK-Denmark, AT-Austria, HU-Hungary, SK-Slovakia, LV-Latvia, SE-Sweden, FR-France, LU-Luxembourg, LT-Lithuania.
2 – Emissions from the combustion of fossil fuels in electricity and heating supply.

Sources: IEA, own calculations

decarbonisation. In these countries in particular, moreover, **innovation** and the **development of new lower-emission production technologies** are highly important for the transformation of value added. ↘ ITEMS 537 FF. Although this is likely to incur higher costs than decarbonisation in developing countries and emerging economies, ↘ ITEM 525 new technology can be highly important in globally establishing a decarbonisation path that is consistent with the climate targets. ↘ ITEMS 537 FF.

528. Of central importance to **decarbonisation** is the **electricity supply**, which accounts for the largest share of greenhouse gas emissions in most economies. The composition of energy sources used to generate electricity is a key factor in the emission intensity of value added. In the EU, for example, France and Sweden – whose electricity supplies contain a large share of nuclear energy (IEA, 2021b) – have relatively low carbon emission intensities of value added. ↘ CHART 131 Germany and Poland in particular, whose electricity supplies are generated to a much greater extent by coal-fired power plants (IEA, 2021b), have a much higher carbon emission intensity. The effect of the energy sources used – irrespective of economic structure – is also illustrated by the level of carbon emissions per MWh of electricity generated. ↘ CHART 133 EU member states that obtain a large share of their electricity supplies from fossil fuels have high carbon emissions per MWh of electricity generated.

529. In addition to electricity supplies, **energy supplies for buildings** – particularly for heating – **and for the transport sector** are especially important for decarbonisation. In the advanced economies a particularly large proportion of carbon emissions from the burning of fossil fuels can be attributed to these sectors. Even if abatement costs in the transport and buildings sectors are very uncertain, they

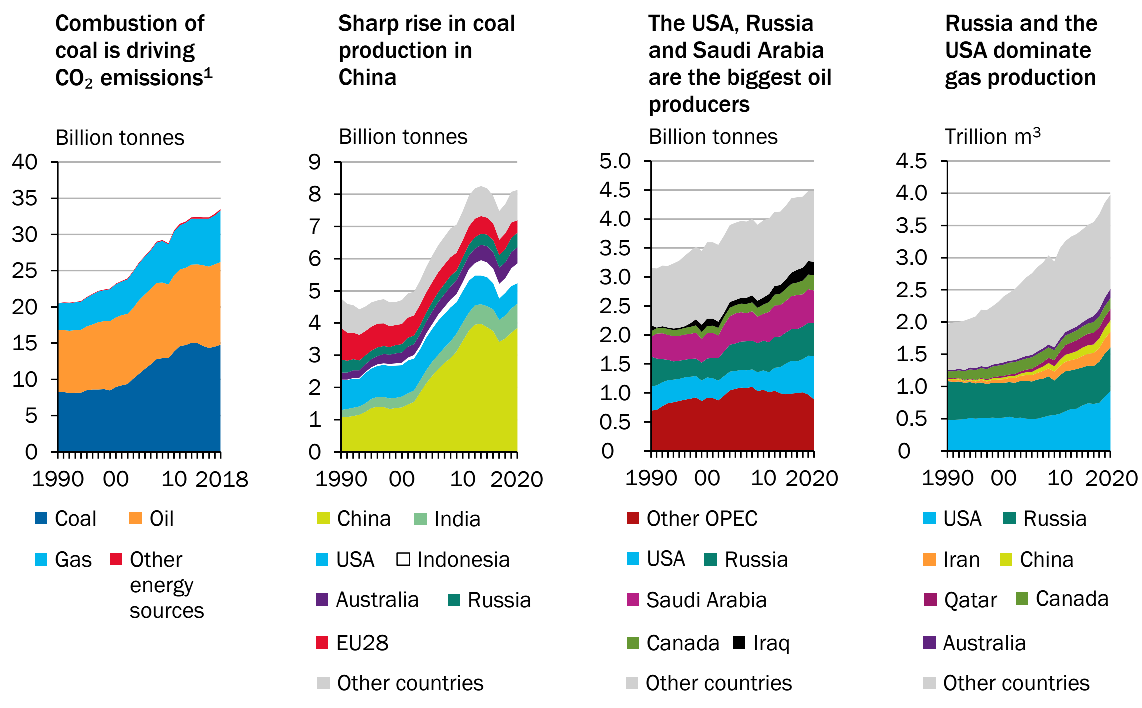
are likely to be much higher than they are in the industry and electricity supply sectors (GCEE Special Report 2019 items 133 ff.).

Situation of countries with large reserves of fossil fuels

530. The **combustion of fossil fuels** is responsible for roughly 85 per cent of global carbon emissions (IPCC, 2014b). The main contributors at present are **coal and oil**, which account for over 40 per cent and just under 35 per cent, respectively, of the carbon emissions caused by fossil fuels (IEA, 2021c). In terms of the CO2 stored in the global reserves of fossil fuels, particular mention should be made of the estimated coal reserves, whose carbon content comfortably exceeds that of the estimated gas and oil reserves (Rogner, 1997; Bauer et al., 2016; Hassler et al., 2016). ↘ CHART 135 The largest coal-producing country is China, followed by India, Indonesia, the United States and Australia. ↘ CHART 134 The five largest oil-producing countries are the United States, Russia, Saudi Arabia, Canada and Iraq.

531. The **extraction of fossil fuels** often generates high profit margins for the producers. This applies to oil, for example, whose price has been 76 US dollars per barrel on average over the past ten years and recently rose to around 85 US dollars per barrel. ↘ ITEM 10 The production companies involved are mainly state-owned, such as Saudi Aramco in Saudi Arabia and Gazprom in Russia. The profits generated vary across those countries because their production costs differ enormously. Production costs in the Canadian oil sands, for example, amount to roughly 40 US dollars per barrel, whereas in the oil fields of Saudi Arabia costs are as low as 4 US

↘ CHART 134
CO_2 emissions and extraction of fossil fuels



1 – CO_2 emissions broken down by energy source.

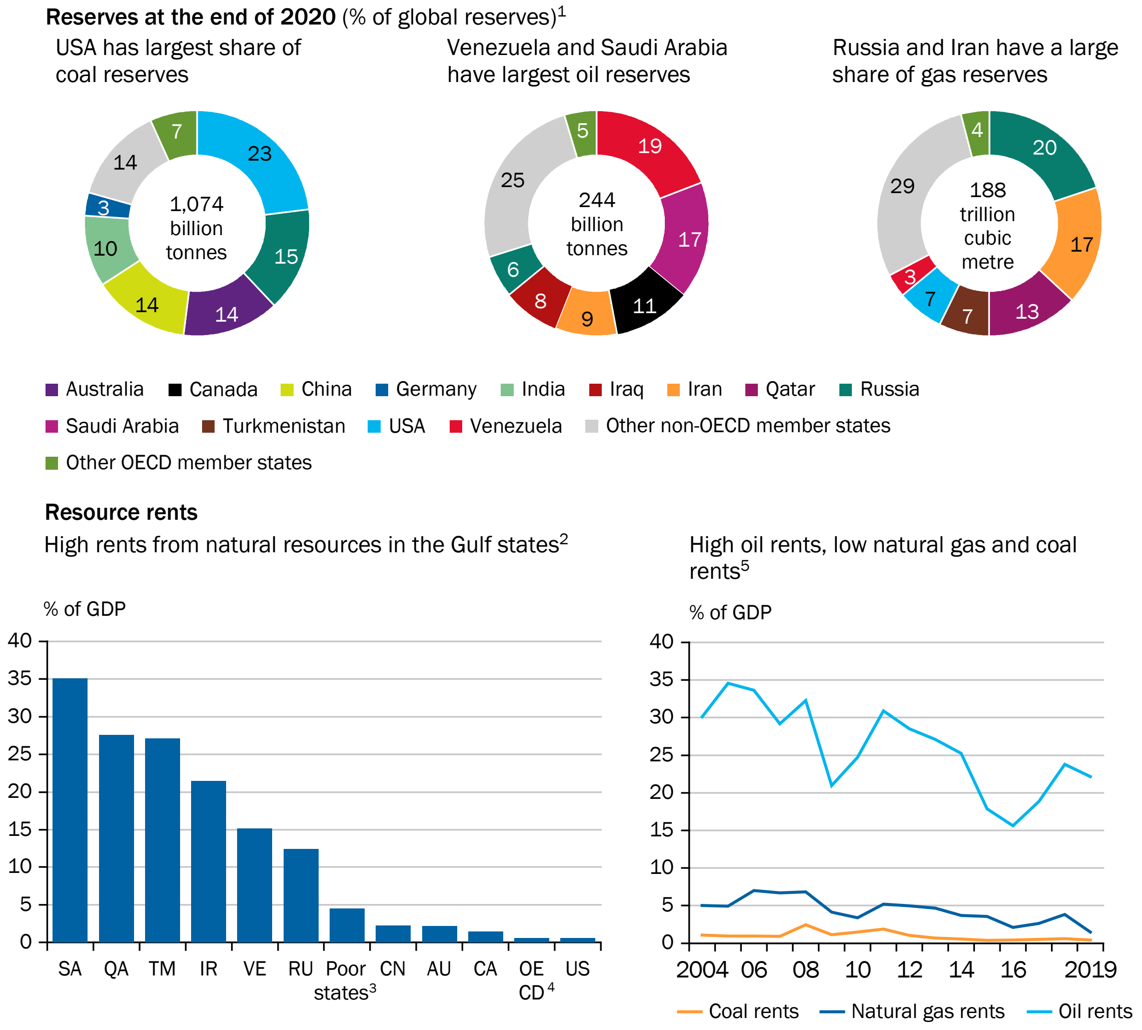
Sources: BP (2021), IEA

dollars (Karl, 2010; Asker et al., 2019). However, the profits expected by production companies are likely to decline – especially in the advanced economies – when there is a transition to non-fossil fuels. This should create incentives for them to develop alternative fields of business. ↘ ITEMS 538 FF. ↘ CHART 135 BOTTOM RIGHT Their currently still high profits might facilitate this transformation.

532. The producing countries in some cases heavily rely **on their profits from the extraction of fossil fuels** and have built a considerable proportion of their value added on it. Countries with large crude-oil reserves such as the Gulf states earn especially high oil rents as a percentage of their GDP, even though these have declined over the past ten years. ↘ CHART 135 BOTTOM RIGHT ↘ CHART 135 TOP AND BOTTOM LEFT Oil rents represent the difference between the value of extracted crude oil and

↘ CHART 135

Reserves and rents from natural resources in selected countries



1 – Proven reserves of coal, oil and gas. 2 – Sum of the average natural gas, coal, and oil rents as a percentage of GDP from 2009 to 2019. SA-Saudi Arabia, QA-Qatar, TM-Turkmenistan, IR-Iran, VE-Venezuela, RU-Russia, CN-China, AU-Australia, CA-Canada, US-USA. 3 – Average of all countries defined by the World Bank as 'low-income countries', 'lower-middle income countries' or 'upper-middle income countries'. 4 – Average of all OECD member states. 5 – Gas, coal and oil rents represent the difference between the value of the gas, coal or oil extracted and the relevant extraction costs as a percentage of GDP. The average used here relates to the eight countries with the largest reserves.

Sources: BP (2021), World Bank, own calculations the extraction costs involved. The same definition applies to coal and gas rents. However, there is considerable heterogeneity both between countries and between energy sources. Countries with large coal and gas reserves, for example, earn relatively low rents. ↘ CHART 135 BOTTOM RIGHT Moreover, the group of other non-OECD countries possesses the largest oil and gas reserves. In terms of gas reserves, the most important countries here are China, Saudi Arabia and the United Arab Emirates. In terms of oil reserves, the most important countries are Kuwait, the United Arab Emirates, and Kazakhstan. The rents from natural resources earned by the entire group of non-OECD countries, however, account for a relatively small proportion of GDP, which can be explained by the minor importance of the primary energy sector, high extraction costs, or both. ↘ CHART 135 BOTTOM LEFT AND 134

533. In countries with large fossil-fuel reserves it is usually the case that sectors based on the extraction of these energy sources account for a large proportion of value added. The low proportion of value added in other sectors can partly be explained by the so-called **Dutch Disease** (Frankel, 2010; van der Ploeg, 2011). While natural-resource rents can have overall positive effects on growth in resource-rich countries (Yanıkkaya and Turan, 2018), exports of natural resources can drive up macroeconomic wages and exchange rates to such an extent that other sectors – such as manufacturing – are no longer internationally competitive and get crowded out. Nonetheless, some major resource-producing countries are attempting to diversify the structure of their economies. In the Emirate of Dubai, for example, the proportion of value added by oil production has fallen from 50 per cent in 1990 to less than 5 per cent in 2021. Saudi Arabia is also planning to significantly reduce the share of value added by oil production by 2030 (Havrlant and Darandary, 2021; Saudi Arabian government, 2021). ↘ ITEMS 537 FF.

534. Given that fossil fuels account for a large proportion of value added in some countries, one factor to consider is that climate policy measures taken by countries that currently import these fuels could have undesirable consequences. The **Green Paradox** suggests, for example, that the announcement of measures that would normally be expected to limit importing countries' demand for fossil fuels could actually cause an increase of supply of these resources in the global market. ↘ BACKGROUND INFO 13 By expanding this supply, owners of natural resources might try to convert their reserves of fossil fuels more quickly into financial capital, which in future is likely to yield higher returns than the natural resources themselves (Sinn, 2009).

↘ BACKGROUND INFO 13

Carbon leakage and the green paradox

Domestic climate policy measures such as the regulation or pricing of emission-intensive activities can cause these activities to be relocated to countries with less regulation. This can lead to a situation in which domestic emission reductions are wholly or partly offset by the increase in emissions abroad, such that the reduction in global emissions is either only modest or non-existent. This phenomenon is described in the economic literature as **carbon leakage.** Direct leakage occurs if this relocation occurs as a direct result of changes in relative production prices.

Indirect leakage arises if the decline in domestic demand for fossil fuels causes the world market prices of these natural resources to fall, leading to an increase in consumption of fossil fuels abroad (German Environment Agency [UBA], 2020; Board of Academic Advisors at Germany's Federal Ministry for Economic Affairs and Energy [BMWi], 2021).

A further undesirable indirect side-effect of climate policy measures is referred to as the **green paradox**. This states that when demand for fossil fuels is expected to fall in the future (as a result of climate policy measures, for example), the extraction of these resources is accelerated, thereby increasing their supply in the global market (Sinn, 2008; van der Ploeg and Withagen, 2012). The green paradox therefore describes an intertemporal shift in the supply of fossil fuels, whereas carbon leakage constitutes a spatial relocation. Both carbon leakage and the green paradox can arise from either unilateral or plurilateral climate policy measures. If these measures are implemented plurilaterally, however, the desirable effects are likely to outweigh the undesirable ones (Sinn, 2008, 2009; Board of Academic Advisors at the BMWi, 2021).

535. Climate policy measures taken in countries that currently import fossil fuels can also have undesirable effects due to the technical conditions under which the natural resources are extracted. Long development periods or high adjustment costs for the extraction of oil, for example, can lead to a situation where lower demand for fossil fuels is primarily reflected not in lower supply but in lower prices. Empirical studies have shown that the short-term **price elasticity of supply** is very low (Kilian and Murphy, 2012; Güntner, 2014; Baumeister and Hamilton, 2019; Caldara et al., 2019). A low price elasticity of oil supply can cause **indirect carbon leakage**, which counteracts climate policy measures. ↘ BACKGROUND INFO 13 One caveat to mention here is that the elasticity is likely increase if prices fall, as it will then no longer be worth exploiting reserves that involve very high extraction costs. ↘ ITEM 532 Estimates of the long-term price elasticity of supply are also slightly higher than those of short-term elasticity (Arezki et al., 2017). Estimates for coal as an energy source suggest that it has a higher elasticity of supply than oil does (Burniaux and Oliveira Martins, 2016). Coal is therefore likely to be less susceptible to indirect carbon leakage.

536. Carbon leakage and the green paradox need to be considered as part of attempts to improve the effectiveness of climate policy measures. Firstly, **an international approach to climate policy** should be pursued in order to restrict or prevent emissions from being transferred abroad. ↘ ITEMS 613 FF. And, secondly – in addition to curbing demand for fossil fuels – there should be a greater focus on supply by, for example, tying the resource-producing countries into international agreements and partnerships on transitioning to the use and export of renewable energy. ↘ ITEMS 583 FF.

3. Economic opportunities and the need to take action on decarbonisation

537. If the international community pushes ahead with climate protection, demand for **less emission-intensive products, manufacturing processes** and energy sources is likely to rise steadily. **Considerable investment** will be needed in order to meet the commitments given by countries under the Paris Agreement. Estimates for the needed investment vary significantly, however. ↘ TABLE 24

The transformation will reduce the costs of climate change ↘ ITEMS 512 FF. by, for example, mitigating it. In addition, economies can benefit from the transformation if domestic firms are the ones that **meet** the new **demand for lower-emission products and capital goods**. The **opportunities and risks for companies** and **climate policy** are interdependent: more ambitious multilateral climate policy strengthens demand for low-emission technology. This can accelerate the scaling-up of technologies and help to reduce costs which, in turn, can facilitate the implementation of climate policy. At the same time, climate policy impacts the profitability of investments that have already been made and, in doing so, influences the investment risks.

↘ TABLE 24

Studies on estimates of the global investment needed to achieve the climate targets

Study	Area	Period	Climate target (degree Celsius)	Investment needed over the entire period: total	Investment needed over the entire period: of which: additional investment needed[1]	Investment needed per year: total	Investment needed per year: of which: additional investment needed[1]	Investment needed per year: as a share of GDP
				Trillions of US dollars				%
OECD (2017)	Infrastructure[3]	2016 – 2030	2 °C[4]	103	9	6.9	0.6	
IRENA (2019)	Energy sector	2016 – 2050	2 °C[5]	110	15			2[b]
IRENA (2021)	Energy sector	2021 – 2050	1.5 °C[6]	131	33	4.4	1.1	5[c]
IEA (2021)	Energy sector	2021 – 2050	1.5 °C[7]			4.5–5.0[a]		2.5–4.5[d]
McCollum et al. (2018)[2]	Energy sector	2016 – 2050	2 °C[8]			3.0	1.1	2.5
			1.5 °C[9]			3.4	1.6	2.8

1 – Investment needed to achieve the climate targets in addition to the measures already announced in the studies (reference path). 2 – Various models are estimated. The figures here represent their averages. 3 – Comprises the energy, telecommunications, transport and water sectors. 4 – Based on a scenario in which there is a 66 % probability that global warming will remain below 2 °C until the year 2100. 5 – Target from the Paris Agreement, under which global warming is to be kept well below 2 °C compared with pre-industrial levels. 6 – The target is to achieve carbon neutrality by 2050, which would keep global warming below 1.5 °C until the end of the century. 7 – The target is to achieve carbon neutrality by 2050, with 50 % of global warming being above 1.5 °C. 8 – Well below 2 °C. 9 – Approaching 1.5 °C. a – Amount of investment dependent on the year considered (2030: 5 trillion US dollars; 2050: 4.5 trillion US dollars). b – Average amount of total investment as a percentage of annual GDP. c – As a percentage of GDP in 2019. d – As a percentage of annual GDP over time. Rising to around 4.5 % of GDP by 2030 and potentially falling to 2.5 % of GDP by 2050.

Sources: IEA (2021d), IRENA (2019, 2021), McCollum et al. (2018), OECD (2017)

Economic potential of technologies

538. The reliable identification of the technological potential – in other words, an economy's comparative advantage in the technologies required for the future – is very difficult and is subject to considerable uncertainty. By the time global **carbon neutrality** has been achieved, the relative appeal of various technologies may have changed. In addition, new technologies can appear. Although many of the technologies to be applied in the medium term are probably already known today, ↘ BOX 31 the future macroeconomic conditions can have either a positive or negative impact on the competitiveness of individual technologies and entire economies. Based on the present economic structure, however, it is possible to attempt to assess **countries' current situation** in terms of their technological potential.

↘ BOX 31

Manifold ways of achieving carbon neutrality

Achieving carbon neutrality by the middle of the 21st century will require a **fundamental transformation** of the energy sector (IRENA, 2020a; Rat für Nachhaltige Entwicklung, 2021). For this transformation to be successful, renewable energy will be needed for decarbonising the heating, transport, and industrial sectors (acatech et al., 2017; GCEE Annual Report 2020 item 359). This **sector coupling** can be achieved either by means of electrification or through the use of hydrogen and synthetic fuels based on it. For example, heat pumps and battery-operated vehicles can be used to directly electrify the buildings and transport sectors respectively. Hydrogen and synthetic fuels based on it (e-fuels), on the other hand, enable **renewable forms of energy to be used indirectly.** Green hydrogen and e-fuels are obtained by means of electrolysis (i.e., the use of electricity to split water into hydrogen and oxygen) and can replace fossil fuels. Carbon-neutral hydrogen and energy carriers based on it are mainly needed to decarbonise applications that can be directly electrified either only with difficulty or not at all, such as in HGV (heavy goods vehicles) traffic, industry and the long-term storage of electricity. Although hydrogen-based sector coupling is often technically less efficient than direct electrification due to the conversion processes involved, the associated energy carriers are easier to store and transport (Meylan et al., 2016; Hebling et al., 2019).

The process of electrolysis uses water and electricity to obtain hydrogen. Unlike the partial oxidation of coal, steam reforming and the autothermal reforming of natural gas – the processes most commonly used today to obtain grey hydrogen – electrolysis involves either very low or no greenhouse gas emissions if it is performed using low-emission electricity. **Green hydrogen** based on renewable energy is expected to play an especially important role in the future decarbonised energy system (IRENA, 2020a; dena, 2021; Luderer et al., 2021; NWR, 2021; Prognos et al., 2021; Wietschel et al., 2021). Wietschel et al. (2021) provide an overview of the latest studies on future imports of gaseous and liquid energy carriers. Over the long term it is expected that between 53 per cent and 80 per cent of Germany's hydrogen requirements and between 79 per cent and 100 per cent of its demand for hydrogen-based synthetic products are likely to be covered by imports. This is because the levelized cost of production ↘ GLOSSARY of green hydrogen in regions of the world with plenty of wind and sun is likely to be much lower than in Europe and, in addition, the low demand for electricity in these regions (relative to the generating capacity) makes exports of renewable energy (in the form of hydrogen) attractive.

Various **supply-side and demand-side factors are making a rapid establishment of green hydrogen as an energy source difficult.** Because of the still high investment costs of electrolysers (due to the still low number of plants) and the still unexploited efficiency potentials in electrolysis, green hydrogen is not yet competitive with grey hydrogen, which is currently mostly used in the chemical industry (Hebling et al., 2019, p. 12 f.; Egerer et al., 2021). The current cost ranges from 0.8 to 2.0 euros per kilogramme for grey hydrogen compared to 4.0 to 9.0 euros per kilogramme for green hydrogen. In addition, industrial processes that use hydrogen instead of fossil fuels are not competitive because carbon price signals are currently inadequate (Koch Blank, 2019; Wood and Dundas, 2020). In order to make green hydrogen available in large quantities, it will be necessary to build the electrolysis plants, expand the facilities used to generate renewable energy at the future production sites (mainly abroad), and build the relevant transport infrastructure, which will involve considerable investment costs and coordination effort. The construction of a transport infrastructure able to handle large quantities of hydrogen also requires long-term planning as well as coordination between the countries involved. The build-up of generating capacity abroad requires establishment of new energy partnerships with the potential exporting countries. The considerable amounts of coordination and investment needed will significantly limit the supply of green hydrogen during this decade. This will particularly hinder the scaling-up and cost reduction of technologies reliant on hydrogen usage. They will therefore remain expensive and innovations will be developed only slowly.

Blue hydrogen can perform an important bridging function in this context (dena, 2021; Grimm, 2021a; Grimm and Kuhlmann, 2021; Grimm and Westphal, 2021a, 2021b). Like grey hydrogen, it is based on the reforming of natural gas. However, the associated greenhouse gas emissions are captured and stored underground in, for example, exploited gas fields (carbon capture and storage [CCS]) or, alternatively, they are used as input for manufacturing of various products (carbon capture and utilisation [CCU]). This process today is cheaper than electrolysis (Machhammer et al., 2016; Speirs et al., 2017; Al-Qahtani et al., 2021). The cost of **blue hydrogen** in the medium term is roughly 1.5 to 2.5 euros per kilogramme (Wang et al., 2021). Potential suppliers of blue hydrogen are countries that possess gas reserves and with which energy trading relationships already exist, such as Norway, Scotland, the United Arab Emirates, and Australia. Russia could also potentially supply blue hydrogen. The **importing** of blue hydrogen for a transitional period could significantly accelerate the availability of hydrogen as an energy source. Innovation and the **scaling-up** of transport infrastructure and various hydrogen applications might **happen sooner**, and companies could build **competences at an earlier stage**. This would create opportunities to export technology and would also **more quickly enable** German industry to **use green hydrogen on a large scale** as soon as it became available. A transformation path could be agreed with exporters of blue hydrogen that stipulates a transition to green hydrogen over the medium term – or, alternatively, to turquoise hydrogen, which is also obtained from gas, although the carbon emissions are stored as a solid. Other countries such as Japan and South Korea are already pursuing this strategy in partnership with Australia and the United Arab Emirates as the exporting countries so that they can scale up a hydrogen industry more quickly (Kölling, 2021; Saadi, 2021).

The challenge posed by the use of blue hydrogen, however, is that it can entail much higher emissions than its green counterpart. This problem is particularly relevant if the extraction and transportation of the necessary natural gas cause higher diffuse methane emissions owing to leakage or the CCS and CCU processes applied can only capture a relatively small fraction of the greenhouse gases (Howarth and Jacobson, 2021; Zhou et al., 2021). When initiating collaborations on blue hydrogen it is therefore necessary to devise **certification options** that would ideally be implemented and overseen by an international and independent institution. The fact that production plants and their processes can be represented in detail by digital twins ↘ GLOSSARY nowadays can make it easier to monitor emissions. Furthermore, investment in infrastructure (Bauer et al., 2021) and the technological progress expected to be achieved on CCS processes (Nemet et al., 2018) will be able to cut emissions of blue hydrogen in future. And, last but not least, the use of blue hydrogen could mean that green hydrogen will be widely used sooner than it would have been in the absence of blue hydrogen.

In addition to direct and indirect electrification the **removal of greenhouse gas emissions** will be necessary in order to achieve carbon neutrality (IPCC, 2018; dena, 2021; GCEE Special Report 2019 box 1). Such removal will be especially relevant because, in all likelihood, it will not be possible to abate all greenhouse gas emissions even in 2050 – and because removing CO_2 from the air is cheaper than abating all emissions entirely. This may in particular apply to agricultural methane and nitrous oxide emissions and to selected industrial processes. This removal of carbon also enables excess emissions to be offset retrospectively (Luderer et al., 2021, p. 228 ff.). There are various ways of removing greenhouse gases, each of which entails different costs as well as technical advantages and disadvantages (Fuss et al., 2014, 2018). Forests, marshland and waterways are natural carbon sinks. Reforestation, can, for example, sequester carbon. It is, however, uncertain whether emissions are stored permanently. Bioenergy with carbon capture and storage (BECCS) involves burning biomass and capturing the resultant emissions. The carbon sequestered by plants through photosynthesis is thus removed from the atmosphere. Direct air carbon capture and storage (DACCS) removes CO_2 from the surrounding air and then sequesters it geologically. However, there are physical limits to storing it underground. Prognos (2021, p. 56 f.) estimates the potential for Europe to be 300 gigatonnes of CO_2, of which the North Sea accounts for roughly two-thirds. This potential can be limited among others by local residents' concerns (Luderer et al., 2021, p. 229 f.).

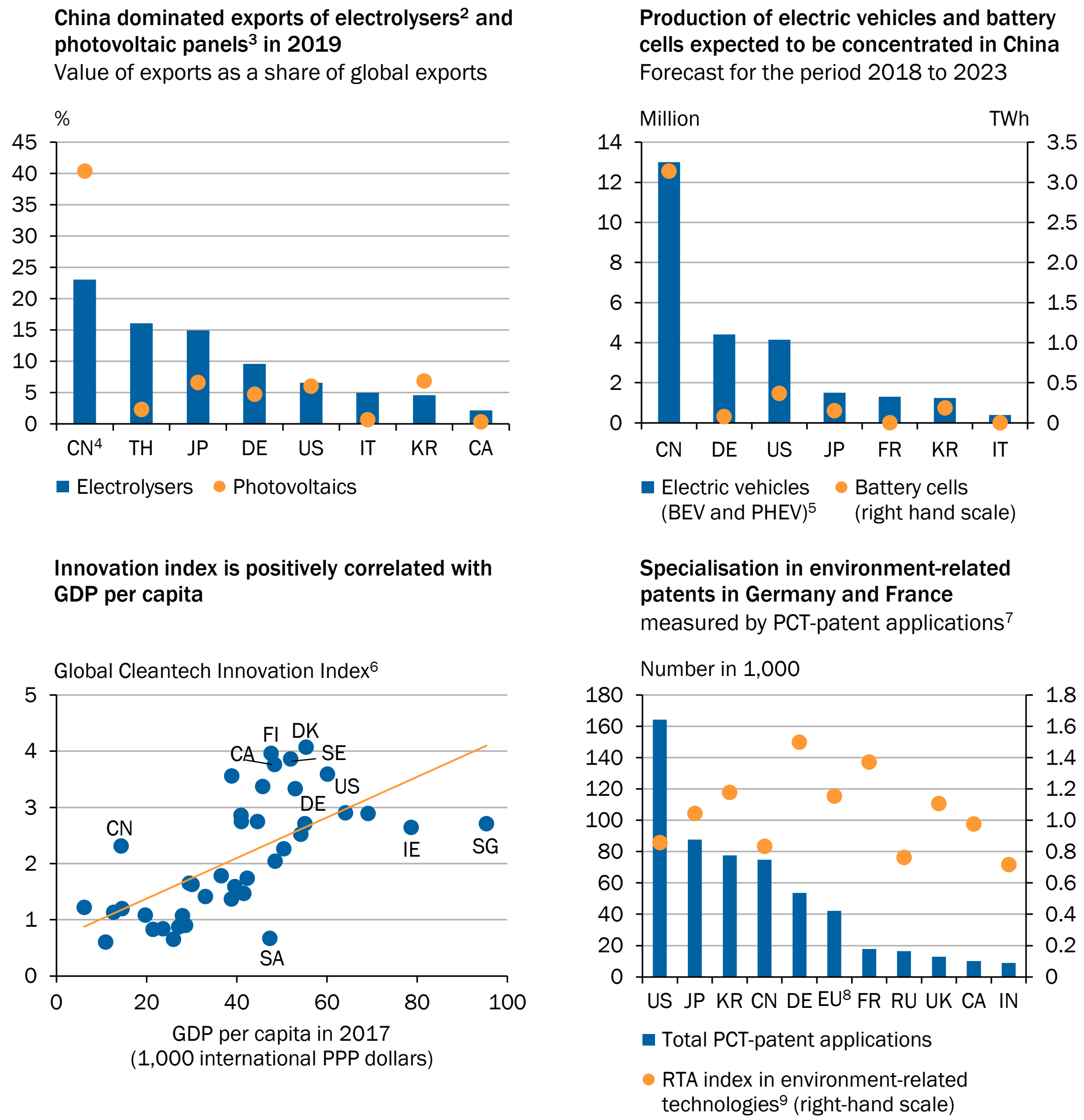
539. **Path dependencies** imply that today's capabilities can determine an economy's future technology competences (Aghion et al., 2016; Stucki and Woerter, 2017; Popp, 2019). China's currently dominant role in various technology fields such as photovoltaic panels, lithium-ion batteries and electrolysers (Finamore, 2021), for example, could indicate that Chinese companies will continue to dominate these areas in future. ↘ CHART 136 TOP LEFT AND TOP RIGHT Perner et al. (2018) show that German firms – based on the strength of their current exports – are already well-placed in the area of plants for the production of hydrogen and synthetic energy carriers. As far as materials and software solutions are concerned, Wu (2020) points to US companies' strong competitive position. However, the current competitiveness is constantly being challenged by international markets and industrial policy initiatives. ↘ ITEM 546 A **strong position today is** therefore **no guarantee** of **future success**.

540. An economy's **ability** to introduce and implement innovations will be key to exploiting the opportunities presented by decarbonisation. In order to compare individual countries' current situations, it is therefore helpful to look at innovation indices. Such indices include **input factors** such as national climate policy, public research funding for green technology, infrastructure and the business start-up environment (OECD, 2011; GCEE Annual Report 2020 items 352 ff.). The indices also include **output factors** such as patent applications, business start-ups, and firms that already exist in this field.

The available indices mostly show a strong positive correlation with current GDP. The **Global Cleantech Index** (Sworder et al., 2017), for example, reveals the highest index values to be in **Scandinavian countries** and **North America**. ↘ CHART 136 BOTTOM LEFT A similar picture is presented by the ASEM Eco-innovation Index, which compares the innovative capabilities of European and Asian countries (ASEIC, 2018).

↘ CHART 136

Indicators for identifying technological potential[1]



1 – CA-Canada, CN-China, DE-Germany, DK-Denmark, EU-European Union, FI-Finland, FR-France, IE-Ireland, IN-India, IT-Italy, JP-Japan, KR-Republic of Korea, RU-Russia, SA-Saudi Arabia, SE-Sweden, SG-Singapore, TH-Thailand, UK-United Kingdom, US-USA. 2 – Approximated using exports in the product field of electroplating, electrolysis and electrophoresis (HS number 854330 according to the Harmonised System of the World Customs Organisation). 3 – Approximated using exports in the product field of photosensitive devices and semiconductors including photovoltaic cells (HS numbers 854140 and 854150 according to the Harmonised System of the World Customs Organisation). 4 – China including Hong Kong. 5 – Production of battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). 6 – As at 2017. 7 – This relates to patents applied for under the Patent Cooperation Treaty (PCT). As at 2018. 8 – EU27 excluding France and Germany. 9 – The Revealed Technological Advantage (RTA) index is defined as an economy's share of PCT patents in a particular technology field divided by the economy's share of all PCT patent fields worldwide. Index values of more than 1 may indicate a specialisation in the technology field concerned. Environment-related technologies are defined according to the OECD.

Sources: OECD, Roland Berger and fka (2021), Sworder et al. (2017), World Bank, own calculations

541. Patent applications relating to environmental technologies (OECD, 2016a) can serve as an indicator of an economy's innovation environment in the field of low-emission technologies. Although in absolute terms, Germany and France apply for far fewer patents than the United States, Japan and South Korea, in relative

terms their patents are more frequently related to environmental technology (**green patents**). The **revealed technological advantage (RTA)** – a measure of an economy's specialisation in specific technology fields (GCEE Annual Report 2020 item 533) – shows that Germany and France are market leaders in environmental patents. ↘ CHART 136 BOTTOM RIGHT

There are several drawbacks of analyses based on the current number of patent applications. For example, such aggregate view does **not assess the quality** of patents. Just a few patents can compensate for the quantity if they are high quality. Such analysis also fails to take account of the **trends over time**. Although Europe and North America currently dominate in terms of applications for green patents, China has seen a strong upward trend in recent years (Breitinger et al., 2020; IRENA, 2020a; OECD, 2021a). And, last but not least, the **definition** of green patents used in analysis of patent numbers is probably often **too narrow**. For example, although expertise in the processing and transportation of gases might not be classified as green, it might facilitate the processing of green hydrogen in future. Such non-environmental patents then have a complementary effect (Barbieri et al., 2021).

Financing innovation

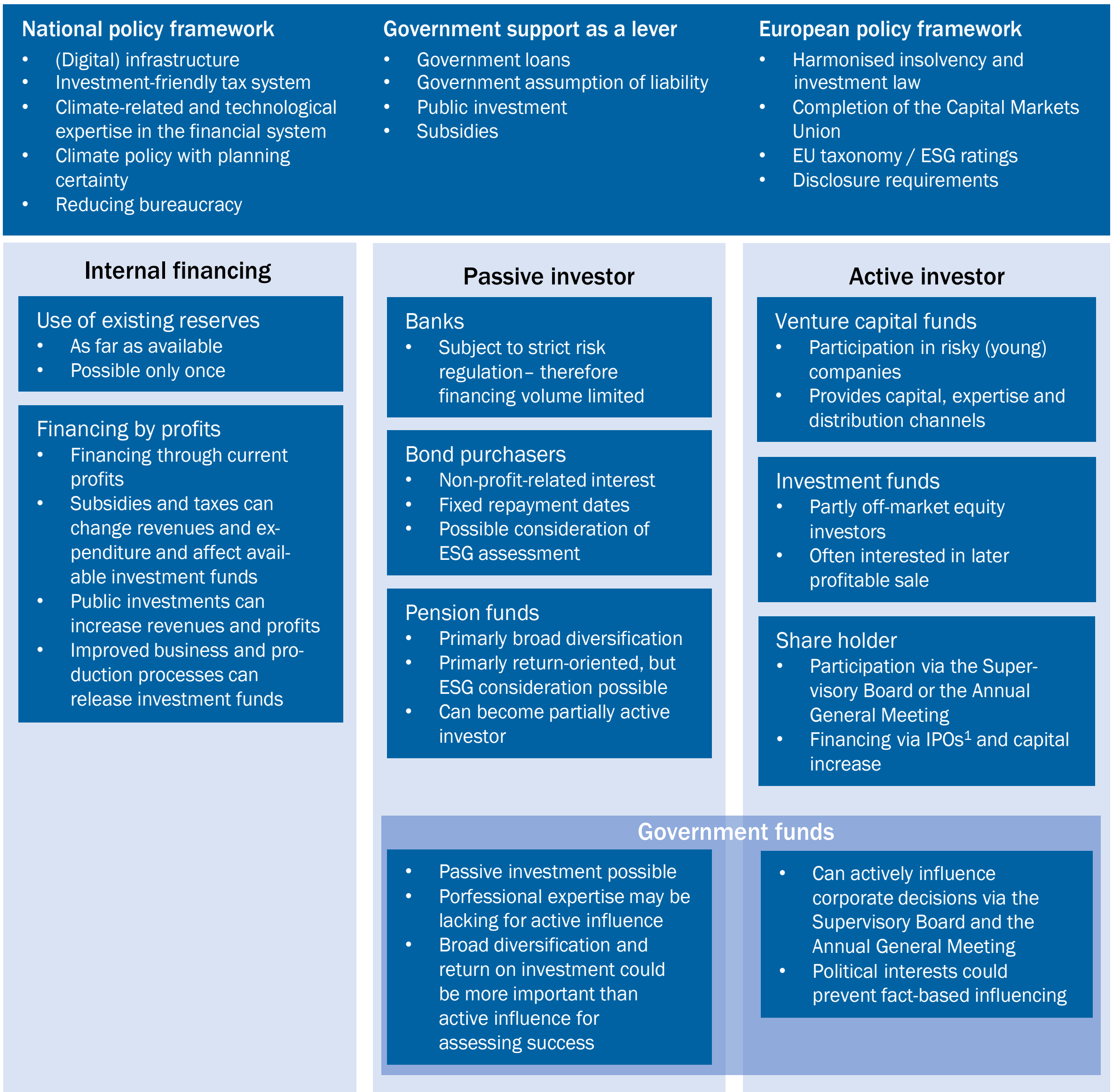
542. Substantial investment will be needed to implement firms' innovations and increase the use of environmental technology. ↘ TABLE 24 Their **financing** can come from the firm itself, from passive investors – such as banks or bond purchasers – or from active investors such as venture capitalists or investment funds. ↘ CHART 137 Although passive investors can base their financing decisions on factors such as sustainability criteria – for example those defined in the EU taxonomy ↘ GLOSSARY (GCEE Annual Report 2020 items 421 f.) – they do not exert any active influence on the firm's policies. However, investors are most likely to have a positive impact on more sustainable corporate behaviour by exerting an active influence on firms' policies. Passive investors are only likely to have an impact on the real economy if the supply of capital available for sustainable investment opportunities comfortably exceeds demand for any given capital market interest rate (Advisory Board to the BMF, 2021, p. 6 ff.). ↘ ITEM 567

543. Given the considerable risks and the information asymmetry involved, banks' ability to finance innovations is limited. **Capital market financing** is therefore highly important in implementing innovation. In the euro area, however, it currently plays a minor role compared with the United States (GCEE Annual Report 2018 items 538 ff.). ↘ CHART 138 LEFT This is particularly evident in the case of **venture capital investments**, which vary significantly across the countries. ↘ CHART 138 RIGHT At the same time, these investments have an especially positive impact on business start-ups, thereby making it easier to implement innovations (Metzger, 2020; GCEE Annual Report 2019 items 284 ff.; GCEE Annual Report 2020 items 518 ff.).

W

Through its plans for a **capital markets union** ↘ GLOSSARY, in 2015 the European Commission set itself the goal of deepening the integration of European financial markets in order to mobilise more investment in businesses and infrastructure (GCEE Annual Report 2015 items 437 ff.; GCEE Annual Report 2018 items 547 ff.). Grimm (2021b, p. 109) and Mauderer (2021, p. 152) discuss the possibility of strengthening funded private and occupational pension schemes in Germany in order to mobilise capital. This might help to create larger funds and anchor investors that would invest in the EU. ↘ ITEMS 428 F. In the United States, where funded pension schemes play a more important role than they do in the EU, the OECD reports that the assets invested in pension funds amounted to around 86 per cent of GDP in 2019 (18.4 trillion US dollars), while in the EU they totalled around 20 per cent of GDP (3.1 trillion US dollars).

↘ CHART 137
Diverse framework conditions and forms of financing for sustainable companies

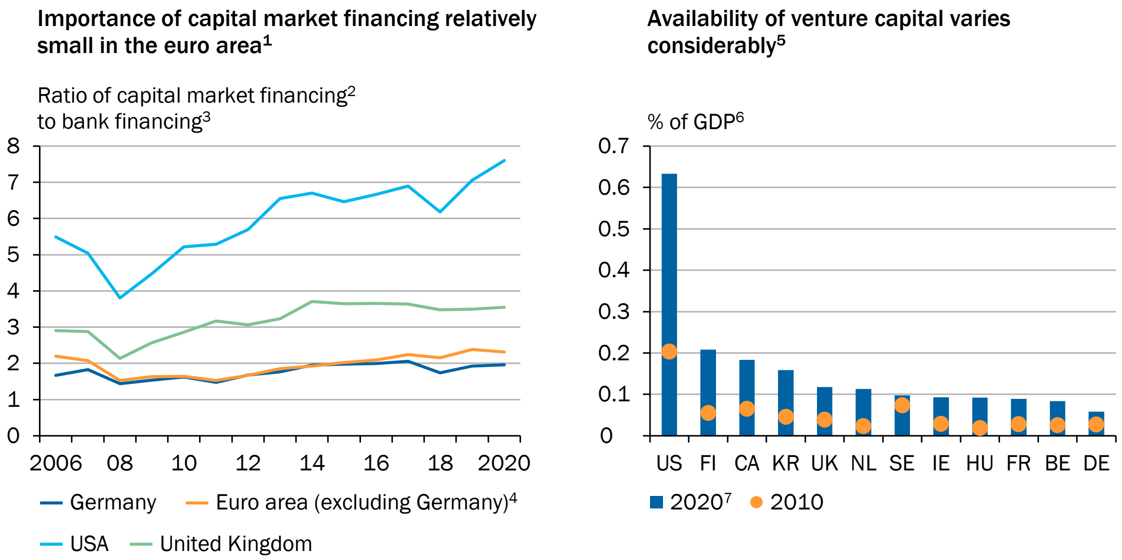


1 – Initial public offerings.

Source: own representation

↘ CHART 138

Capital market financing very common in the US



1 – Excluding trade finance and advance payments. 2 – Debt securities, other liabilities, listed equity shares, non-listed equity shares and other shares. 3 – Loans. 4 – Excluding Malta and Cyprus. 5 – The countries shown here are the eleven OECD member states with the largest venture capital investments as a share of GDP plus Germany (in 17th place). Israel cannot be included owing to lack of data. US-USA, FI-Finland, CA-Canada, KR-South Korea, UK-United Kingdom, NL-Netherlands, SE-Sweden, IE-Ireland, HU-Hungary, FR-France, BE-Belgium, DE-Germany. 6 – Venture capital investments as a share of GDP. 7 – The figure for 2019 has been used for the United States.

Sources: Eurostat, OECD, own calculations

544. **China** has **invested** especially heavily in environmental technologies in recent years. BloombergNEF (2021) reports that in 2020 China accounted for roughly a quarter (135 billion US dollars) of global investment in renewable energy, hydrogen, carbon capture and storage (CCS), and the electrification of transport and heating. ↘ BOX 31 The corresponding amounts invested in the United States, Germany and Japan were well below this level and equalled 85 billion, 29 billion and 27 billion US dollars respectively. However, China's investment looks much less impressive when regarded in relation to the country's population. While China invested just under 100 US dollars per capita, the United States, Germany and Japan invested approximately 260, 350 and 210 US dollars per capita respectively.

China's investment is likely to be guided at least partly by **political priorities**. Improving energy efficiency and increasing the use of renewable energy have been priorities since the eleventh five-year plan (2006 to 2010) (Hong et al., 2013). The 'Made in China 2025' industrial strategy has focused China's policy on further sustainable technology fields such as electric mobility and power generation (Wübbeke et al., 2016; Schirrmeister et al., 2020; GCEE Annual Report 2019 items 320 ff.). This is likely to enable China to mobilise further investment in these areas. China's National Energy Administration (NEA), for example, planned to invest roughly 361 billion US dollars in renewable energy over the period from 2017 to 2020.

Policy framework

545. In addition to the ability to innovate and to the availability of capital there are a number of other factors that affect an economy's **technology potential**. For example, **inadequate regulation, lack of infrastructure, and bureaucratic hurdles** can make it difficult or time-consuming to set up businesses and adopt new ideas (GCEE Annual Report 2020 items 570 ff.). A **shortage of skilled workers** (Grimm et al., 2021; GCEE Annual Report 2020 items 442 ff. and 580 ff.) or **public scepticism** about new, unfamiliar technology (L'Orange Seigo et al., 2014; Siegrist and Hartmann, 2020) can also prevent domestic firms from entering new fields of technology. The ability to quickly test and scale up technologies is a key locational advantage.

546. It is the core objective of **industrial policy** to shape the framework conditions in such a way, that discovery processes can take place open-ended.. Technology-specific network externalities and coordination problems can, however, lead to a situation where entire **technology paths in an economy remain blocked** (GCEE Annual Report 2019 items 250 ff.). When hydrogen is being produced, transported or used, for example, this creates a considerable need for coordination, which can delay the scaling-up of the relevant technologies in various sectors (GCEE Annual Report 2020 items 461 ff.). ↘ BOX 31 If these obstacles are not removed, domestic firms can suffer competitive disadvantages. Industrial policy can specifically address these obstacles. National strategies such as the National Hydrogen Strategy (NWR, 2021, p. 8 ff.; GCEE Annual Report 2020 items 461 ff.) can facilitate coordination between sectors and reduce regulatory uncertainty. The coordination and acceleration of the expansion of infrastructure for the transportation of energy (electricity, hydrogen) and for carbon-neutral mobility (charging points, hydrogen filling stations) are key preconditions for firms to develop the appropriate applications.

However, these strategies should **continue to ensure technology openness**. Japanese and South Korean hydrogen strategies, for example, are not purely restricted to green hydrogen (Ministerial Council on Renewable Energy, Hydrogen and Related Issues, 2017; Ha, 2019). They also allow non-green energy sources as bridging technologies so that the relevant technology can be ramped up more quickly. ↘ BOX 31 This could make it easier for this technology to become established in these countries and, potentially, enable substantial emission reductions to be achieved sooner than if purely carbon-neutral energy sources were used right from the outset. The EU should retain this openness in its hydrogen strategy (European Commission, 2020a).

Renewable energy is changing energy imports

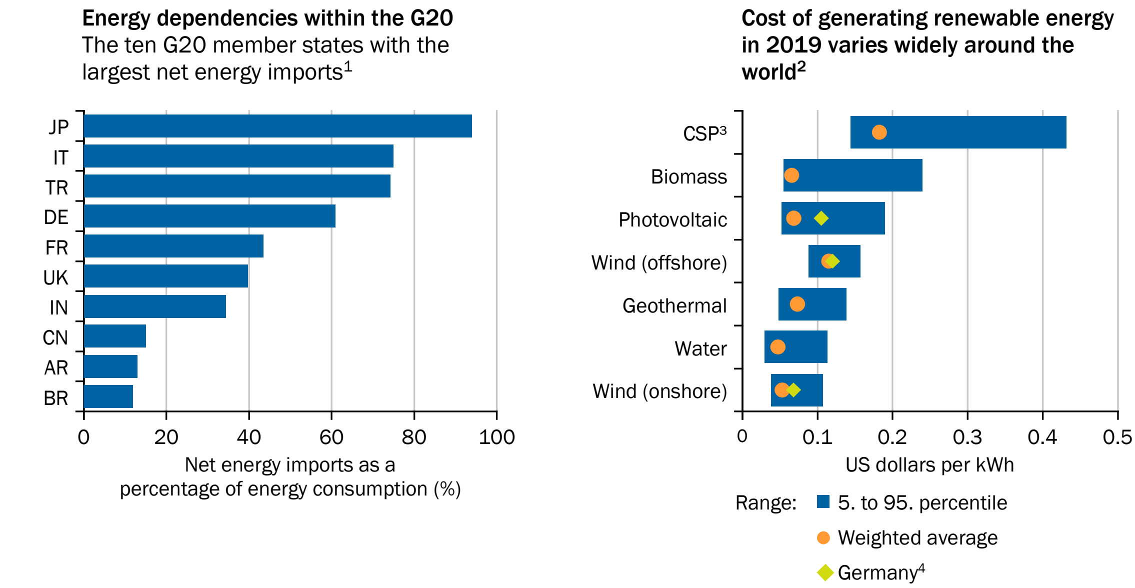
547. The **use of renewable energy** will **grow** sharply over the coming years. The IEA (2021d, p. 195) estimates that in 2050 almost 70 per cent of global energy production would need to come from renewables in order to achieve global carbon neutrality. The relevant proportion in 2020 was 12 per cent. Because global energy demand is expected to fall slightly owing to increasing energy efficiency,

energy production from renewables will rise from 69 exajoules in 2020 to 362 exajoules in 2050 (IEA, 2021d, p. 195).

548. The potential to produce renewable energy has not only climate policy implications but also geopolitical relevance. The ability to generate electricity from renewables will enable countries to **cut their energy imports**. For China, the world's biggest importer of fossil fuels, the reduction of its energy dependence is one of the main reasons for expanding its generation of renewables (Meidan, 2021). The European Commission (2018a, p. 214 f., 2021a, p. 19) also sees the potential to lower the European Union's energy import rate ↘ CHART 139 LEFT by 2050 by expanding its use of renewables. Nonetheless, a desire for greater independence from energy imports can lead to higher **energy costs** if energy can be procured more cheaply from abroad. There is already a huge heterogeneity in renewables' production costs and it is likely to further increase as the scaling up of renewables generation continues. ↘ CHART 139 RIGHT

549. **Renewable energy** can be **exported and imported** by means of cross-border transmission lines (Zheng, 2021) – such as the German-Norwegian Nordlink project – or by using hydrogen and Power-to-X processes (Runge et al., 2020). ↘ BOX 31 This will provide new profit opportunities for countries that have low production costs (IRENA, 2020b) and generate surplus renewable energy. ↘ CHART 139 RIGHT For today's producers of fossil fuels in particular this could be a (partial) low-emission substitute for their current business model. ↘ ITEMS 521 FF. AND 583 FF. Meanwhile, countries with relatively high renewables generation costs (IRENA, 2020b) could procure energy more cheaply (Grimm, 2020a, 2020b). Energy

↘ CHART 139
Energy dependencies and the cost of generating renewable energy



1 – As of: 2014; JP-Japan, IT-Italy, TR-Turkey, DE-Germany, FR-France, UK-United Kingdom, IN-India, CN-China, AR-Argentina, BR-Brazil. 2 – Lifetime cost of a plant divided by the electricity generated over its lifetime. Discounted in accordance with IRENA (2020b, p. 12). Subsidies are not taken into account. Subsidies are not taken into account. 3 – Concentrated Solar Power. 4 – Average cost of generating selected types of renewable energy in Germany. The average for commercial plants is shown for photovoltaics.

Sources: IEA, IRENA (2020b)

imports can also be diversified geographically in order to avoid political and economic dependencies. This can, however, mean – as with the desire for energy self-sufficiency – that energy costs increase overall.

Extraction of critical minerals

550. New technologies such as photovoltaic panels and battery cells are altering the demand for minerals. On the one hand, this creates opportunities for the countries potentially producing these minerals but, on the other hand, a need for the countries purchasing them to act. The European Commission (2020b) currently identifies 30 different **critical raw materials** which, it believes, will become increasingly important in future and on whose **import** the EU is **highly dependent** and whose extraction or processing is highly regionally concentrated. ↘ TABLE 25 Such market settings raise concerns that this dependence could put domestic firms at a **competitive disadvantage** if producing countries were to exploit their monopoly position.

Many of these critical raw materials are highly **regionally concentrated** (Reichl and Schatz, 2020). ↘ TABLE 25 The exporting countries will likely be able to meet some of the growing demand. However, rising raw materials prices and technological advances might make it profitable to **exploit new reserves**. It might therefore be worthwhile for South American and African countries in particular to extract more of the raw materials in future (U.S. Geological Survey, 2021). What is not clear is whether they also possess the **technical expertise to process** these materials. ↘ ITEMS 568 FF.

551. Meanwhile, importing countries are making increasing efforts to **avert future import bottlenecks** (European Commission, 2020b; JOGMEC, 2020; ERGI, 2021). While China has been investing in reserves of raw materials abroad for some years now, the United States and the EU are currently redoubling their efforts to build partnerships and secure the needed natural resources supplies (Schmid, 2019). ↘ ITEMS 583 FF. The EU is also increasingly looking to strengthen research and development that focuses on material substitution and the circular economy (European Commission, 2020b). This might reduce the need for raw materials and, especially, imports over the long term.

↘ TABLE 25

Critical raw materials identified by the European Commission (selection)[1]

Raw material	Relevant production stage	Selected uses	World's largest producers	World's largest reserves[2]	EU's dependence on imports
Beryllium	Extraction	– Electronic and communication devices – Components for the automotive, aerospace and defence industries	USA (88 %) China (8 %) Madagascar (2 %)	NA	NA
Borates	Extraction	– High performance glass – Fertiliser – Permanent magnets	Turkey (42 %) USA (24 %) Chile (11 %)	Turkey USA Chile	100 %
Cobalt	Extraction	– Batteries – Super alloys – Catalysts – Magnets	Congo (59 %) China (7 %) Canada (5 %)	Congo (51 %) Australia (20 %) Cuba (7 %)	86 %
Gallium	Processing	– Semiconductors – Photovoltaic cells	China (80 %) Germany (8 %) Ukraine (5 %)	NA	31 %
Germanium	Processing	– Optical fibres and infrared optics – Solar cells for satellites – Polymerisation catalysts	China (80 %) Finland (10 %) Russia (5 %)	China Russia	31 %
Indium	Processing	– Flat screens – Photovoltaic cells and photonics – Soldering metals	China (48 %) Republic of Korea (21 %) Japan (8 %)	NA	0 %
Lithium	Processing	– Batteries – Glass and ceramics – Steel and aluminium metallurgy	Chile (44 %) China (39 %) Argentina (13 %)	Chile (44 %) Australia (22 %) Argentina (9 %)	100 %
Natural graphite	Extraction	– Batteries – Fireproof materials for steel production	China (69 %) India (12 %) Brazil (8 %)	Türkei (28 %) China (23 %) Brazil (22 %)	98 %
Scandium	Processing	– Solid oxide fuel cells – Light alloys	China (66 %) Russia(26 %) Ukraine (7 %)	NA	100 %
Silicon metal	Processing	– Semiconductors – Photovoltaic – Electronic components – Silicones	China (66 %) USA (8 %) Norway (6 %)	NA	63 %
Metals of the platinum group	Processing	– Chemical catalysts – Fuel cells – Electronic applications	South Africa (84 %)[3] Russia (40 %)[4]	South Africa (91 %) Russia (6 %) Zimbabwe (2 %)	100 %
Heavy rare earths	Processing	– Permanent magnets for electric engines and power generators – Fluorescent phosphorus – Catalysts	China (86 %) Australia (6 %) USA (2 %)	China (37 %) Vietnam (18 %) Brazil (18 %)	100 %
Ligth rare earths	Processing	– Batteries – Glass and ceramics			

1 – The European Commission has identified a total of 30 critical raw materials. Because of the purpose for which they are used, the following are not shown here: antimony, baryte, bauxite, fluorspar, hafnium, coking coal, magnesium, natural rubber, niobium, phosphorus, phosphate rock, strontium, tantalum, titanium, vanadium, bismuth and tungsten. Data on light and heavy rare earth elements is only available in aggregated form. 2 – Figures are based on the U.S. Geological Survey (2021). Estimates of global reserves are either non-existent or incomplete in some cases. 3 – For Iridium, Platinum, Rhodium and Ruthenium. 4 – For Palladium.

Sources: European Commission (2020b), U.S. Geological Survey (2021)

4. Implications for negotiating positions in climate policy

552. Successful multilateral climate policy must take account of **countries' heterogeneity** with respect to the challenges, risks and opportunities they face. This applies to the climate-related risks faced by the countries, ↘ ITEMS 512 FF. the transition cost of decarbonisation, ↘ ITEMS 521 FF. and economies' technological potential ↘ ITEMS 538 FF. as well as the available financing options. ↘ ITEMS 542 FF.

↘ TABLE 26

Overview of climate risks, transition costs and economic opportunities for selected countries[1]

	Global GHG emissions	Direct climate risks	Costs of decarbonisation	Specialisation in green technologies	Investment environment	Energy imports and exports	Climate policy
	(Share in %)[2]	according to ND-GAIN vulnerability index[3]	according to carbon emissions per inhabitant (tonnes per year)[4]	according to RTA for environment-related technologies[5]	according to amount of investment[6]	according to net energy import ratio (%)[7]	according to EPI[8]
Australia	1.3	30.6	15.5	0.89	23.2	– 192.0	74.9
Brazil	2.3	38.1	2.0	0.97	15.4	11.9	51.2
Chile	0.2	31.7	4.6	1.36	23.0	64.2	55.3
China	26.9	38.8	7.4	0.83	43.3	15.0	37.3
Germany	1.8	28.4	8.6	1.50	21.4	60.9	77.2
France	0.9	29.0	4.6	1.37	24.2	43.5	80.0
India	7.4	50.3	1.8	0.72	30.7	34.3	27.6
Indonesia	2.1	44.6	2.2	0.57	33.8	– 103.1	37.8
Japan	2.6	36.1	8.7	1.04	24.5	94.0	75.1
Canada	1.6	29.2	15.5	0.98	23.0	– 67.9	71.0
Poland	0.8	31.7	8.2	1.08	19.7	28.4	60.9
Russia	5.5	33.1	11.1	0.76	22.8	– 83.7	50.5
Saudi Arabia	1.4	38.9	15.3	2.14	28.8	– 191.5	44.0
South Africa	1.1	40.6	7.5	0.87	17.6	– 14.5	43.1
Ukraine	0.6	36.8	4.2	0.94	14.9	27.2	49.5
USA	13.1	32.1	15.2	0.86	21.0	9.2	69.3
UAE[9]	0.6	35.7	20.8	1.01	23.8	– 183.8	55.6

1 – The colour coding takes account of the global distribution of indicators. Green/amber/red shows the positive/neutral/negative current situation. 2 – Analysis is based on CO_2-equivalent greenhouse gases (as at 2018). 3 – The ND-GAIN vulnerability index evaluates on a scale of 0 to 100 how much an economy is exposed to climate threats (as at 2019). 4 – As at 2018. 5 – The Revealed Technological Advantage (RTA) for environment-related technologies is defined as the number of patent applications for environment-related technologies divided by the total number of all patent applications under the Patent Cooperation Treaty (PCT). Environment-related technologies are defined according to the OECD. Index values of more than 1 imply a specialisation in the relevant field (as at 2018). 6 – Gross fixed capital formation as a share of GDP (as at 2019). 7 – The net energy import ratio is defined as annual net energy imports divided by total energy consumption (as at 2014).Negative values imply net energy exports. 8 – The Environmental Performance Index (EPI) evaluates economies in terms of their environmental and climate policy progress on a scale of 0 to 100 (as at 2020). 9 – United Arab Emirates.

Sources: Chen et al. (2015), OECD, Wendling et al. (2020), World Bank, own calculations

These factors mean that nowadays there are strong differences in the **willingness** to pursue **environmental and climate policies**. The Environmental Performance Index (EPI), for example, reveals a **wide divergence** between countries in terms of their environmental and climate policy efforts (Wendling et al., 2020). Whereas many advanced economies attach considerable importance to regional environmental protection, developing countries and emerging economies are still often either unable or insufficiently willing to increasingly decouple economic growth from emissions.

553. The wide range of negotiating positions and their underlying explanatory factors make it much more difficult to categorise countries according to their willingness to collaborate. Even an **overview of just a few selected explanatory variables** illustrates how divergent the various current positions can be. ↘ TABLE 26 Given their low levels of climate risk compared with other countries worldwide and the opportunity for them to derive commercial benefit from the transformation, **Germany** and **France**, for example, are likely to be in a relatively favourable position. The **oil-producing countries**, on the other hand, could well face significant challenges in some cases, especially if the nature of their financial system and real economy makes it difficult for them to transform their economic model – as in Russia, for example.

III. MULTILATERAL CLIMATE COOPERATION

554. Limiting climate change requires the international community to coordinate. If countries do not participate in large numbers, **free-riding** as well as **direct and indirect carbon leakage** ↘ BACKGROUND INFO 13 can render climate efforts made by the EU or Germany ineffective. At the same time, countries' highly divergent current situations make negotiation and coordination more difficult. ↘ ITEM 552

The progress made so far on **multilateral climate coordination** falls short of the ambitions needed to keep global warming to below 2°C – let alone to 1.5°C – compared with pre-industrial levels. The following section therefore discusses potential ways of achieving progress at multilateral level. The focus here is on the climate policy coordinated by the United Nations (UN) and its Framework Convention on Climate Change (UNFCCC) ↘ ITEMS 555 FF. and on the multilateral trade system. The latter is largely determined by the World Trade Organization (WTO) and can play a key role in climate protection. ↘ ITEMS 574 FF.

1. Climate policy within the United Nations

555. The multilateral coordination of climate policy has achieved only limited success to date. The first multilateral coordination mechanism – the **Kyoto Protocol** – only set emission reduction targets for the advanced economies. However, major emitters – such as the United States, Canada, Japan and Russia – did not participate such that in 2011, the participating countries accounted for only 13 per cent

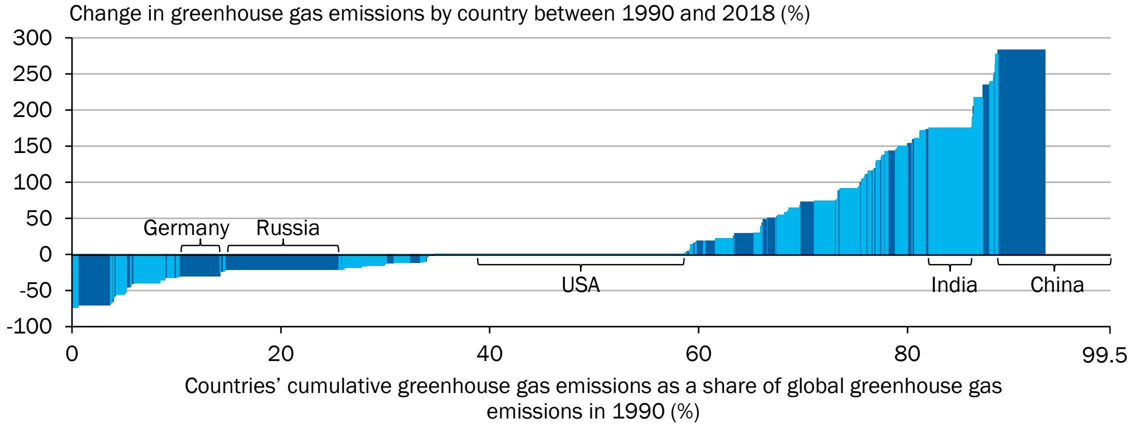
of global greenhouse gas emissions (Edenhofer and Jakob, 2019, p. 80 f.). The reduction in emissions in the participating countries since 1990 has been therefore low compared with the emission increases elsewhere. ↘ CHART 140

556. The 2015 **Paris Agreement** continues the endeavours of the Kyoto Protocol after 2020. The main success of the Agreement is the consensus on a **common climate target** and the obligation for **all participating countries** to formulate individual climate protection contributions (UNFCCC, 2021a). ↘ CHART 141 In many respects, however, the Paris Agreement is still unable to resolve the key challenges of multilateral climate cooperation. There are, for example, **no sanction mechanisms** available, and there are no consequences under international law when nationally determined contributions (NDCs) are not met (German Bundestag, 2018). The consequences of non-compliance therefore do not go beyond potential naming and shaming.

The Paris Agreement therefore does not resolve the issue of **free-riding**. National targets can continue to be set very low and – as in the Kyoto Protocol – a wait-and-see approach can be adopted (Beccherle and Tirole, 2011; Gollier and Tirole, 2015). The current targets set in the NDCs are likely to be inadequate to achieve the jointly formulated long-term target (Liu and Raftery, 2021). The Climate Action Tracker (CAT, 2021) reveals that the current NDCs imply global warming of between 1.9 and 3.0°C by the year 2100. On top of that, the authors point out that the climate policies currently being implemented will not be sufficient to meet the targets set in the NDCs. Instead, they predict that – under the current climate policies – temperatures will rise by between 2.1 and 3.9°C compared with pre-industrial levels.

↘ CHART 140

Global emissions have risen sharply since 1990 despite the Kyoto Protocol[1]

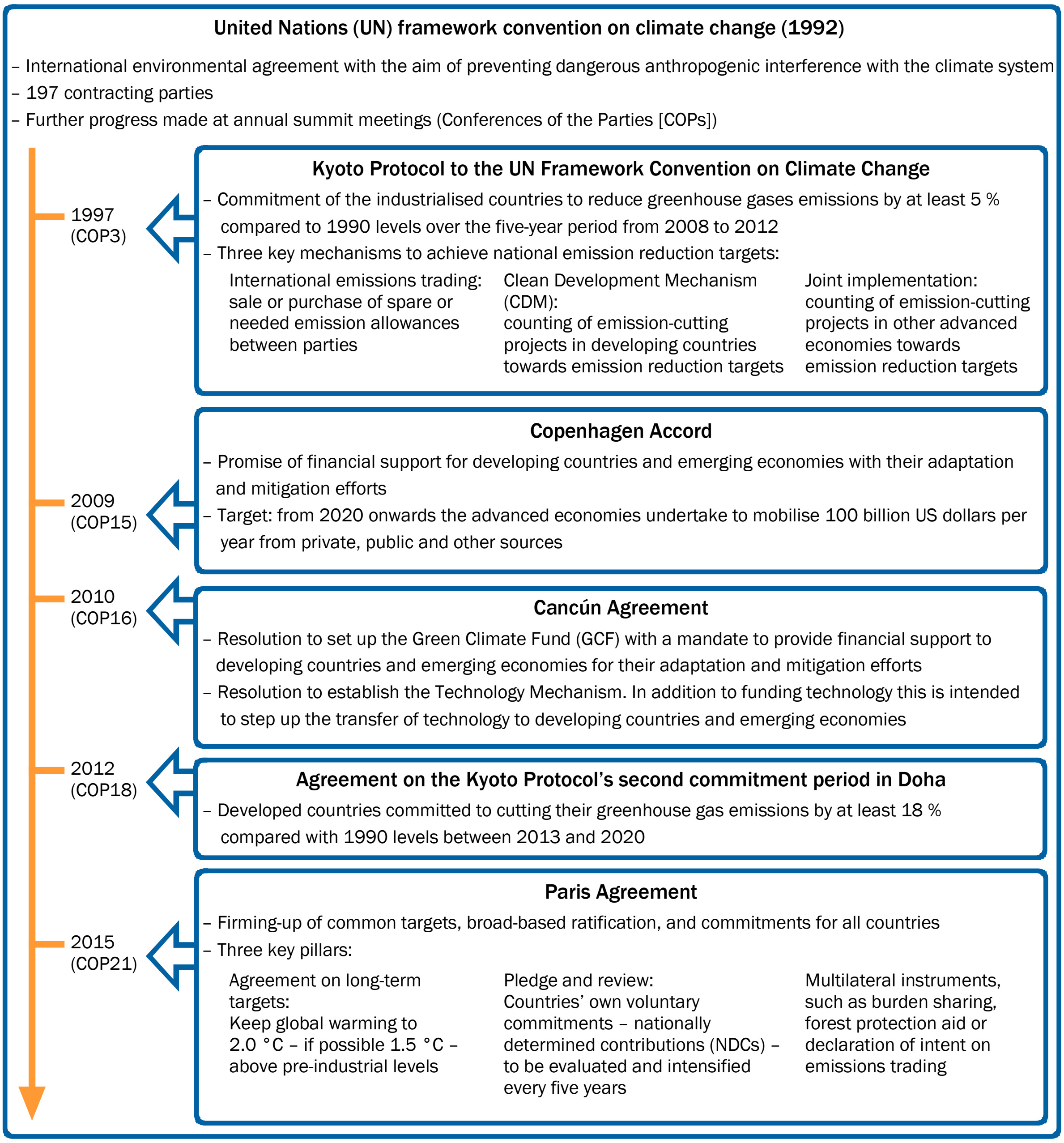


1 – 0.5 % of emissions are not shown here either because their share of global emissions is less than 0.001 % (Dominica, Cape Verde, Kiribati, the Comoros, Liechtenstein, Nauru, São Tomé and Príncipe, the Seychelles, St. Kitts and Nevis, St. Vincent and the Grenadines, Tonga, Tuvalu) or because the change in their level of emissions exceeds 300 % (Lebanon, Cameroon, Vietnam, Chad, Oman, Afghanistan, Qatar, Maldives, East Timor, Equatorial Guinea).

Sources: World Bank, own calculations

557. Although the Paris Agreement has weaknesses, it can make a contribution by strengthening mutual trust in the ambitions of the parties to the agreement. **Trust** and **reciprocity** are essential for successful cooperation, and both factors strengthen each other (Pateete et al., 2010, p. 350 f.; Ostrom, 2014). Climate change is likely to be effectively mitigated only if the parties to the agreement can rely on the fact that their own efforts will have a positive impact on the other parties' efforts and will thus not be exploited. Instruments such as a multilateral carbon pricing mechanism can ensure reciprocity (Cramton et al., 2015; MacKay et al., 2015), however, they do not appear to enjoy majority support at present. If the Paris Agreement strengthens mutual trust in the other countries' ambitions and intentions, it could pave the way for better instruments.

↘ CHART 141
Selected results of the World Climate Change Conferences



Sources: BMU (2021), Edenhofer and Jakob (2019), UNFCCC, own representation

558. The Paris Agreement contains a few elements that can build **trust**. **Compliance with the NDCs** in particular could perform this function. However, NDCs are only scheduled to be evaluated and tightened every five years. Progress can therefore only happen slowly. The expansion of the disclosure requirements, which are specified in the agreement and are summarised in the **Enhanced Transparency Framework (ETF)**, can also make a contribution. If partners are able to see tangible progress being made on implementing the NDCs, this could give rise to greater ambitions. However, the regulations leave plenty of room for interpretation. It is therefore doubtful to what extent they can actually build trust (Weikmans et al., 2019). The disclosure requirements therefore need to be continuously improved and expanded.

559. **Burden sharing** – in other words the transfer of financial resources and technology between developed countries and developing economies – offers a good opportunity to strengthen trust between partners. Burden sharing will not only be responsible for enabling developing countries and emerging economies to follow a low-emission growth path as a result of mitigation measures and for cushioning the consequences of climate change through adaptation measures. If progress can be made here, burden sharing might also build trust and win majority support for mechanisms that can restrict free-riding effectively.

Although burden sharing forms a significant part of the Paris Agreement, **many** of its **aspects remain unresolved** (Edenhofer and Jakob, 2019, p. 83). It has yet to be decided, for example, in what form the transfers are to be provided, how much funding is to come from the public and private sectors, and which countries are to mobilise funding and, if so, how much.

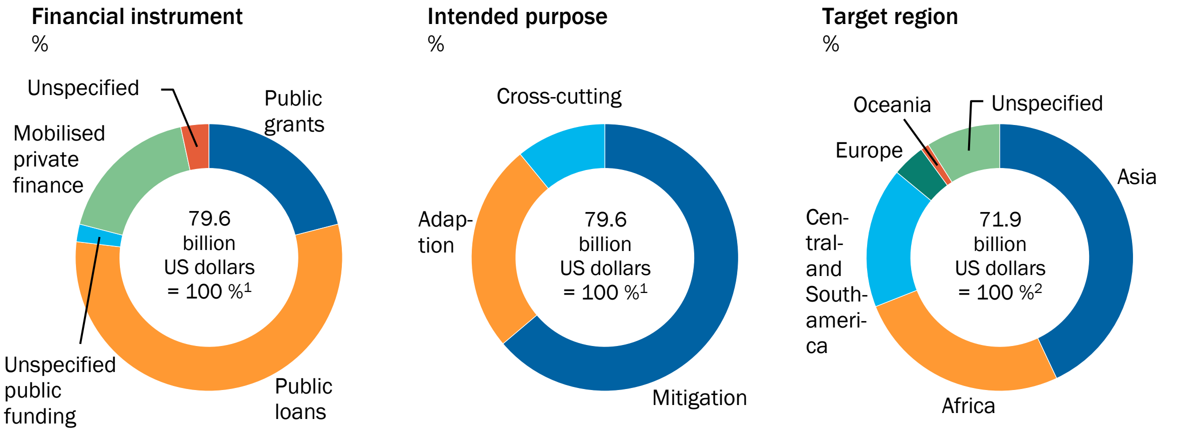
560. The Framework Convention on Climate Change states that the international community bears a **common but differentiated responsibility** to protect the climate system. Given their capabilities, developed countries are to have a leading role here (Article 3.1). Article 4.4 of the Paris Agreement implies not only that they should commit to emission mitigation targets, whereas developing countries do not have to do so. They are also supposed to provide **financial and technology transfers** in order to make the transformation possible or easier for the developing economies (Paris Agreement Article 9). ↘ ITEMS 512 FF. AND 537 FF.

Burden sharing through international climate finance

561. The term **international climate finance** ↘ GLOSSARY covers the financial flows that support mitigation and adaptation measures. The flows can come from private, public or other institutions and can be used regionally, nationally or internationally. This includes the transfers from developed to developing countries and to emerging economies (UNFCCC, 2021b).

As part of the Copenhagen Accord signed back in 2009, the advanced economies committed to mobilising **100 billion US dollars per year** from 2020 onwards for adaptation and mitigation in developing countries and emerging economies. ↘ CHART 141 This figure includes private funds provided that these are incentivised by the public climate finance offered by the donor countries (Bhattacharya et al.,

↘ CHART 142
Climate finance provided by advanced economies for developing countries and emerging economies in 2019 consists mainly of public loans



1 – Data for 2019. 2 – Average from 2016 to 2018.

Source: OECD (2021b)

2020, p. 28 f.; OECD, 2021b, p. 11 f.). In 2019 – the latest year for which data is available – roughly 80 billion US dollars were mobilised (OECD, 2021b). ↘ CHART 142 Although more recent data is unavailable, the **target for 2020 is unlikely to have been met** (Bhattacharya et al., 2020, p. 33).

It is not only the anticipated missing of the target that is criticised. The **additionality** of funds and the supportive effect of public loans made available to developing countries and emerging economies, which currently account for a substantial proportion of funding, ↘ CHART 142 are also being questioned (Dasgupta et al., 2015). Moreover, the methods used to identify the mobilised funds are being criticised for being **intransparent** and **inconsistent** (Bhattacharya et al., 2020, p. 27 ff.).

562. The potential missing of the target for the mobilised funds is likely to be largely attributable to the bottom-up approach currently applied. There is **no allocation formula** for distributing the envisaged 100 billion US dollars among the developed countries. Instead, the countries involved announce their funding commitments at irregular times.

The **implementation of an allocation formula** based on factors such as GDP or historical and current emissions might enable more funds to be mobilised (Pickering et al., 2015; Schalatek and Bird, 2020). According to Germany's Federal Ministry for Economic Cooperation and Development (BMZ, 2021), in 2020 Germany made available public funding amounting to roughly 7.6 billion euros, some 2.6 billion euros of which was provided in the form of loans from KfW. The subject of public climate finance for developing countries and emerging economies was discussed at this year's **G7 meeting** in Cornwall (G7, 2021a). Germany should revisit this topic during its G7 presidency next year in order to progress the mobilisation of funds.

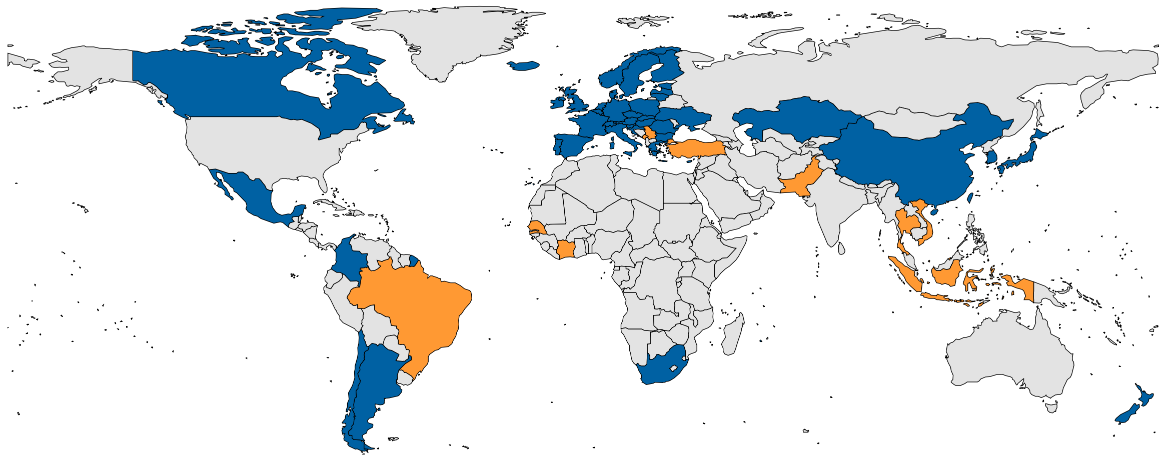
563. Various plurilateral and bilateral institutions allocate the funding for public climate finance to the developing countries and emerging economies (Watson and Schalatek, 2021). **Plurilateral institutions** include development banks such as the World Bank and climate funds such as the Green Climate Fund (GCF). ↘ CHART 141 The advantage of plurilateral institutions is their coordination role: they enable a global strategy to be established. However, their organisational structures can slow down implementation processes (Kumar, 2015; Schalatek and Watson, 2020). **Bilateral projects** are therefore a sensible addition. They can be used more flexibly and make it easier to try out project ideas. This can improve the effectiveness of burden sharing. At the same time, bilateral projects offer the opportunity to build strategic alliances that can form the basis of future economic or climate policy partnerships. In Germany, as in other countries, political and economic interest in energy partnerships has grown in recent years (BMWi, 2020; Kiyoshi and Al Mazrouei, 2021; U.S. Department of State, 2021a, 2021b). ↘ CHART 583 FF.

564. The public climate finance contributed by the developed countries can only raise part of the funding required – even if the mobilisation of these funds were improved in future. ↘ ITEM 537 It can, however, be used to **mobilise private investment** in developing countries and emerging economies. This applies especially in cases where market imperfections lead to inefficiently low levels of investment (Metz et al., 2000, p. 19; Bowen, 2011). In addition to the mobilisation of public funds for burden sharing, the stronger mobilisation of private investment is therefore understandably a key topic on the agenda at this year's COP26 in **Glasgow** (Carney, 2021; COP26 Presidency, 2021).

565. In addition to market imperfections, **inadequate climate policy, poorly designed climate policy instruments** and **unrealistic climate ambitions** are likely to be major investment obstacles for private actors. The Climate Finance Leadership Initiative (CFLI, 2019), an association of private financial institutions, attributes the shortage of private investment to factors such as the uncertainty around governments' emission targets and a lack of regulation and standards. Developing countries and emerging economies such as Bangladesh, India and Pakistan have increasingly been investing in coal-fired power stations (Steckel et al., 2015; Sustainable Energy for All and Climate Policy Initiative [SEforALL and CPI], 2021). This has short-term consequences for the appeal of private investment in renewable energy. Coal-fired power stations also delay investment in renewable energy over the long term as they stay operational for up to 45 years and (Tong et al., 2019; Sato et al., 2021).

Transfers from advanced economies to developing countries and emerging economies should be used **strategically** to specifically **reduce climate policy uncertainty** in target countries, thereby **mobilising private investment**. This could be achieved, for example, by making financial transfers conditional on emission cuts or on climate policy measures and instruments. The amounts of transfers could be based on factors such as the levels of emission reductions (Steckel et al., 2017; Kornek and Edenhofer, 2020). It is important to ensure, however, that this conditionality does not create **perverse incentives**. Measures to be taken in the target countries could, for example, be strategically delayed in order to

↘ CHART 143
Supraregional and national carbon pricing mechanisms in 2021[1]



1 – Existing or planned carbon pricing systems at subnational level are not taken into account.
Sources: EuroGeographics for the administrative boundaries, World Bank

benefit from the transfers at a later date. If sector-specific conditionality is agreed, other sectors might be neglected (Steckel et al., 2017).

566. The **introduction of carbon pricing mechanisms** in developing countries and emerging economies could reduce political uncertainty for private investors, thereby mobilising more private capital (GCEE Annual Report 2020 items 372 f.). ↘ ITEM 542 At the same time, carbon pricing would lower the macroeconomic cost of transformation, making it easier for these countries to meet their NDCs (German Council for Sustainable Development (RNE) and Leopoldina, 2021, p. 21 f.; GCEE Special Report 2019 items 107 ff.). At present, however, carbon pricing is the exception in developing countries and emerging economies (World Bank, 2021a). ↘ CHART 143 Developed countries can **provide** broad **assistance** in establishing pricing systems. Transfers could be paid to cushion undesirable distributional effects of carbon pricing (Steckel et al., 2017; Edenhofer and Jakob, 2019, p. 91 f.). The provision of advice and guidance could also be expanded in order to help build the necessary governance structures.

For various reasons, the barriers to introducing a carbon pricing mechanism can be considerable (Stiglitz, 2019). A first step, which might be quicker and easier to implement, would be to **cut subsidies for fossil fuels**. Large sums of money continue to be spent on such subsidies both in advanced economies and in developing countries and emerging economies (International Institute for Sustainable Development [IISD], 2020; Taylor, 2020). The subsidies for fossil fuels can hinder and delay the transformation (GCEE Special Report 2019 item 95).

567. The **availability of information** on the climate impacts of individual investment projects will play a key role in **mobilising private investment** in both the developed countries and in developing countries and emerging economies. If

investors can clearly and reliably identify the sustainable purpose of an investment (**environmental, social and governance [ESG]**), this can have a positive impact on the supply of capital (Bhattacharya et al., 2020; Liebich et al., 2021; GCEE Annual Report 2020 items 419 ff.). Such criteria can – if properly formulated – help to reduce information asymmetries between lenders and borrowers, thereby mobilising the capital needed for the transformation (Mauderer, 2019; task force on climate-related financial disclosures [TCFD], 2020). ↘ ITEM 542

The EU can use its taxonomy ↘ GLOSSARY (European Commission, 2018b; EU Technical Expert Group [TEG], 2020) to gain initial experience and thus play a supporting or leading role in establishing regional or multilateral standards. The long-term objective should be to establish a **transparent and practicable evaluation system** that makes investments' contribution to achieving carbon neutrality clearly visible and that includes all countries – irrespective of their levels of prosperity. ↘ ITEM 577 The success of the ESG criteria will depend on how **credibly the sustainable usage of funds can be ensured** and how great the complexity of the system and the associated **administrative expense and workload** will be (EU TEG, 2019, p. 97 ff.). The Advisory Board to Germany's Federal Ministry of Finance (Advisory Board to the BMF, 2021) recently expressed scepticism about both factors. Additionally, if the ESG criteria are not properly formulated, barriers to sustainable investment can emerge. This is the case, for example, if incremental innovations and associated investment projects in emission-intensive industries are declared not to be sustainable owing to the lacking differentiation in the criteria (Friedrich and Wendland, 2021).

Burden sharing through diffusion of technology

568. Adaptation and mitigation can pose challenges **for developing countries and emerging economies** for various reasons. The countries may lack the necessary technology, equipment or expertise. They may also have insufficient regulatory experience, for example, to integrate renewable energy systems or to improve energy efficiency. The transfer of technology by the advanced economies has the potential to accelerate the technology diffusion and to **enable developing countries and emerging economies** to implement the necessary mitigation and adaptation measures (Metz et al., 2000, p. 15 ff.). Ideally, developing countries and emerging economies will not follow the technology path taken by advanced economies but will instead leapfrog certain technologies (Energy Leapfrogging; van Benthem, 2015). This will enable them to pursue a lower-emission growth path.

569. The transfer of technology by developed countries can take on various forms in order to account for the particular situation in the target country (Metz et al., 2000, p. 20; de Coninck and Sagar, 2015). **Equipment** can be provided, **research findings** can be shared, and proprietary research capacity can be built locally. **Advice** – such as that offered by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) – can help countries to establish their policy framework in a way that facilitates mobilisation of private investment and, consequently, fosters technology diffusion. And, last but not least, the actors concerned can jointly

identify **key research areas**, strengthen research collaboration and trial innovations by conducting **demonstration projects** (Stern, 2006, p. 495 ff.).

570. The **UNFCCC Technology Mechanism**, which is designed to coordinate the transfer of technology, was launched under the auspices of the UN at COP16 in 2010 (Abdel-Latif, 2015). ↘ CHART 141 It performs an advisory and coordinating function in the research and development of mitigation and adaptation technologies. It also provides developing countries and emerging economies with technical support on how to use these technologies, informs them about new technologies and solutions, and connects various actors with each other (UNFCCC, 2015).

571. Emerging economies – although not the least developed economies – have increasingly been participating in the international diffusion of technology since 1992. Glachant and Dechezleprêtre (2017) attribute this to imports of intermediate products, foreign direct investment (FDI) and patent applications. The **least developed economies** face the greatest barriers to the transfer of technology (Glachant and Dechezleprêtre, 2017). This is visible in trade but also in other developments. Developing countries have benefited the least from the **Clean Development Mechanism** (CDM) developed under the Kyoto Protocol, which has enabled developed countries to count emission-cutting projects in developing countries and emerging economies towards their own emission reductions. ↘ CHART 141 Although the CDM is often criticised for the questionable additionality of its emission cuts (Paulsson, 2009), it is said to have a positive side-effect on the transfer of technology (de Coninck et al., 2007; Dechezleprêtre et al., 2008; Lema and Lema, 2013). However, the **shortage of technical and institutional capacity** in developing countries is cited as the reason why CDM projects were mainly conducted in emerging economies (Castro and Michaelowa, 2011).

572. Technology diffusion is supported by **free trade** (Dechezleprêtre et al., 2013). The fact that developing countries and emerging economies are increasingly integrated into global markets through mechanisms such as **trade agreements** could therefore facilitate the use of the latest technologies there. ↘ ITEMS 574 FF. Whether **intellectual property rights** act as a barrier to the transfer of technology is hard to say from the perspective of the economic theory. Empirically, however, there is no evidence so far to suggest that patent laws have an adverse impact on the diffusion of technology (Stern, 2006, p. 500 f.; Dechezleprêtre et al., 2013). A reliable **regulatory framework** and **credible climate policy** can create incentives for green investment in developing countries and emerging economies, thereby encouraging the diffusion of technology (Glachant and Dechezleprêtre, 2017).

573. The measures taken in connection with technology transfers provide European and German firms – as well as companies from other advanced economies around the world – with new opportunities to sell their products and services. **Technology partnerships** can already help to lay the strategic foundations for this. They can assist European and German firms in the process of scaling up their technologies and products abroad at an early stage. ↘ ITEMS 583 FF. The opportunities for trade in green energy carriers provide developing countries and emerging economies with new export potential. Europe and Germany can benefit from the

comparative advantage that the developing countries and emerging economies have in the production of renewable energy. **Energy partnerships** can already help to lay the foundations for this energy trading. ↘ ITEMS 547 FF.

2. Adjustment of international trade cooperation

574. Through strengthening specialisation and the division of labour, **international trade** has significantly **improved efficiency and welfare** in almost all countries (GCEE Annual Report 2017 items 153 ff. and 649 ff.). As international trade has intensified, poverty – especially in developing countries and emerging economies – has fallen sharply (Mitra, 2016; World Bank and WTO, 2018; GCEE Annual Report 2017 items 629 ff.) At the same time, however, international trade can have an adverse impact on climate protection and the environment (Copeland, 1994; Antweiler et al., 2001; Neary, 2006; Managi et al., 2009; Weber and Peters, 2009; McAusland and Millimet, 2013; Keen and Kotsogiannis, 2014; Cherniwchan et al., 2017; Larch and Wanner, 2017).

Trade flows affect emissions not only through their impact on the location and volume of production (Garnadt et al., 2020) but also because they can impair the effectiveness of unilateral climate protection measures owing to factors such as **carbon leakage** ↘ BACKGROUND INFO 13 (Aichele and Felbermayr, 2015). In addition, a potential **loss of competitiveness** can prevent countries from pursuing ambitious climate policies (Board of Academic Advisors at the BMWi, 2021). Growth in international trade can also increase deforestation – for example by relocating agricultural production – and thus destroy natural greenhouse gas sinks (Abman and Lundberg, 2020).

575. **International trade policy**, which is mainly coordinated by the WTO, has so far **largely ignored the climate aspects of trade**. This has given rise to a global trading system which in some respects is harmful to the climate. In most countries, for example, both **import tariffs** and **non-tariff trade barriers** – such as product standards – are **higher for low-emission goods** than they are for emission-intensive goods (de Melo and Solleder, 2019; Shapiro, 2021). This constitutes an implicit subsidy for the production of emission-intensive goods. Shapiro (2021) estimates the average amount of this subsidy to be between 85 and 120 US dollars per tonne of CO2. Shapiro shows (2021) in simulations that equalising the tariffs for low-emission and emission-intensive goods could produce positive effects. His study suggests, for example, that cutting tariffs on low-emission goods to the level of the average tariff while raising tariffs on emission-intensive goods to the same level would reduce carbon emissions while global income would hardly change. The study also shows that cutting tariffs on low-emission goods to the level of the tariffs on emission-intensive goods would reduce carbon emissions while slightly raising income.

In addition to the asymmetries observed in the structure of tariffs, **direct subsidies for emission-intensive goods and fuels** can also affect international trade flows and impair the reduction of global greenhouse gas emissions (Moerenhout, 2020).

576. The WTO's current legal framework around climate policy measures is inadequate in various respects. For example, the WTO rules tolerate many **subsidies that are harmful to the climate**. At the same time, however, there is a lack of clarity about the legality of subsidies for environmentally friendly goods (Green, 2006; Fischer, 2016; Pirlot, 2017). There is also a risk that the WTO might classify individual countries' **carbon emission labelling rules** as a non-tariff trade barrier (Mavroidis and de Melo, 2015). Moreover, current international law is silent on what to do if climate agreement provisions clash with WTO law (Soobramanien et al., 2019). This might be the case, for example, if the measures required by climate agreements have an impact on trade (WTO, 2021a). These uncertainties could mean that countries engage in climate protection to a lesser extent.

577. Given this situation, a number of potential reforms to the global trading system are being discussed. These include the introduction of a mechanism to reduce environmentally harmful subsidies (Bacchus, 2018) and the agreement on uniform rules on the labelling of carbon footprints and standards (Soobramanien et al., 2019). The latter would also lower the cost that a patchwork of varying national regulations would impose. ↘ BOX 32. Ahmad (2020) recommends that future negotiations on **reforming the WTO rules** should aim to **liberalise trade** in **green technology, goods and services** and ensure their **diffusion**. Strengthening legal certainty is seen as a key element here (Soobramanien et al., 2019). It could encompass, for example, defining what counts as subsidies for climate-friendly goods and services. There is also criticism of the lack of legal certainty in cases where national climate protection measures could be in conflict with WTO law to the extent that they impact on trading partners. In addition, demands are being voiced to clarify any conflicts between climate agreements and WTO rules.

↘ BOX 32

The measurement of product-specific greenhouse gas emissions

Efficient climate protection requires the ability to measure and estimate greenhouse gas emissions – especially the carbon footprint of processes, products and investment projects – as well as the establishment of measurement and estimation standards. The **measurement of emissions must be transparent and clearly comprehensible** so that the emission mitigation commitments given under the Paris Agreement, for example, can be verified (Weikmans et al., 2019). The estimation of carbon footprints can also form the basis for sustainability criteria such as those defined in the EU taxonomy. Such criteria make it easier for investors to factor climate-relevant aspects into their investment decisions. In addition, it is important to be able to measure products' carbon footprint reliably if, for example, consumers wish to take the climate impact of their purchasing decisions into consideration, or if carbon border tax adjustment mechanisms are to be introduced, as the EU is currently planning to do (European Commission, 2021b).

When measuring the product-specific carbon footprint it is first necessary to define which emissions are to be included. A narrow definition encompasses only the direct emissions that arise during the final stage of the value chain. A broad definition, on the other hand, also includes indirect emissions and, therefore, all **emissions throughout a product's entire value chain.** Another option would be to include the direct emissions and the primary indirect emissions from the use of energy but not the other indirect emissions (Dröge and Fischer, 2020). Depending on the objective in the individual case, a different definition of the product emissions may be optimal. In the case of the EU's border tax adjustment mechanism, for example, the latter definition would be relevant because, for many industries, it corresponds to most of the emissions covered by the EU's emission trading scheme. There is, however, a risk of creative accounting and process management. This can lead to a situation where a certain process is accounted for in the certification procedure and the associated carbon emissions for the product are published accordingly. For the actual operations, however, the relevant production facilities might then be run in a more emission-intensive way, resulting in much higher real emissions than those accounted for during the certification process. In addition to certifying these production facilities it would therefore be necessary to conduct regular checks when the facilities are in full operation. Moreover, renewable electricity might be deliberately attributed to those goods that have to provide proof of their carbon footprint for exports to a region that has a border tax adjustment mechanism (Peterson, 2021). This can create problems such as resource shuffling ↘ GLOSSARY (Caron et al., 2015; Fowlie et al., 2021).

Deciding which emissions are included has a significant impact on the **complexity of measurement** and, consequently, on the cost of implementation. Even direct emissions pose considerable challenges because the carbon emissions are determined not just by the type of product but also by the production process (GCEE Special Report 2019 item 180). In order to capture all indirect emissions from individual products, it would be necessary to make the supply chains completely – i.e. including the emissions for all individual activities – transparent and verifiable (Garnadt et al., 2020).

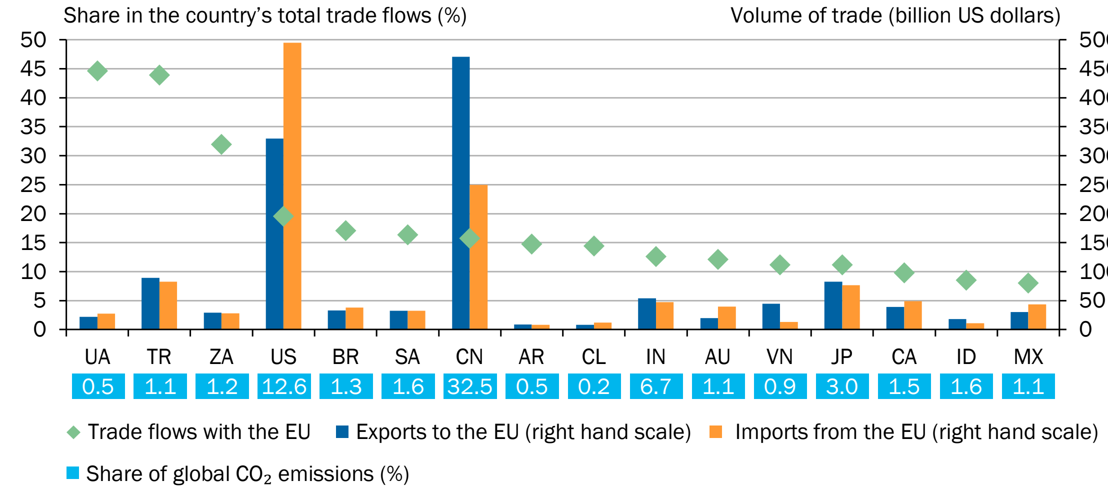
The credibility of the measurement system requires **standardised certifications and testing procedures** which can, however, impose considerable costs on firms. This is likely to mean that the emission-relevant information for many internationally traded goods will not be fully available. Product-specific greenhouse gas emissions in these cases will need to be **approximated using alternative methods.** This would make it possible, for example, to use input-output tables to calculate the average emissions specific to the sector concerned for individual countries and regions (Garnadt et al., 2020). These could then be used as a benchmark for the products in the sector concerned, irrespective of how the emissions are distributed within the sector in the country or region concerned. If production involves lower emissions, firms should be allowed to provide evidence of this and assert their claim accordingly. The European Commission included analogous provisions in its draft for the planned carbon border adjustment mechanism (2021b). Approaches which rely on benchmarks can, however, weaken the incentives for firms to cut emissions. Firms have no incentive to introduce incremental innovation particularly if their process emissions are far in excess of the standard values.

578. As part of its new trade strategy, the EU is looking to reform the WTO (European Commission, 2021c). In order to achieve this objective, the **EU could use its role in global trade and exert influence internationally**. The EU is one of the main trading partners for the countries that account for a large proportion of global greenhouse gas emissions. ↘ CHART 144 The EU, for example, is the most important trading partner for the United States and the second most important trading partner for China. Further strengthening the European single market by, for example, completing the capital markets union ↘ ITEMS 542 FF. and the digital single market ↘ ITEM 498 would enhance the EU's significance as a market and, consequently, further improve its negotiating position. As the size of the European market and production location increases, access to it is likely to become increasingly important for countries such as the US and China.

579. Many other countries have also recognised the vital role that the WTO plays in climate protection. 50 WTO member states – including the EU member states and the United Kingdom – have launched the Trade and Environmental Sustainability Structured Discussions initiative, under which they are attempting to align the WTO's work with the objectives of environmental and, especially, climate protection (WTO, 2020, 2021b). The G7 has also identified trade reforms – including reform of the WTO – as one of the top priorities (G7, 2021b). It is unclear, however, how realistic it is to reform the WTO. Given its large membership and the highly divergent interests of its member states, **cooperation within the WTO has proved to be increasingly difficult over the past two decades** (Hoekman, 2019). The latest major attempt to **align trade with environmental protection has been stalling** ever since the Doha round of WTO negotiations launched back in 2001 (de Melo and Solleder, 2019). Even the negotiations on an Environmental Goods Agreement being conducted by the EU, the US, China and 14 other WTO members since July 2014 have achieved little progress. Given this situation, a sensible short-term strategy might be to focus specifically on effective climate policy reforms that can be implemented owing to their broad-based support in the WTO. There are signs, for example, that it might be possible to reach agreement on cutting the subsidies given to deep-sea fishing using bottom trawl nets which, through stirring up sediment containing CO2, is responsible for more carbon emissions than the Japanese economy (Sala et al., 2018, 2021; Pike, 2021).

580. In summary, it is clear that a **reform of** the international trading system within the framework of **the WTO** that would have a positive impact on climate protection efforts **is proving difficult**. The multilateral negotiations on emissions reductions and on mechanisms for spreading climate-friendly technology are also facing major challenges. ↘ ITEM 556 Consequently, there is currently an increasing

↘ CHART 144
Importance of trade with the EU28 for selected economies in 2019[1]



1 – In 2019, total exports to the EU amounted to 2,301.9 billion US dollars, while total imports from the EU came to 2,279.5 billion US dollars. UA-Ukraine, TR-Turkey, ZA-South Africa, US-United States, BR-Brazil, SA-Saudi Arabia, CN-China, AR-Argentina, CL-Chile, IN-India, AU-Australia, VN-Vietnam, JP-Japan, CA-Canada, ID-Indonesia, MX-Mexico.

Sources: Comtrade Database (United Nations), European Commission, own calculations focus on bilateral and plurilateral opportunities for coordinating climate policy available to Germany and the EU.

IV. BILATERAL AND PLURILATERAL WAYS OF CONDUCTING CLIMATE POLICY

581. Multilateral climate negotiations pose a challenge because of the wide diversity of countries involved – especially the substantial differences in terms of the risks and opportunities of climate policy ↘ ITEMS 511 FF. – and the resulting differences in the negotiating positions taken. This **heterogeneity makes it more difficult to reach agreement** in negotiations within the framework of multilateral organisations such as the UN and the WTO. ↘ ITEMS 554 FF.

Cooperation between smaller groups of countries may be easier, especially if the parties negotiating with each other have similar preferences and complementary interests. **Bilateral and plurilateral collaborations** are therefore likely to offer a much **greater chance of reaching agreement**. ↘ BACKGROUND INFO 12 Although cooperation between just a few countries **tends to be less efficient** than multilateral collaboration, it nonetheless offers many opportunities and should be seen as complementing multilateral efforts.

582. Stronger coordination in small groups could make **national climate policy more effective** by, for example, creating additional climate protection incentives, which can arise for non-collaborating countries as a result of plurilateral approaches. ↘ ITEMS 585 FF. Moreover, smaller groups of countries entering such cooperations could **act as a role model** for other countries by demonstrating how climate policy can be successfully aligned with trade. And, last but not least, environmentally friendly **technologies** could be **scaled up** more quickly if a joint effort is made to improve the framework within which they are used and if new technology collaborations are initiated. This might lower the cost of transformation for the international community. The EU has participated in various plurilateral climate protection initiatives in the past.

1. Bilateral partnerships

583. **Bilateral partnerships** constitute a key **pillar of international cooperation on climate protection** and often form the basis for financial and technological transfers to developing countries and emerging economies. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), for example, helps countries to meet their NDCs and provides support with the financing of climate measures (GIZ, 2021). Germany's KfW and its subsidiaries finance and insure various projects in developing countries and emerging economies and provide investment advice (KfW, 2021), while the German Chambers of Commerce Abroad help firms outside Germany to organise and implement their projects (DIHK, 2020).

584. In future there will be opportunities for **partnerships on climate-relevant technologies** that could simultaneously benefit the EU as well as developing countries and emerging economies. Such partnerships can be especially beneficial for the generation and supply of energy. Although the European Commission expects (2018a) Europe's total energy demand to fall by roughly 30 per cent by 2050 compared with 2016, the energy sources used to meet this demand will change significantly. Consumption of electricity and synthetic energy carriers such as hydrogen and synthetic fuels will grow particularly. It might be cost-effective to meet a large proportion of future energy demand using energy carriers that are produced in third countries and then imported to Europe. There are already signs of such developments in the case of hydrogen, for example (Runge et al., 2020; NWR, 2021; Wietschel et al., 2021). ↘ ITEMS 547 FF.

585. It is important to **lay the technical foundations for the new energy imports already today**. This can be done, among others, by initiating the production and transportation of the necessary energy carriers in the target country and identifying customers in the EU. The technical foundations for the energy imports can also be strengthened through correcting market failures by, for example, solving the problem of network externalities arising in connection with infrastructure (Greaker and Heggedal, 2010; Currarini et al., 2016), removing information asymmetries (Ulph and Ulph, 2007), and preventing coordination failures (Mielke and Steudle, 2018). The German projects HY Supply (acatech, 2021) and H2 Global (2021) are currently preparing the ground to launch their first partnerships in international hydrogen trading.

Support provided to partner countries to help them remove potential regulatory inefficiencies and construct the necessary policy framework ↘ ITEM 569 will bring further improvements. Since German companies are in a good position to develop and produce capital goods for the exploration of the new energy sources, there are **opportunities** for them **to export technology** ↘ ITEMS 538 FF.. In addition, the partnerships allow to test and scale different technologies for the global transport of renewable energy carriers. This should open up new growth opportunities in the target countries and facilitate their transition towards carbon neutrality, while the EU could **diversify its energy imports**.

586. **The inclusion of** today's **exporters of fossil fuels in the global transformation** ↘ ITEMS 530 FF. increases the chances of success for multilateral climate protection (Lazarus and van Asselt, 2018), as it could be more successful in preventing or mitigating carbon leakage ↘ BACKGROUND INFO 13. In particular, it might be helpful to include these countries in new energy partnerships based on cooperations on blue hydrogen (Grimm, 2021a). ↘ ITEMS 547 FF. Such partnerships could show these exporters new business opportunities at an early stage of the transformation, making the transformation more attractive for them. ↘ BOX 31 The EU and Germany could additionally promote climate protection if they link the technology partnerships to a (gradual) phase-out of climate-damaging activities. Especially in negotiations with Russia, the prospect of these new business areas and export potentials could help to involve the country more strongly in the transformation towards climate neutrality (Grimm, 2021a; Grimm and Westphal, 2021a).

587. The **transition from blue to green hydrogen** can be facilitated through co-operation on the expansion of renewable energies and electrolysis infrastructure. ↘ BOX 31 In these hydrogen transition scenarios, it is crucial to closely monitor that emissions are avoided as much as possible. The use of renewables as an energy source for carbon capture (CCS or CCU), the certification of plants, and effective monitoring of emission intensity along the entire supply chains would be crucial in such an approach to ensure that the partnerships contribute to climate protection as early as possible (Bauer et al., 2021; Grimm, 2021a). If outdated infrastructure is used, leakage during transport is not prevented, or fossil fuels are used for carbon capture (CCS or CCU), then associated greenhouse gas emissions could be very high (Bauer et al., 2021; Howarth and Jacobson, 2021).

↘ TABLE 27

Overview of German energy partnerships and dialogues as well as their focal topics

	Type[1]	Launch year	Selected focal topics[2]				
			General or sector-specific energy efficiency	Expansion or integration of renewable energy	Hydrogen, Power-to-X and power fuels	Future of fossil fuels and nuclear energy	Energy storage and flexibilisation
Algeria	Partnership	2015	X	X			
Australia	Partnership	2017	X	X	X		
Brazil	Partnership	2017	X	X			
Chile	Partnership	2019	X	X	X	X	
China	Partnership	2007	X	X	X		
India	Dialogue	2006	X	X			X
Iran	Dialogue	2018	X	X			
Japan	Partnership	2019	X	X	X		
Jordan	Partnership	2019	X	X			
Canada	Partnership	2021	X	X	X		
Kazakhstan	Dialogue	2012	X				
Morocco	Partnership	2012	X		X		
Mexico	Partnership	2016	X	X		X	
South Korea	Partnership	2019	X	X	X	X	X
Russia	Dialogue	2010	X	X	X		
South Africa	Partnership	2013	X		X	X	
Tunisia	Partnership	2012	X	X			
Turkey	Dialogue	2012	X	X			X
Ukraine	Partnership	2020	X	X		X	
United States	Dialogue	2019	X	X	X		X
UAE[3]	Partnership	2017	X	X	X		X

1 – Unlike energy dialogues, energy partnerships require a declaration of intent to be signed by both parties. 2 – Topics discussed only in individual partnerships or dialogues have been omitted here. These include digitalisation, raw materials, cyber security, economic cooperation and electric mobility. 3 – United Arab Emirates

Sources: BMWi (2020, 2021), own presentation

588. A number of bilateral technology partnerships already exist. Germany, for example, maintained **energy partnerships and dialogues** with more than 20 countries worldwide in 2019 (BMWi, 2020). ↘ TABLE 27 However, further initiatives in certain areas such as green hydrogen are planned (Jensterle et al., 2019). Germany, for example, plans to invest up to 40 million euros in a partnership with Namibia (BMBF, 2021).

2. International investment agreements

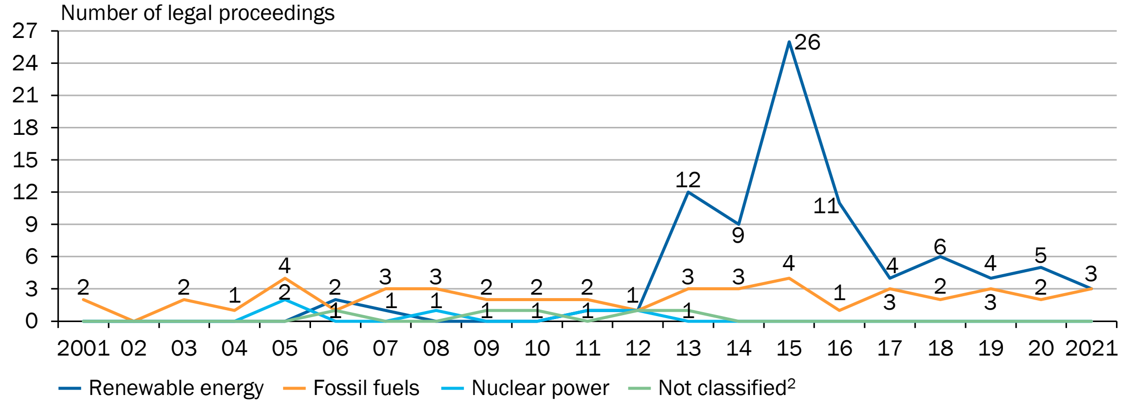
589. Investment is essential to achieve climate policy targets and objectives as carbon neutrality will involve a comprehensive technological transition – especially in the energy sector – and this transition will require significant amount of investment. ↘ TABLE 24 Some of it will have to be provided in the form of **cross-border private investment**. Mobilising these funds will require a stable investment environment in the host country which, above all, limits the political risk (Busse and Hefeker, 2007). The **hold-up problem** can lead to inefficiently low levels of investment: If firms fear the introduction of measures that could reduce the value of investments retrospectively – owing to stricter climate protection regulations, for example – then investment might fail to materialize.

590. **International investment agreements** can help to **create a stable investment environment**. These are international treaties that guarantee protection for investors from a signatory country if they make investments in in other countries party to the agreement. The EU has been responsible for new investment protection agreements since the Treaty of Lisbon came into force in December 2009. The German Council of Economic Experts has commissioned an expert report examining what implications these agreements have for climate protection (Gundel, 2021). The fair and equitable treatment standard imposed by these agreements is designed to prevent foreign firms from being nationalised without receiving compensation or from being subjected to any indirect or de-facto expropriation (Gundel, 2021). If the rules stipulated in the investment agreements are breached, the appropriate compensation for investors is decided through international arbitration.

591. Investment protection agreements can mitigate the hold-up problem (Ossa et al., 2020; Horn and Tangerås, 2021) and have a positive impact on cross-border investment flows (Neumayer and Spess, 2005; Tobin and Rose-Ackerman, 2011; Egger and Merlo, 2012; Berger et al., 2013). Almost 3,000 **bilateral investment protection agreements** have been signed worldwide (OECD, 2016b). Although plurilateral investment protection agreements are also possible in principle, they occur only very rarely. For energy policy, one plurilateral investment agreement is of particular importance – the **Energy Charter Treaty** (ECT) from 1994. There are 54 parties to this treaty.

592. Through their positive impact on cross-border investment flows, **investment protection agreements** can help to mobilise the capital needed for climate-friendly investments. ↘ ITEM 567 The agreements are already relevant **for climate-friendly investment** and are often used to protect it. The lawsuits filed under

↘ CHART 145
Lawsuits[1] under the Energy Charter Treaty by energy source



1 – 142 legal proceedings, 55 of which are pending. 2 – It was not possible to identify the energy source.

Source: Energy Charter Secretariat

the ECT over the past ten years, for example, have mainly related to investments in renewable energy. ↘ CHART 145 A large proportion of these lawsuits have been filed in Spain within the context of changes to the feed-in tariffs. The Czech Republic, Italy, Bulgaria and a few other countries – including some outside the EU – have also faced lawsuits filed by investors in connection with renewables.

593. **Climate protection measures** can **significantly reduce** the **value** of **investments** that have already been conducted. Within the context of climate policy there are thus fears that international investment agreements can give rise to **obligations to compensate** foreign investors – especially for past investments in fossil fuels. This compensation risk is sometimes perceived as an **undesirable factor driving up the cost** of climate protection measures (Tienhaara and Cotula, 2020) and **restricting the contracting states' political freedom of action** (Gundel, 2021). Moreover, some observers fear a regulatory chill effect on climate policy (Janeba, 2019) and on decision-makers' willingness to pass or implement the necessary climate regulation. Consequently, there are growing calls for these agreements to be modernised or even terminated – especially in the case of the ECT (European and National Parliaments Members, 2020; Civil Society Organisations, 2021).

594. It is currently uncertain whether and, if so, to what extent obligations to pay compensation for existing investments might arise as a result of planned climate policies. **Investment protection agreements do not entitle investors to a legal framework that remains unchanged over time**. This implies that new regulations are not banned per se (Gundel, 2021). Rather, such agreements aim to prevent situations of evident regulatory arbitrariness, deliberate discrimination or abusive treatment of investors (Gundel, 2021). **Most climate protection measures** are likely to be **unproblematic** in this respect. Brower and Schill (2009) also point out the existence of control mechanisms that ensure arbitrators' impartiality during arbitration proceedings. Analysis of rulings by courts of arbitration suggests that their decisions have not systematically favoured one side or the other (Franck, 2007; Coop, 2014; Nunnenkamp, 2017; Gundel,

2021). In such circumstances, the rulings handed down as a result of arbitration proceedings would generally be expected to be fair-minded – also in the case of climate protection measures. On the other hand, the protection standards imposed by investment agreements are highly abstract concepts that rely on value judgements. The outcome of their application is not easy to predict in individual cases (Gundel, 2021).

One particular concern is that individual climate protection measures could potentially be classified as expropriation. It is also highly uncertain which of the measures might prove to be problematic because so far there have been **no rulings on climate protection in investor-state arbitration**. Although such lawsuits have been filed in the past, they have not yet resulted in any decisions. Rulings have not yet been released, for example, in the lawsuit filed by UK firm Rockhopper against Italy or in the lawsuit filed by German company RWE against the Netherlands. In other cases, the parties concerned have reached a compromise agreement, as in the lawsuit filed by Swedish firm Vattenfall against Germany. We have therefore yet to see an arbitration court ruling that interprets the rights and obligations arising from investment protection agreements in the context of climate protection.

595. A unilateral termination of investment protection agreements, as discussed in some quarters (Bernasconi-Osterwalder et al., 2021; Euractiv, 2021a), is likely to be problematic in two respects. Firstly, the resulting removal of legal certainty around the regulatory framework is likely to hinder new investment in climate-friendly technologies. ↘ ITEM 592 And, secondly, any **termination of investment protection agreements** will not remove the protection for already existing investments. This is because these agreements contain clauses which, if an agreement is unilaterally terminated, stipulate that existing investments continue to be protected for a period of between ten and 20 years in most cases (sunset clauses). In the case of the ECT, this protection lasts for 20 years. Consequently, termination cannot prevent potential investment protection lawsuits arising from existing investments in fossil-fuel technology.

596. Companies can start successful investment treaty disputes only if new draft legislation or regulations affect the profitability of their existing investments. The **law applicable at the time the investments were made** is **authoritative**. This can include political plans which, although they have not yet been legally implemented, have already been credibly announced. The decisive factor in compensation claims is that firms have been unable to factor such regulations into their profitability calculations. This implies that the possibility of successful investment protection lawsuits is especially relevant in the case of existing investments in technology based on fossil fuels. ↘ ITEM 595

597. Whether future climate protection measures could lead to compensation payments arising from investment protection agreements for existing investments and investments made over the coming years depends on how these **measures are structured** and whether they **are consistent with what an investor can expect** at the time the investment decision is made. If, for example, investors are contractually guaranteed rights – possibly in the form of licensing agreements

– so that they can expect their business models to be permissible from a regulatory perspective, then new climate protection measures that exclude these investors from the market might be viewed critically with respect to investment protection. Other concrete declarations made to investors can also reinforce this protection. Short notice changes in government policy that impair the value of existing investments before they have been fully depreciated are generally more susceptible to lawsuits (Gundel, 2021).

598. **Transitional periods** for climate protection measures are likely to mitigate the risk of successful lawsuits (Gundel, 2021) because the early announcement of measures **reduces the problem of stranded assets**. Many assets have an expected useful life of between 30 and 60 years (Cui et al., 2019; IEA, 2020b). National climate policy and international cooperation are therefore more efficient if they create a clear, long-term policy framework consisting of concrete measures that are predictable for investors. In this respect, for example, it might be beneficial to make an early announcement of the NDCs and the measures planned to achieve the relevant targets. Even the fact that an investment is made at a time when the instability of the legal framework is foreseeable can reduce the potential compensation amounts (Gundel, 2021). Moreover, compensation is unlikely to be paid for **taxation measures** because these are usually omitted from investment protection agreements (Gundel, 2021). For this reason, for example, emissions taxes will probably not be affected by investment protection lawsuits. Generally speaking, the use of market-based instruments instead of regulatory measures is also likely to reduce the probability of investment protection lawsuits being successful.

When new national climate measures are being designed, they should take into consideration the **possibility of compensations** and these considerations should **form part of the cost-benefit analysis** of individual measures.

599. The **modernisation of investment treaties** has also been discussed (European and National Parliaments Members, 2020) in addition to their termination. Unlike the unilateral termination of an agreement, its modernisation can also apply to existing investments if all parties agree to this.

The **EU** has submitted a **proposal for changes to the ECT** which, among other things, narrows the definition of expropriation, highlights governments' right to environmental regulation, and excludes some fossil-fuel technologies from protection in future (European Commission, 2021d). It is unclear, however, whether such modernisation would increase welfare. **Changing the protection offered to specific technologies** could **damage investors' trust in the entire agreement**, thereby delaying the necessary climate-friendly investment. Defining fossil-fuel industries is also difficult given that technologies such as blue hydrogen which, although based on fossil fuels, can nonetheless help to achieve the climate targets. ↘ BOX 31 The EU is trying to allow such technology during the transition to carbon neutrality (European Union, 2020), but it is unclear whether the exceptions granted have not been too narrowly constrained time-wise. Since modernisation requires the agreement of all contracting states, however (Gundel, 2021), the ECT is fairly unlikely to be reformed at the moment (Euractiv, 2021b).

600. Most of the investments protected by the ECT have been made within the EU. The highest risk of a lawsuit is therefore here. The European Court of Justice (ECJ) recently ruled that the arbitration clause in the ECT does not apply to **intra-EU disputes** (ECJ, 2021). The reason given for this ruling is that arbitration court proceedings initiated against EU member states by companies based in the EU are not compatible with the European legal system. While this ECJ ruling will be binding within the EU legal system, European companies will probably still be able under international law to initiate arbitration proceedings against EU member states. It is therefore not certain that the courts of arbitration will adopt the ECJ's new interpretation (Gundel, 2021).

601. In this connection there are also discussions about the option of **suspending the ECT between the EU member states** (Bernasconi-Osterwalder et al., 2021). This would be possible in the case of bilateral agreements and would prevent the survival clause from coming into force. ↘ ITEM 595 According to Article 16 of the ECT, however, agreements between individual contracting states are problematic if they reduce investment protection (Gundel, 2021). Given the important role that the ECT plays in mobilising green investment, suspending this treaty would not appear to be a sensible course of action in any case.

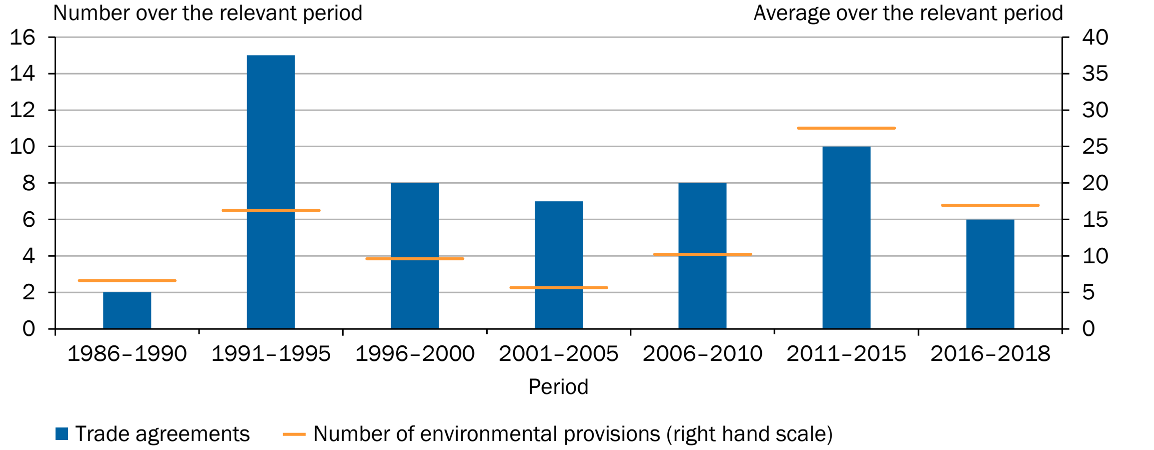
3. Trade agreements

602. Whereas climate-related reforms at the WTO have stalled, ↘ ITEM 579 in the EU there is a discernible trend towards considering environmental policy issues, including climate issues, when drafting bilateral and plurilateral trade agreements. ↘ CHART 146 In addition to provisions on trade relations, **trade agreements** signed over the past three decades have **increasingly** included provisions on **other areas** such as public procurement, human rights, capital flows, and environmental protection (Rodrik, 2018). This trend is likely to intensify in future because the EU has stated its intention that its trade policy will **support the Green Deal** and help to achieve carbon neutrality (European Commission, 2021c).

Trade agreements signed **outside the EU** are also increasingly including provisions on environmental protection. For example, the United States Mexico Canada Agreement – the successor to NAFTA – contains an entire chapter that specifies the numerous environmental obligations incumbent on the contracting states (Laurens et al., 2019).

603. **Trade agreements** offer a **wide range of options** in terms of their legal content. As long as they do not contravene other international rules – such as the WTO's – the parties negotiating the agreement are free to decide what subject areas it addresses and how (Australian Government, 2005). The climate clauses included in trade agreements in the past often related to ratification of, and compliance with, international climate agreements (European Union et al., 2012, 2018; European Union and Central America, 2012). They also created dialogues and collaborations on climate protection, for example in the form of joint research and information sharing in the field of clean technologies. More complex provisions are occasionally included as well. In 2018, for example, Switzerland,

↘ CHART 146
Significance of environmental provisions in EU trade agreements



Sources: TREND Analytics, own calculations

Liechtenstein, Norway and Iceland signed a trade agreement with Indonesia that conditioned lowering of tariffs on palm oil on observance of certain sustainability standards (Switzerland's State Secretariat for Economic Affairs [SECO], 2020).

In addition, there are currently discussions about including **specific emission mitigation targets in trade agreements**, stipulating a **minimum carbon price**, specifying maximum deforestation rates, and coupling the tariff rates for individual products to their carbon footprint (Lawrence and Ankersmit, 2019; Cross, 2020). ↘ BOX 32 Harstad (2020) proposes a mechanism under which the terms and provisions specified in trade agreements are made conditional on the state of forests in the partner countries, and he shows that such a mechanism reduces the deforestation rate.

604. The empirical literature shows that environmental protection provisions in trade agreements can lead to better environmental protection in the partner countries concerned (Baghdadi et al., 2013; Zhou et al., 2017; Morin and Jinnah, 2018; Brandi et al., 2020). However, the provisions that the EU has included in trade agreements to date are often judged by economic and legal studies to be **ineffective in their impact** (Baghdadi et al., 2013; Hradilová and Svoboda, 2018; Bronckers and Gruni, 2021; Heyl et al., 2021). Part of this is likely driven by the design of these clauses: it is often the case that the clauses are a mere **declaration of intent** and include no concrete targets (van 't Wout, 2021). In most cases, moreover, no effective implementation mechanism is provided for these clauses. This means, for example, that potential **disputes about non-compliance with environmental protection provisions** are generally not covered by the usual arbitration mechanism for trade disputes but, rather, are governed by a separate mechanism under which a panel of experts can merely make recommendations but **cannot impose any sanctions** (Duong, 2021).

605. The fact that environmental and climate protection provisions in trade agreements are not linked to sanctions might change in the future because the EU intends to include **compliance with the Paris Agreement** as an **integral part**

of future trade agreements. If the EU then reckons that the partner country is not meeting its NDCs, this might cause the agreement to be suspended (Hoffmann and Krajewski, 2021). Such an approach does, however, involve risks. One factor to consider here is that the current NDCs are not sufficient to limit global warming in line with the target set by the Paris Agreement. ↘ ITEM 556 Any expectation of sanctions in trade agreements is likely to reduce countries' incentive to submit more ambitious NDCs. Moreover, such an approach **does not allow for any gradation of sanctions**. The full suspension of any trade agreement is politically highly unlikely, which severely limits the effectiveness of this approach (Hoffmann and Krajewski, 2021).

606. It is often suggested that the effectiveness of climate protection clauses in trade agreements should be enhanced by, for example, **giving them legal parity with the original trade clauses** (Bronckers and Gruni, 2021). This approach has been adopted by the United States, for example, in the recently negotiated trade agreements, such that preferential access to the US market gets restricted in the event that the relevant environmental protection clauses are not complied with (Bastiaens and Postnikov, 2017). Giving other clauses legal parity with the original trade clauses is, in some cases, likely to be detrimental to the primary objective of trade agreements, i.e. trade liberalisation. If this were the case, a better course of action might be to include climate clauses in separate agreements.

607. On the other hand, negotiations on trade agreements can fail if – from the perspective of individual parties – environmental impacts are not addressed satisfactorily. Such concerns were voiced, for example, during the ratification process for the EU-Mercosur trade agreement (Ambec et al., 2020; Imazon, 2020; BUND, 2021). There were fears that growing European demand for South American agricultural produce such as beef and soya as a result of the agreement, coupled with the less stringent environmental protection regulations in South America, would cause greater deforestation. This, in turn, by suppressing natural absorption of greenhouse gases by the rain forests, would rise greenhouse gas emissions. The **dismantling of trade barriers** could therefore have the **undesirable side-effect of boosting greenhouse gas emissions** and increasing carbon leakage. ↘ ITEM 574 Countries such as the Netherlands and France cited these potential environmental impacts as one of the reasons for rejecting this agreement (Euractiv, 2020). Although the inclusion of environmental and climate protection in trade agreements can therefore hamper negotiations and make it more difficult to implement agreements, their omission can sometimes cause negotiations to fail.

608. Trade agreements that fail to take sufficient account of climate protection might **restrict** the signatory countries' future **regulatory freedom**. This could be the case if a lawsuit is filed against a signatory country's unilateral climate measures as part of arbitration proceedings and these measures are classified as distorting trade (Economist Intelligence Unit [EIU], 2019). In the past, however, only a small number of such lawsuits have been filed.

609. Even if climate protection provisions could be optimally designed, trade agreements are not a broadly applicable climate policy instrument. Trade agreement

negotiations and their **ratification** can take **decades**. Negotiations on Mercosur, for example, were conducted over the period from 2000 to 2020, but this agreement has still not been ratified. ↘ ITEM 607 Although the inclusion of climate protection clauses might make negotiations even more difficult owing to the greater complexity involved, ↘ ITEM 610 it is likely to be unavoidable given the concerns of some negotiating partners. ↘ ITEM 607

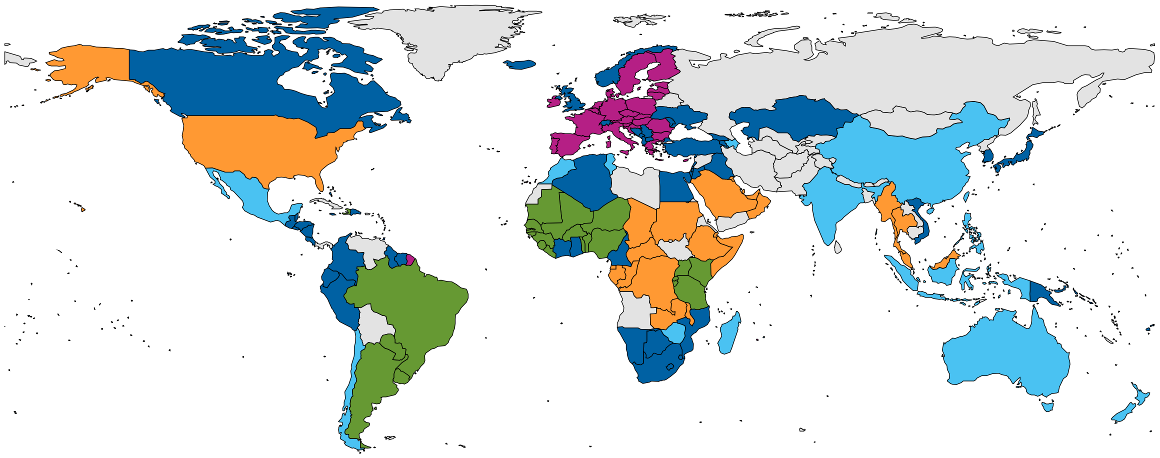
610. In summary, there are a number of interdependencies between trade policy and climate policy, which require the resulting impacts to be carefully analysed in each individual case. While climate protection provisions may have the potential to cut global greenhouse gas emissions, **all welfare effects should be considered** when such clauses are being included and designed as part of trade agreements. The primary objective of trade agreements is to increase partner countries' prosperity by dismantling trade barriers. ↘ ITEM 574 The inclusion of **climate protection provisions** and associated sanction mechanisms might **limit the positive effects of trade liberalisation**.

Moreover, **climate protection provisions could create additional costs** making it less appealing for partner countries to sign trade deals, and thereby decreasing the likelihood of such agreements. Some partner countries, on the other hand, might make the **ratification** of such deals **conditional on** the inclusion of climate protection provisions. ↘ ITEM 607 It is therefore important to evaluate in each case what provisions can alleviate the countries' climate concerns.

611. In order to mitigate the impact of obstacles arising from the interdependencies between trade policy and climate policy concerns, the EU could press ahead with forward-looking climate policy initiatives ↘ ITEMS 583 FF. in places where there are already concrete plans or even negotiations under way to dismantle trade barriers. Negotiations with developing countries in particular could couple climate policy measures with **additional climate finance** or **technology transfer mechanisms**. ↘ ITEMS 583 FF. These transfers could be used to help partner countries to implement climate-related clauses which, at the same time, would make ratification of the agreement appealing to other parties that had specific preferences in respect of climate protection provisions.

612. Trade agreements typically take a long time to negotiate but progress on climate cooperation is urgently needed. Therefore, the incorporation of enhanced climate protection clauses would be worth considering for trade agreements on which **negotiations** are already **well advanced** and for those for which a modernisation– in other words a **renewal involving potential changes** to some clauses – is being negotiated. ↘ CHART 147 This would apply, for example, to the ongoing negotiations with Australia and Indonesia, in which climate protection provisions – such as in the form of clauses concerning the phasing-out of fossil-fuel subsidies – might play a role. Climate protection clauses could also be relevant in the recently resumed negotiations on the trade agreement with India.

↘ CHART 147
Active trade agreements and ongoing negotiations with the EU



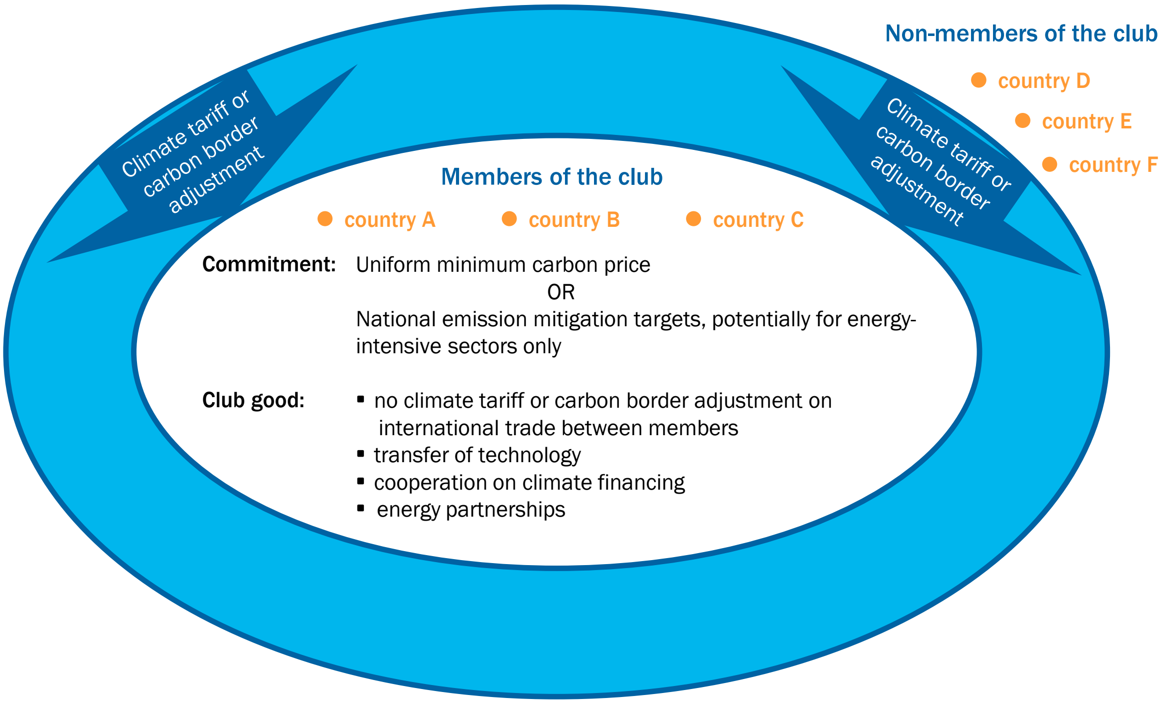
EU member states
Actively negotiating a new agreement or the modernisation of an existing agreement
Active agreements with the EU
Agreements negotiated but not yet in force
Negotiations on agreements paused
No agreement

Sources: EuroGeographics for the administrative boundaries, European Commission

4. Climate club

613. The formation of a **climate club** has been repeatedly discussed as an option for plurilateral coordination (Weischer et al., 2012; Nordhaus, 2015, 2021; German government, 2021; German Council for Sustainable Development (RNE) and Leopoldina, 2021, p. 16; Board of Academic Advisors at the BMWi, 2021; GCEE Special Report 2019 item 43; GCEE Annual Report 2020 item 432). ↘ CHART 148 A climate club comprises countries that have come together to agree on climate protection targets or measures in each of these countries. ↘ ITEMS 614 FF. In addition, a club good is provided and acts as an incentive for non-members to join the club and for members not to leave. ↘ ITEMS 620 FF. The coordination of climate protection measures can mitigate the challenges of **carbon leakage** ↘ BACKGROUND INFO 13 and **competition distortion** – an effect that increases as the club becomes larger. This reduces the cost of climate protection for members (Board of Academic Advisors at the BMWi, 2021). At the same time, the club enables green technologies to be scaled up more quickly, thereby lowering the global cost of transformation. ↘ ITEMS 537 FF. Moreover, the credible coordination approach used could mobilise additional investment as it provides greater planning certainty for firms. ↘ ITEM 567 And, finally, the possibility of joining the club creates climate protection incentives for countries that would otherwise pursue less ambitious climate policies. Through these mechanisms, the climate club might increase the future NDCs.

↘ CHART 148
Potential structural organisation of a climate club



Source: own illustration

Ways of coordinating climate policy

614. The key element of cooperation in the climate club could be **coordination of carbon pricing**. This could take the form of either price regulation (jointly agreed carbon price) or quantity regulation (joint emissions trading). Both options would, in principle, allow the EU, as part of a climate club, to retain its emissions trading scheme (EU ETS) and to extend it to all sectors in future. Price regulation – for example in the form of a **minimum carbon price** – would, however, be administratively easier to implement within a climate club (Parry et al., 2021) and would provide market actors with greater planning certainty in terms of pricing (Nordhaus, 2015). Moreover, it would only be necessary to negotiate one dimension (price) whereas, with emissions trading, it would first be necessary to negotiate the total quantity of emission allowances permitted and then to negotiate how these emission allowances should be allocated among the club members (Gollier and Tirole, 2015; Weitzmann, 2017; Hovi et al., 2019; Nordhaus, 2019; Pihl, 2020). Schmidt and Ockenfels (2021) use an experimentally validated game theorical analysis to show that negotiations on a uniform obligation (such as a uniform carbon price) cause all parties involved to make greater climate policy efforts than negotiations on individualised obligations such as NDCs.

615. Coordination on carbon pricing is especially likely among those countries that are already using pricing systems as a climate policy instrument. Although the superiority of carbon pricing as a climate policy measure has been pointed out across national borders and academic disciplines (Bureau et al., 2019; Econstatement, 2019; Leopoldina et al., 2019; German Energy Transition Commission [EWK],

2021; GCEE Annual Report 2019 items 107 ff.; GCEE Annual Report 2020 items 372 ff.), **only 21.5 per cent of global greenhouse gas emissions** are currently **covered by a pricing system** (World Bank, 2021b). In addition, the established carbon price levels vary massively across countries. ↘ CHART 149 Key actors in the global market such as the United States, however, have still not introduced a carbon price at national level and currently have no plans to do so. ↘ CHART 143 Nonetheless, carbon prices do exist in individual US regions such as California and Massachusetts. ↘ CHART 149

616. There are various approaches to climate protection around the world, reflecting individual countries' differing preferences in terms of their social, industrial and climate policies. If countries' climate policies are based largely on subsidies and regulatory measures such as emission limits and technological requirements, **implicit carbon pricing** could be used to coordinate policies within the climate club. Implicit carbon pricing arises from climate policy support and regulation when these measures make emission-intensive technologies more expensive than lower-emission technologies. Environmentally harmful subsidies – such as those for fossil fuels – have the opposite effect (Peterson, 2021). ↘ ITEM 566

The challenge with implicit carbon prices is that they are **difficult to determine** and have to cover a **wide range** of measures (Cramton et al., 2017). Marcantonini and Ellermann (2015) show that there are substantial differences between the implicit carbon prices of wind and solar power even within the German Renewable Energy Sources Act (EEG). It will therefore probably be difficult to agree on one single procedure for aggregating individual implicit prices. Coordination based on implicit carbon pricing is ultimately likely to pose more problems than coordination using explicit prices.

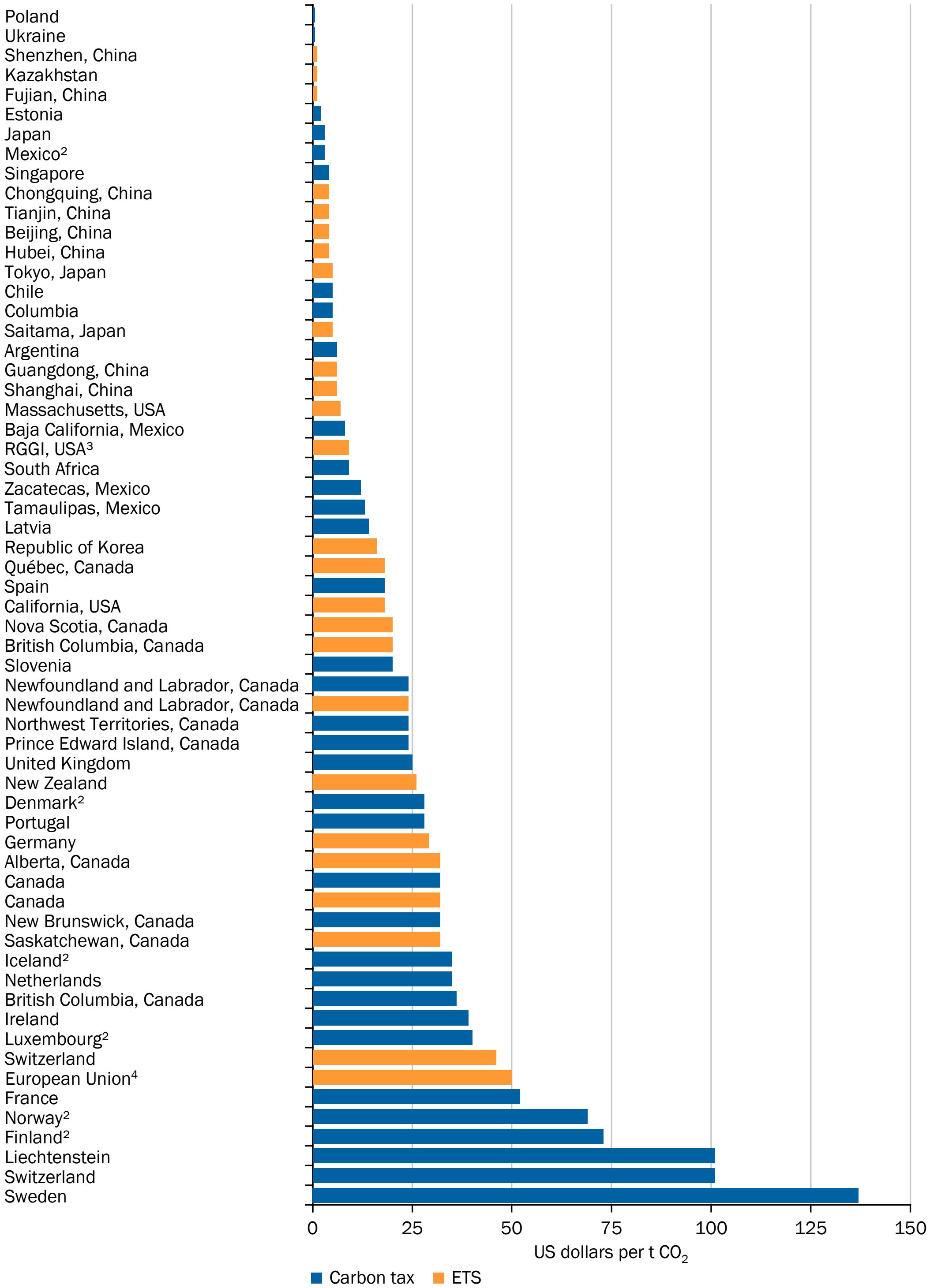
617. Although it would be possible to coordinate the non-market regulations within the climate club, this often leads to highly fragmented regulation. As with subsidies, there is thus a **significant risk** of supporting technologies that eventually fail and of penalising others that turn out to be successful. Such projects can easily be captured by **vested interests** (GCEE Annual Report 2019 items 267 ff.). Although global coordination of the non-market regulations succeeded for example under the Montreal Protocol, in cutting emissions of chlorofluorocarbons ([CFCs]; Chipperfield et al., 2015), these constituted an easily substitutable input factor in a very limited segment of the value chain.

618. **Emission mitigation targets for specific industries** could also be agreed within a climate club, which might **initially focus on individual sectors** with high emission intensities. These include industrial goods such as steel, cement and aluminium (Bardt and Kolev, 2021). The coordinated setting of targets could mitigate competition distortion and carbon leakage. At the same time, negotiations would be restricted to just a few parameters and, consequently, might have more chance of success. Unlike cross-sectoral carbon pricing, however, industry-specific targets do not ensure that emissions are mitigated where this is the most cost-effective. This can increase the overall economic cost of climate policy (GCEE Special Report 2019 item 139).

↘ CHART 149

Carbon prices vary significantly around the world

Supraregional, national and subnational carbon prices in April 2021[1]



1 – Data as at 1 April 2021. No price information is available for the Chinese, Mexican and British emissions trading schemes. Prices cannot necessarily be directly compared with each other owing to factors such as the sectors, exemptions and compensation mechanisms included. 2 – The pricing system is based on a price range. The upper limits are shown here. 3 – The Regional Greenhouse Gas Initiative (RGGI) is a cooperative, market-based effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia to cap and reduce CO_2 emissions from the power sector. 4 – The EU Emissions Trading System is applied in all member states (GCEE Special Report 2019 items 55 ff.).

Source: World Bank (2021a)

619. A climate club could also **establish international standards**. This might involve setting up a system to capture product-specific carbon footprints. ↘ BOX 32 This could facilitate the introduction of emission-dependent tariffs and simplify coordination within the club. It might also involve establishing **sustainability criteria** that introduce uniform and robust key performance indicators for corporate financial reporting purposes. ↘ ITEMS 542 AND 567

Club benefits and sanctions as incentives to join and cooperate

620. For countries for which climate protection is currently not a major political priority ↘ ITEMS 552 FF. climate protection on its own offers insufficient incentive to join a climate club. Their less ambitious climate policies cause them few competitive disadvantages, while they also benefit from the successes of the club's climate policies (**non-excludability**). Establishing a climate club therefore **requires** some form of **club good**, in other words a good from which the climate club's member countries derive benefits while non-member countries do not (**excludability**). The benefits arising from this good would therefore provide an incentive to join the club and remain a member.

621. One way of establishing such a form of club good would be to impose tariffs on imports from non-member countries (Nordhaus, 2015). Nordhaus (2015) suggests levying these **penalty tariffs** on a uniform **ad valorem** basis, especially as this would be the simplest and most transparent method. This then also broadens the base of goods on which tariffs are levied and consequently – if the tariff rate is sufficiently high – increases the benefit of belonging to the club. This would **create an incentive** for non-members to join the climate club and to comply with its climate protection provisions in order to benefit from lower trading costs within the club. As far as members are concerned, the possibility of losing the club's trading benefits upon failure to cooperate offers an incentive to continue cooperation, thereby strengthening the club's stability. The main idea of a climate club based on tariffs is thus to alter the strategic situation of all countries in such a way that they engage in climate protection out of self-interest. A climate club designed along these lines could achieve the internationally set targets in an environment of rapid technological change (Nordhaus, 2021).

From a **political** perspective, however, it will probably **not be possible to levy** penalty tariffs on an ad valorem basis. This is primarily because such tariffs would **not be compatible with currently applicable WTO law** (Board of Academic Advisors at the BMWi, 2021). In addition, ad valorem tariffs do not take account of the climate policy efforts made by non-members. Moreover, non-members might react by taking retaliatory measures. For Germany as an export-driven economy in particular this could involve a considerable loss of welfare over the medium term, especially if economically powerful countries participate in these retaliatory measures (Bardt and Kolev, 2021; Hagen and Schneider, 2021; Board of Academic Advisors at the BMWi, 2021; GCEE Annual Report 2020 items 431 f.). These costs need to be traded off against the benefits of a climate club that imposes ad valorem penalty tariffs.

Before these tariffs are introduced it would therefore be necessary to **amend WTO law** so that it allows such tariffs. Given the WTO's unanimity rule, however, this kind of reform is unlikely to be implemented. ↘ ITEMS 574 FF.

622. As an alternative to ad valorem penalty tariffs, it has been suggested that compensatory payments should be levied **based on the product-specific greenhouse gas emissions** generated by imports from non-member countries (**carbon border tax adjustment**) in order to create a level playing field between club members and countries outside the club (Tagliapietra and Wolff, 2021). However, it is challenging to calculate the greenhouse gas emissions associated with the manufacture of an individual product. ↘ BOX 32 A compensatory payment of this kind would offset the carbon price differential between the exporter outside the climate club and the importer within the climate club. Unlike ad valorem penalty tariffs, a carbon border tax adjustment is **more likely to be compatible with** existing **WTO law** (Board of Academic Advisors at the BMWi, 2021). There is thus probably less risk of retaliatory measures.

In addition to compensating for greenhouse gas emissions from imports, a carbon border tax adjustment could include a **mechanism for exports**. The cost of domestic **carbon pricing** could, for example, be **reimbursed** for exports. Although such compensation for exports could also mitigate carbon leakage as well as competition distortion caused by climate policy (Kolev et al., 2021), it is probably not compatible with WTO law (Garnadt et al., 2020; Board of Academic Advisors at the BMWi, 2021). The risk of other countries taking retaliatory measures might also be greater than if the border tax adjustment were restricted solely to imports.

623. Trading partners' responses to the current discussions within the EU about the unilateral introduction of a carbon border tax adjustment (European Commission, 2021b) suggest, however, that there might be a risk of **retaliatory measures** even if the carbon border tax adjustment were introduced at a climate club's external borders. Various trading partners (China, South Africa, India and Brazil) have, for example, criticised the implementation of border tax adjustment mechanisms by the EU as discriminatory (Republic of South Africa, 2021). A coordinated approach within a climate club would, however, provide the EU with a stronger negotiating position than it has on its own. The more members the climate club has, the less likely it is that it will suffer a significant loss of welfare as a result of trade conflicts.

624. The revenue received from the border tax adjustment could be used and distributed in various ways. If this revenue is distributed to the club's members, the **prospect of receiving such revenue** might provide an **incentive** for non-members **to join the club**.

Alternatively, this revenue could be used to prepare for – and to make it easier for – countries currently outside the climate club to join the club. These funds should be made conditional on climate policy objectives, such as helping to set up an emissions trading scheme or conducting **climate projects** in developing countries and emerging economies. This would be very similar to the suggestions to use transfers in order to facilitate and accelerate the establishment of carbon pricing around the world (Steckel et al., 2017; Edenhofer and Jakob, 2019, p. 91 f.). ↘ ITEM 566 This would enable the club to give a credible signal that the aim of the border tax adjustment is not to generate revenue. This, in turn, could reduce the likelihood of retaliatory measures. However, this also means that the club would forego a major incentive for those countries that join not for climate protection reasons but for the club good.

625. The implementation of a **carbon border tax adjustment** poses significant technical challenges. This procedure is likely to be highly **complex** and **administratively time-consuming** because the process of attributing emissions to goods might take into account not only the final stage of production but also the entire value chain. ↘ BOX 32 Any incomplete inclusion of emissions from along the value chain might cause imports to shift towards highly processed goods – and in whose final stage of production only low levels of greenhouse gases are emitted – but which use emission-intensive goods as intermediate products (Garnadt et al., 2020; Kolev et al., 2021; Stede et al., 2021). This would render climate policy efforts less effective and, at the same time, would limit the competitiveness of the club's member countries.

Several observers are in favour of introducing a carbon border tax adjustment at the climate club's external borders (Tagliapietra and Wolff, 2021; Board of Academic Advisors at the BMWi, 2021). It is **questionable** whether the **border tax adjustment alone will be a sufficient** incentive to join the club and remain a member (Nordhaus, 2015; Board of Academic Advisors at the BMWi, 2021, p. 28). Especially if the border tax adjustment is used for emission-intensive goods that are traded fairly little – such as electricity from coal-fired power stations – then such a border tax adjustment is likely to offer little incentive to join the club (Nordhaus, 2015).

626. One alternative or additional measure to take within the framework of a climate club might be to **lower existing tariffs and non-tariff trade barriers** between club members. Bardt and Kolev (2021) suggest setting up a trade club for climate (TCC), which would pursue the objectives of increasing the trading of environmental and climate-relevant goods while, at the same time, standardising the price of carbon. However, this raises the question of why these countries have not already lowered these tariffs and trade barriers as part of a trade agreement not specifically relating to the climate. As is the case with bilateral trade agreements, it might be **difficult** to reach a swift consensus on trade agreements that contain additional climate clauses. ↘ ITEMS 602 FF. On the other hand, the desire to achieve joint progress on climate protection could give impetus to the negotiations.

627. A further incentive to join a climate club could be to **collaborate on the research and development of climate-friendly technologies** (Tagliapietra and Wolff, 2021) such as green hydrogen, solid-state batteries and CCS technology. Energy partnerships – including technology transfers – are also feasible and can act as an incentive for partners to join and remain members of a climate club. ↘ ITEMS 583 FF. International synergies and economies of scale could accelerate the

development of climate-friendly technology within the framework of climate clubs (Tagliapietra and Wolff, 2021). ↘ ITEM 589

628. In addition to transferring technology, a climate club could provide **financial transfers** to members classified as **developing countries or emerging economies**. The club could adopt the same approaches here as those planned under the Paris Agreement. ↘ ITEMS 555 FF. These could focus particularly on enabling countries to implement a carbon pricing system. Over the long term the club could also introduce mechanisms that base transfers on the level of national emissions and their intensity (Cramton and Stoft, 2012; Rajan, 2021). The advantage of this approach is that it would incentivise donor and recipient countries to cut emissions.

629. If members behave in a way that is incompatible with the club's objectives, **sanctions** – such as fines or the gradual withdrawal of the club good – may be a key element in ensuring the club's stability. Such sanctions would ensure **reciprocity** (Pateete et al., 2010). ↘ ITEM 557 At the same time, however, they could increase the perceived cost of joining the club, thereby making it less likely that new members will join. Arbitration procedures, such as those used by the WTO, would also be an option.

Procedure for setting up a climate club

630. The **formation of a climate club** can either be driven by as many countries as possible right from the outset (top-down approach) – similarly to the formation of the International Monetary Fund and the WTO – or it can be initially launched by a smaller group of ambitious countries (bottom-up approach). The **advantage of a top-down approach** would be that a large club with many members offers a significant benefit to its members because this **increases the value of the club good**. Moreover, Hagen and Schneider (2021) conclude that sanctions (such as penalty tariffs) only offer an incentive to join the club if the club is already sufficiently large.

631. A **bottom-up approach** – such as that favoured by Hovi et al. (2019), Pihl (2020), and Bardt and Kolev (2021) – has the advantage that a small group of a few ambitious countries can **negotiate more quickly and efficiently** so that they can agree on the club's exact design. It would presumably also be easier in a small group to implement rules, controls and sanctions. A climate club can be successful with just a few member countries if they have a large economic output (Farrokhi and Lashkaripour, 2021). If a bottom-up approach is chosen, the objective must still be to offer effective incentives for further countries to join so that the club grows and global emissions are ultimately cut effectively. This would, in turn, strengthen the club's stability over the long term.

632. Which countries are most likely to be among those **willing** to be one of the founder members of the climate club will probably depend on several factors. ↘ ITEMS 511 FF. The founder member countries must be responsible **for a substantial proportion of global emissions** or – which amounts to the same thing – constitute sufficiently large economies (Hovi et al., 2019). The club would likely

have more chance of success if the EU and the US were both founder members (Hovi et al., 2019; Hagen and Schneider, 2021). Even if it is not a founder member, China should join the club as soon as possible. Because the EU, the United States and China together account for 61 per cent of global GDP and 43 per cent of imported goods, a club consisting of these three regions would offer a strong incentive for other countries to join the club (Tagliapietra and Wolff, 2021).

V. CONCLUSION

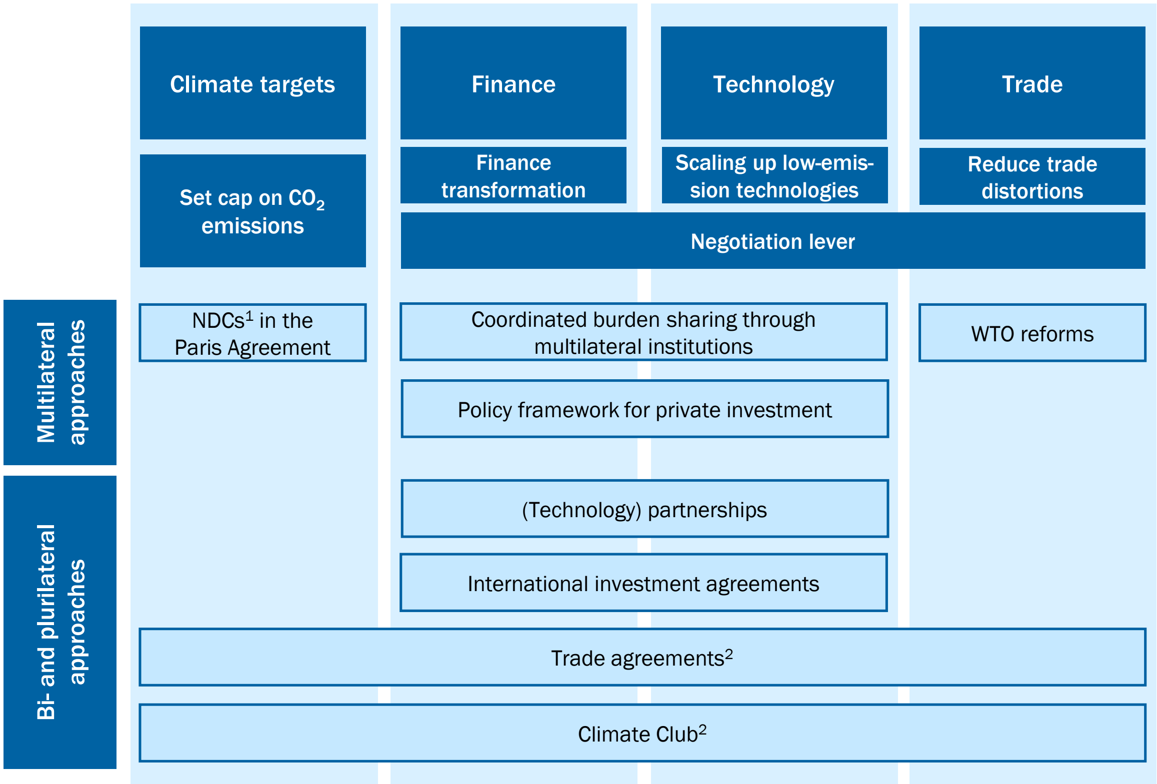
633. The progress made on cutting greenhouse gases around the world continues to fall short of the targets set by the Paris Agreement. Countries' current **NDCs and climate policies are unlikely to be adequate** to limit global warming to below 2°C or even 1.5°C compared with pre-industrial levels. At worldwide level there is still no established mechanism available to give adequate incentives for climate protection. **Naming and shaming**, which is supposed to discipline international climate policy at present, is not sufficient to solve the global climate crisis. ↘ ITEMS 555 FF.

634. The varying situations in which economies currently find themselves mean that the negotiating positions and climate ambitions diverge widely across the countries and this needs to be accounted for when effective mechanisms are being designed and established. While developing countries in particular are threatened by the **direct risks of climate change**, ↘ ITEMS 512 FF. developed countries and the firms based there are facing particularly high **transition risks**. ↘ ITEMS 521 FF. Nonetheless, the transition will create diverse **opportunities for firms and economies:** They will be able to serve the growing demand for low-emission products and manufacturing processes around the world. ↘ ITEMS 537 FF.

The EU and Germany have **a number of options** available for advancing the cause of **international climate cooperation**, all of which, however, pose challenges. The EU and Germany should increasingly assert their influence on multilateral institutions while, at the same time, pushing ahead with plurilateral cooperation. ↘ CHART 150 These approaches can be pursued in parallel.

635. Efforts to **contain climate change effectively** require a global solution. Multilateral negotiations in the past have yielded **only very slow progress**. Building on the Paris Agreement, trust between the parties involved should be strengthened so that, over the medium term, majority support can be achieved for mechanisms that boost climate protection efforts and the willingness to collaborate within an international context. The **international climate finance** and **transfer of technology** specified in the Paris Agreement play a key role in strengthening this trust. ↘ ITEM 542 By helping developing countries and emerging economies to implement their climate policies and improving the operating environment, the two mechanisms can mobilise private investment and thus facilitate the transformation.

↘ CHART 150
Selected approaches for international climate cooperation



1 – Nationally determined contributions. 2 – Can explicitly relate to climate targets.

Source: own illustration

The efforts undertaken by the EU and Germany could increasingly be strategically directed towards **establishing a carbon pricing scheme** – or at least cutting **subsidies for fossil fuels** – in developing countries and emerging economies.

636. **International investment protection agreements** are an important mechanism for reducing uncertainty for companies. ↘ ITEMS 589 FF. They therefore strengthen cross-border capital mobility, which will play a key role in decarbonising the economy. International investment agreements can, however, trigger compensation payments for existing foreign investments if climate policy impairs the value of these investments. These investment agreements should be maintained despite the cost risk associated with them. Such agreements **could**, however, **be modernised** so that they allow the EU and Germany more latitude in the way they conduct their climate policies.

637. Climate policy and trade policy are intertwined in many ways . Accordingly, potential ways to **use trade policy for climate policy purposes** are discussed. Conversely, countries are increasingly reluctant to ratifying trade agreements that would be accompanied by negative climate impacts.

Given the relative majorities in the WTO, a climate policy-oriented reform seems unlikely. ↘ ITEMS 574 FF. The challenge for negotiating partners – especially in the case of bilateral and plurilateral trade agreements – is therefore to account for the close interrelations between climate protection and trade, while considering the diverse preferences of the countries involved. On the one hand, climate policy regulations can reduce the welfare gains from trade agreements. On the other hand, agreements increasingly fail due to the lack of climate protection regulations. Here, climate protection concerns must be taken into account in such a way that the goal of realizing welfare gains through trade is not thwarted or, if possible, even strengthened. Since the conclusion of trade agreements already takes a long time and climate protection requires prompt action, there are **tight limits to the implementation of effective climate protection via trade agreements**. The complexity of negotiations is likely to be further increased by the greater inclusion of environmental policy aspects. In the short term, therefore, trade agreements are likely to be able to raise climate protection ambitions only to a limited extent. However, climate provisions can increase the social acceptance of trade agreements and thus make them more likely to be signed. ↘ ITEM 607 Climate protection ambitions can therefore also provide a basis for closer trade relations. Such opportunities should be seized.

638. The **establishment of a climate club** represents one approach to strengthening plurilateral climate cooperation. In a climate club, a group of countries would coordinate their climate policies with each other, thereby reducing potential **carbon leakage** and **distortions of competition**. In the long run, a club could create climate policy incentives for those countries that would otherwise have pursued only limited climate policies. In order to strengthen the stability of the club and to create incentives for other states to join the club, different mechanisms could be considered, each with different advantages and disadvantages. ↘ ITEMS 613 FF.

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