Transform to React
Climate Policy in the New World Order

Executive Summary

The Russian invasion of Ukraine has compelled Europe to look for alternative oil and gas suppliers. At the same time, the need for a rapid climate action and energy transition is ever more pressing. Following the Paris agreement, many countries have set climate neutrality goals based on different time horizons and introduced associated policies to reduce their national CO_2 emissions and incentivize development of clean energy technologies. These policies, along with industry initiatives, continued globalization and growing international consensus, have led to significant cost reductions and efficiency gains in many clean energy technologies, notably solar PV, onshore wind power and battery storage.

The war in Ukraine introduced two new dimensions for ongoing energy transition efforts: resilience and sovereignty. For instance, Europe is highly dependent on imports of Russian oil, gas, coal and raw materials. Energy-intensive sectors such as chemicals, refining, metals or power generation have the greatest exposure to imports from Russia. These new factors have prompted Europe to reevaluate its strategic choices in terms of the energy transition, especially the role of Russian natural gas or low-carbon hydrogen. To increase resilience, a faster transition to renewables and a diversification of energy sources and imports are the most obvious actions to take. However, increased oil and gas prices may lead to new investments in exploration and production, which could create stranded assets in the future and diverge from the climate ambitions.

Companies, policymakers and civil society are making an urgent call for action. This analysis suggests governments to consider taking the following steps:

1. setting clear and binding targets to fulfil the commitments of the Paris climate agreement,

2. linking climate action and resilience policies to leverage any existing synergies, notably in terms of electrification, diversification of energy sources, energy efficiency improvements and a circular economy for strategic materials,

3. minimizing the investment risks for clean technologies caused by cost uncertainties and recent price volatility, seeking to limit the burden on the population,

4. enhancing international cooperation for the implementation of climate and resilience policies.

Industry leaders are critical enablers of the transformation. On the one hand, their actions are dependent on the policy framework; on the other hand, companies can accelerate the transformation with proactive initiatives. Companies should, among other things, consider doing the following:

1. pursuing comprehensive restructuring and diversification processes beyond energy sources (i.e., looking to other strategic raw materials and goods). This includes analyzing potential vulnerabilities and identifying alternative supply structures,

2. diversifying their investment portfolios, not only in terms of fossil fuels such as oil, natural gas and coal, but also in terms of low-carbon energy technologies,

3. making greening the value chain a key part of their analysis and restructuring process to unlock major synergies,

4. resisting the impulse to misinterpret high fossil fuel prices as an indicator of the long-term viability of new investments in fossil fuel assets,

5. investing the additional profits from recent cost inflation primarily and consistently in transformative technologies and/or systems to generate additional benefits for growth, jobs and social welfare.

Climate policy and the transition to clean energy

Russia's invasion of Ukraine has changed the global political arena. It affects security and geopolitical paradigms and strategies, the future path of globalization as well as energy, food and many commodity markets in particular, but also the financial markets. This will also likely trigger extremely intensive debates in one key area in politics and business: climate policy.

The prevailing change in the global climate and the urgent need for effective counter-strategies represent one of or perhaps the greatest, most existential challenge mankind has faced. The scientific evidence that human activity is causing the changes in the global climate, both in terms of past observations and future forecasts, is persuasive. That evidence has grown massively in recent years and leaves no room for doubt about the anthropogenic nature of climate change (IPCC, 2021). The rate of climate warming due to human emissions of greenhouse gases has reached an unprecedented rate, at least for the last 2000 years. Extensive and rapid changes in the oceans, the cryosphere, and the biosphere have been observed as a result of the human-induced increase in global mean temperature of over 1°C to date (IPCC, 2021).

In some cases, the science-based probabilities for global climate change differ from the observed changes in some areas. Over the course of recent decades, however, the certainty relating to climate change impacts increase significantly in almost all areas based on scientific evidence of the correlation between human activity and climate change (IPCC, 2021).

- the rise in sea level is very likely due to human-induced climate warming;
- the Arctic ice sheet as well as almost all glaciers worldwide are retreating due to the global warming induced by human activities;
- hot weather extremes are becoming more frequent and intense, cold weather extremes are significantly less frequent, due with a high degree of certainty to climate change;
- heavy precipitation events have increased significantly, which is likely driven by human-induced climate change;
- changes in the monsoons have also been attributed to human influence (with medium confidence);

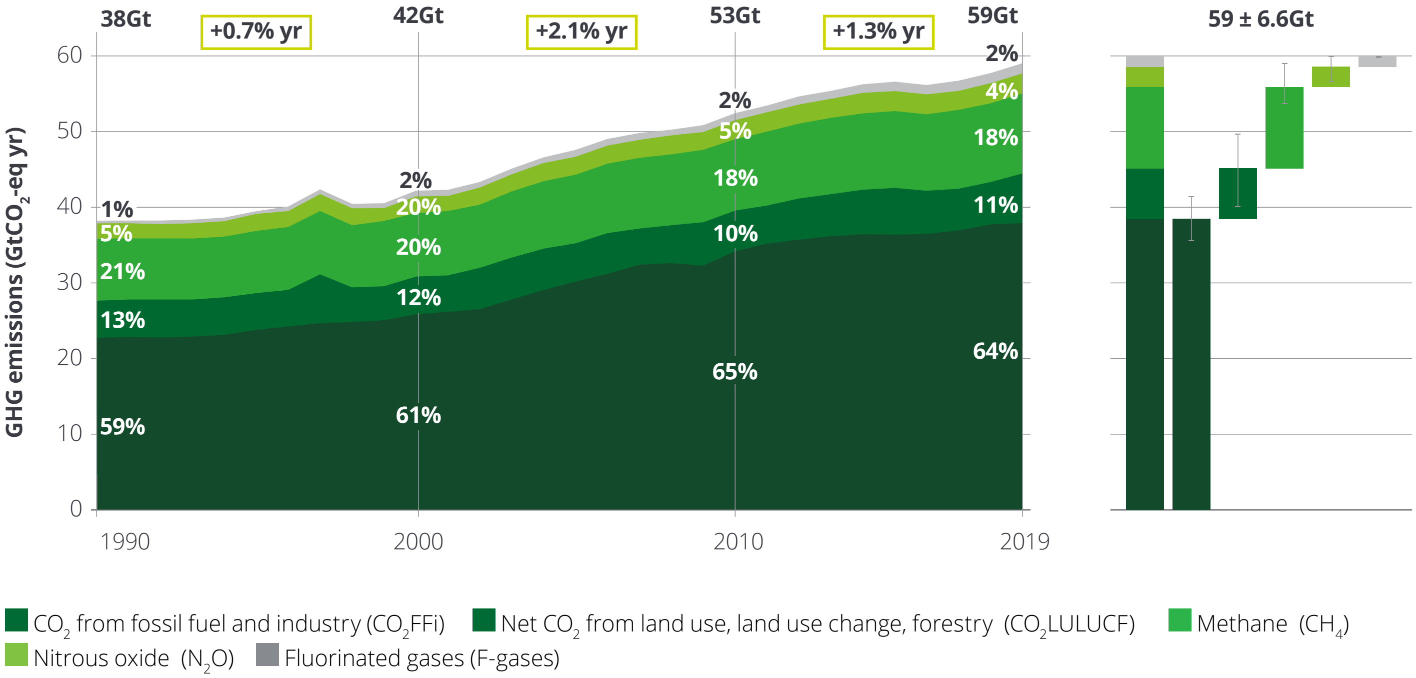
With increasing warming, these changes are expected to become substantially more intense. In certain areas (oceans, ice sheet, sea level), they will be irreversible for centuries to millennia (Solomon et al, 2009).

Changes in the global climate have far-reaching consequences for nature and people. They affect ecosystems, human health and livelihoods (agriculture, water supply, etc.), settlements and infrastructure. The consequences will vary widely based on different regional and socio-economic factors as well as over different time horizons. About 3.3 to 3.6 billion people live in areas that are particularly vulnerable to the impacts of climate change (IPCC, 2022a). Some of the future consequences of climate change will result from processes that are already underway, can no longer be avoided and must be offset by mitigation measures. However, there is still an opportunity to introduce active counter-measures to avoid the most severe consequences of additional anthropogenic climate change, which can no longer be offset by adaptation.

Anthropogenic greenhouse gas emissions are the main driver of global climate change. They have risen steadily in recent decades with only a few interruptions and are currently around 55% above the 1990 level (Figure 1). The largest increases occurred in CO_2 emissions from fossil fuel use and industry (IPCC, 2022b), which represent almost two-thirds of current global anthropogenic greenhouse gas emissions.

The second-largest increase came from methane emissions, mainly due to agriculture but also partly caused by the extraction and use of fossil fuels. Even though a sufficiently ambitious climate policy must go well beyond the energy sector (agriculture and land use, forestry, waste management, industrial processes, etc.), the fastest possible transition to a climate-neutral energy system is undoubtedly the core issue in a robust climate policy.

Fig. 1 – Global net anthropogenic greenhouse gas emissions from 1990 to 2019



Source: Contribution of Working Group III to the 6th assessment report of intergovernmental panel on climate change (IPCC, 2022b).

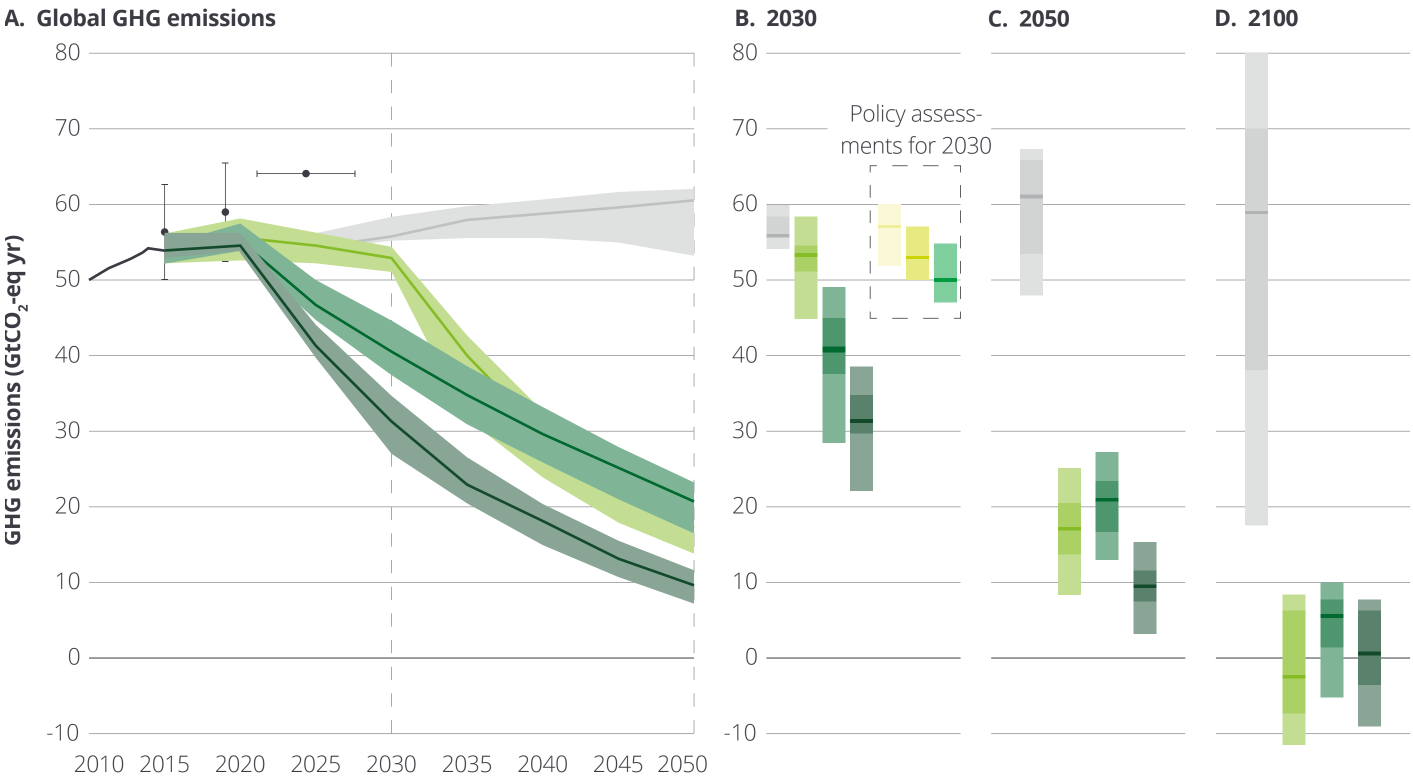
Even if some consequences of anthropogenic climate change are unavoidable, future changes in the climate can be limited considerably. Reducing the increase in global mean temperature to well below 2°C or, if possible, 1.5°C (compared to pre-industrial levels) can avoid particularly dangerous changes to the climate (Figure 2). However, according to IPCC (2018) this would mean:

- reducing annual global greenhouse gas emissions by more than 50% by the middle of this century (or by more than 80% to hit the 1.5°C target),
- reaching emissions peak in the current decade and starting to bend the curve away from current emission trends.

The climate policies introduced so far, and the additional energy and climate policy initiatives or pledges announced since the Paris agreement are beginning to have a mitigating effect on climate change. However, these efforts will need to be much stronger to turn the emission trend around and meet emission reduction targets in a timely manner (IRENA, 2021a).

To a large extent, the basic technical and economic conditions are already in place for the transition to a climate-neutral energy system. Taking action in the area of energy policy, is an existential challenge but a key pillar in climate action efforts. So, the question is not whether the new geopolitical situation following the Russian invasion of Ukraine will slow down enacting ambitious climate policies in line with what is needed. The questions are rather how synergies between demands for security and geopolitical resilience on the one hand and climate-driven energy transition on the other can be achieved, whether any conflicts that might arise in some areas can be resolved, and what the best strategy would be.

Fig. 2 – Projected global GHG emissions based on different future models in IPCC's Working Group III 2022 Assessment Report



Trend from implemented policies
Limit warming to 2°C (>67%) or return warming to 1.5°C (>50%) after a high overshoot, NDCs until 2030
Limit warming to 2°C (>67%)
Limit warming to 1.5°C (>50%) with or no limited overshoot
Past GHG emissions and uncertainty for 2015 and 2019 (dot indicates the median)

Policy assessments for 2030:
Policies implemented by the end of 2020
NDCs prior to COP26, unconditional elements
NDCs prior to COP26, including conditional elements

Percentile:
95th
75th
Median
25th
5th

Source: Contribution of Working Group III to the 6th assessment report of intergovernmental panel on climate change (IPCC, 2022b).

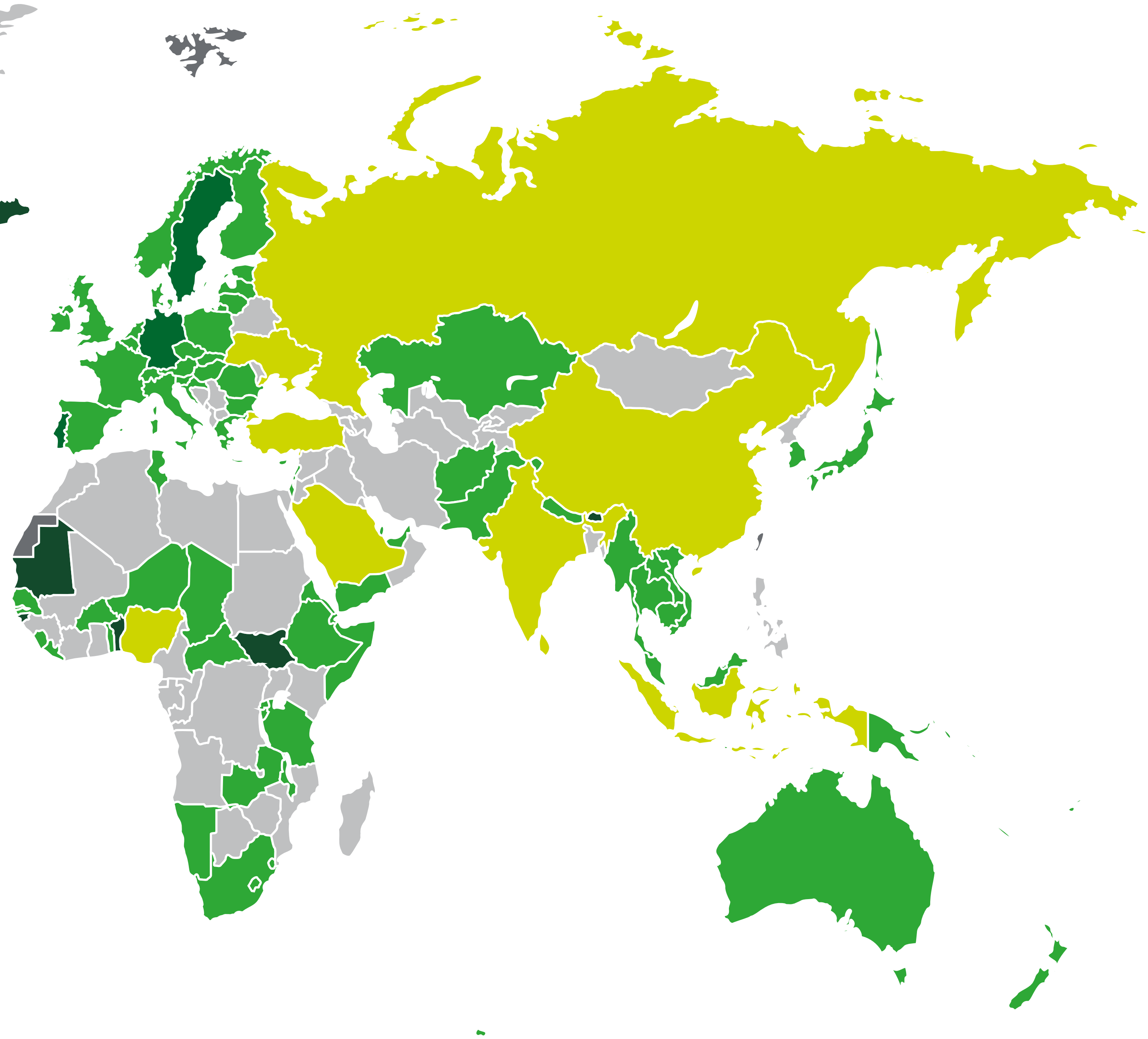
Drivers of the clean energy transition

Government targets and regulation
In the policy process following the Paris agreement, several states or groups of states made a commitment to climate neutrality as the new paradigm for the climate and energy policies of most countries (Figure 3).

- 11 countries worldwide (0.4% of the world's population, 0.1% of the world's gross domestic product[1] and 0.3% of the global greenhouse gas emissions[2]) have made commitments to achieve climate neutrality[3] by 2040 or before;
- 15 countries worldwide (2% of the world's population, 4% of the world's GDP and 2.4% of the global GHG emissions) have set themselves the goal of climate neutrality by 2045 or before;
- 125 countries worldwide (34% of the world's population, 54% of the world's GDP and 42% of the global GHG emissions) have set the goal of climate neutrality by 2050 or before;
- 134 countries worldwide (63% of the world's population, 82% of the world's GDP and 81% of the global GHG emissions) aim for climate neutrality by 2060 or before;
- Including India, 135 countries worldwide (81% of the world's population, 89% of the world's GDP) have committed to climate neutrality by 2070 or before.

Fig. 3 – Global climate neutrality commitment map

Source: Deloitte analysis based on Net-Zero Tracker and announced policies and pledges.



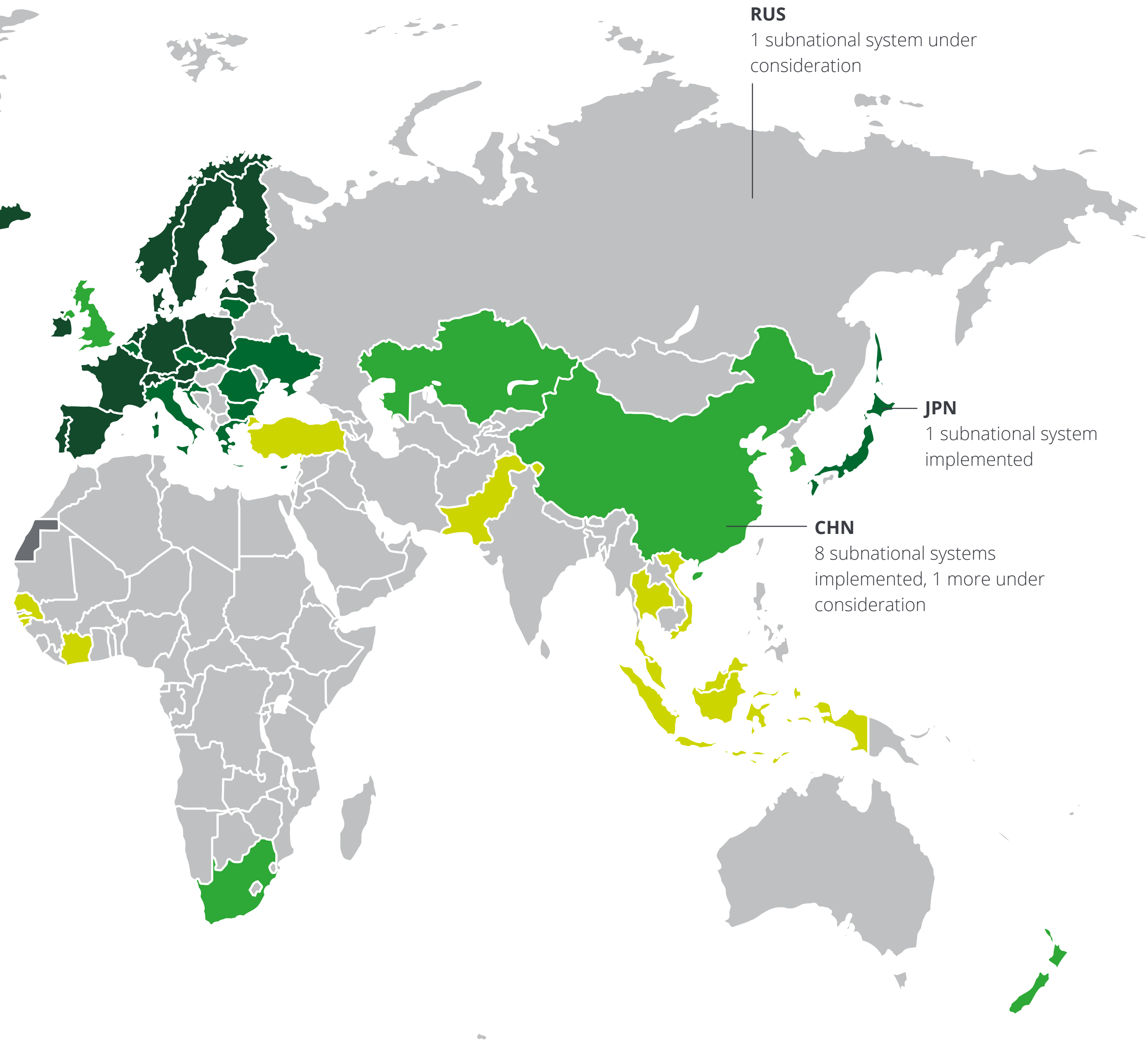
There are major differences in the specifications and the binding nature of the various commitments in some cases, and many countries have not even developed or published a strategy for intermediate targets (which have a decisive influence on climate change impacts). Despite this, efforts to quickly transition to climate neutrality in just two to four decades clearly represent a new paradigm or meta-trend.

Whether the current energy systems, industrial and agricultural structures as well as consumption patterns can be transformed and completely new climate actions can be introduced (natural and technical net sinks like afforestation, use of bioenergy with carbon capture and storage, direct air capture and storage, etc.) will largely depend on whether the policy framework needed for this purpose can be established. In the past two decades, many countries have taken initial steps that have led to the first significant changes in greenhouse gas emissions in some areas of the world. These regulatory approaches vary widely and depend heavily on the prevailing political circumstances, the economic development status and various national characteristics.

The prices of CO_2 or other greenhouse gas emissions play a pivotal role in redirecting energy usage and climate-friendly actions. Many countries around the world have introduced pricing policies in recent years (Figure 4), with about 23 % of global greenhouse gas emissions priced in 2021 (World Bank, 2022a). However, the underlying models, ambitions and the sectors involved vary significantly. Effective CO_2 prices range from less than one U.S. dollar to well over $100 per ton, and coverage ranges from individual sectors to nationwide systems. The different carbon pricing mechanisms generated approximately $84 billion of revenues in 2021 (World Bank, 2022a). Nonetheless, the global revenue from CO_2 pricing is still well below the total volume of subsidies for fossil energy extraction and use. As fossil fuel prices and energy consumption fell, fossil fuel subsidies hit a record low value of $180 billion in 2020. However, according to the International Energy Agency, this value surged to $440 billion in 2021[4]. These subsidies are granted even as the oil and gas industries report record-breaking profits. According to Rystad Energy, public exploration and production (E&P) companies are set to generate a record $834 billion in profit in 2022[5] (70% increase compared to 2021 profits) due to the skyrocketing prices of oil and gas in 2022.

Fig. 4 – Global status of CO_2 pricing and technology-specific support for renewable energies

Source: World bank, carbon pricing dashboard[6] , ICAP (2022), own research.

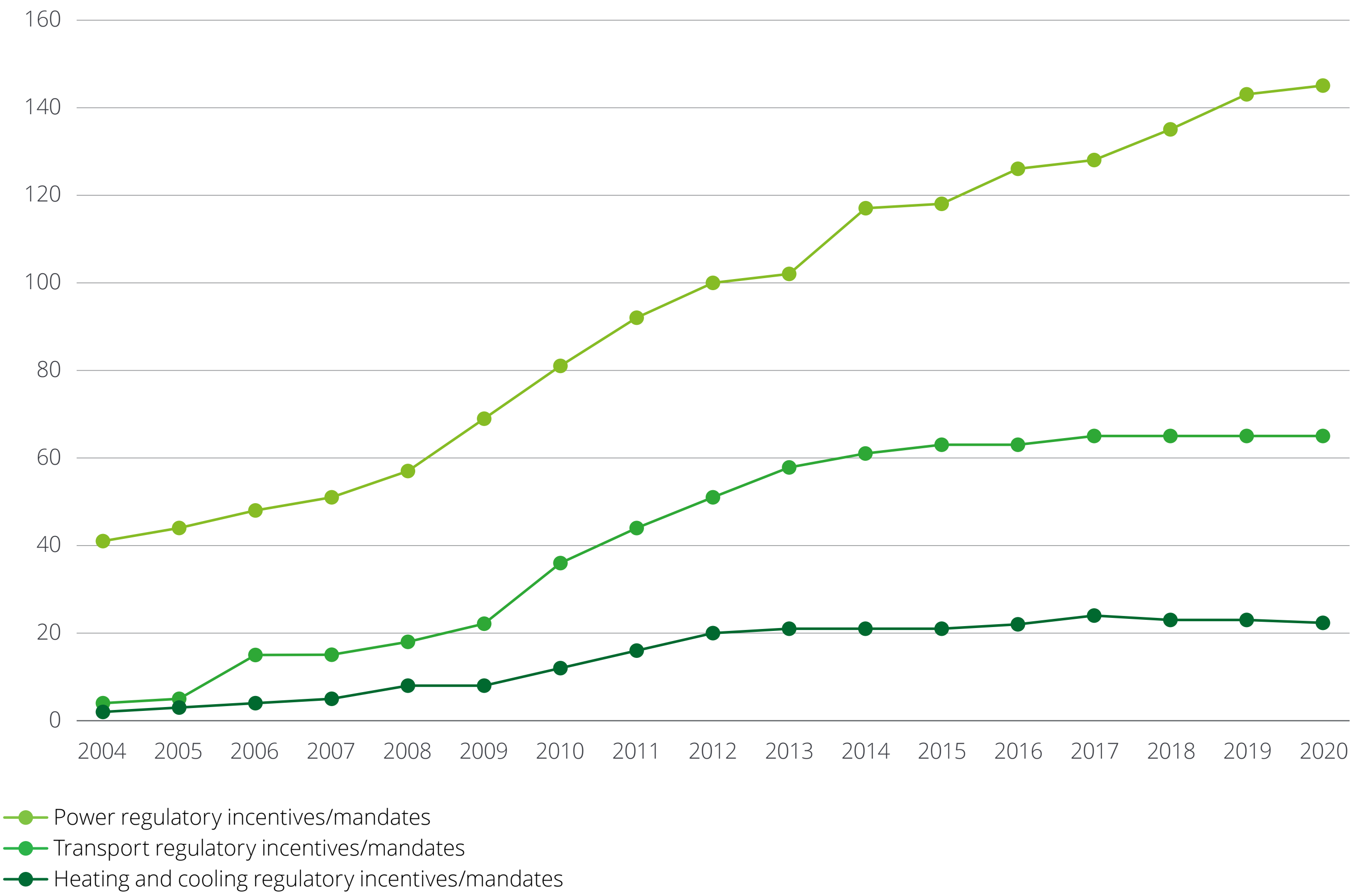

RUS
1 subnational system under consideration
JPN
1 subnational system implemented
CHN
8 subnational systems implemented, 1 more under consideration

In addition to price instruments, there are also instruments designed to overcome specific market development barriers that play a major role on a global level. Support for energy generated by renewable sources (Figure 5) is a particularly striking example here. The 2021 edition of Renewables Global Status report (REN21, 2021) shows that the spectrum of corresponding policy mechanisms and the levels of ambition are again very broad:

- So far, 145 countries have implemented policies to promote electricity generated by renewable energies. That number is increasing relatively steadily over time, with these policies in place in almost three quarters of all countries in the world.
- The number of countries with policies in support of renewable energies in the transport sector is significantly lower at 65 (one third of all countries). It should be noted that the number of countries with renewable-specific policies for the transport sector increased significantly from 2009 to 2015, after which the rate of increase slowed significantly.
- Only 22 countries (11% of all countries) have implemented specific policies for the use of renewable energy in heating and cooling systems. Here, too, a sharp increase for the period 2009 to 2013 can be observed, after which the trend largely stagnates.

At least support mechanisms for electricity generated from renewable energy sources have been established across the world. Of course, the effectiveness of these instruments requires specific analyses, which would go beyond the scope of current analysis. It is nevertheless noteworthy that society almost universally accepts how important renewable energy is in the fight against climate change and supports expanding this energy source. Similarly, other support mechanisms in the energy efficiency and electrification areas (such as low-interest loans and subsidies for electric vehicles and renovation of buildings) have also led to the take-off of clean technologies' usage in these sectors.

Fig. 5 – Number of countries with renewable energy policies, by sector, 2004–2020



Note: Figure does not show all policy types in use. In many cases countries have enacted additional fiscal incentives or public finance mechanisms to support renewable energy. A country is considered to have a policy (and is counted a single time) when it has at least one national or state/provincial-level policy in place. Power policies include feed-in tariffs (FITs) / feed-in premiums, tendering, net metering and renewable portfolio standards. Heating and cooling policies include solar heat obligations, technology-neutral renewable heat obligations and renewable heat FITs. Transport policies include biodiesel obligations/mandates, ethanol obligations/mandates and non-blend mandates.

Source: REN21 (2021).

Technology and commodity trends

Technology trends

To transition energy systems and industry to carbon-neutrality will require implementation of transformative technologies and/or systems on a huge scale. Some of these strategies drive technological progress and reduce cost (as observed over the past two decades for wind and solar energy). Other technologies are at a comparatively early stage of development or market penetration, but there have definitely been technological breakthroughs and especially cost breakthroughs in many areas.

Progress in some key climate neutrality technologies has been unmistakable on a global scale, much of it taking place in the 2010s and therefore in parallel with the breakthroughs in international climate policy, above all the Paris Climate Agreement of December 2015. This is a serious indication that both advances in technology and cost reduction are important success factors for climate neutrality policies at the international and national levels.

The sharp drop in the cost of renewable power generation as well as energy storage technologies has been among the most important breakthroughs of the past 20 years (Figure 6). More precisely:

- The cost of generating electricity from solar energy using photovoltaic systems fell by almost 90% between 2010 and 2020 (Ritchie and Roser, 2021) and is now below the levelized cost of fossil fuel-based or nuclear power in many regions of the world, and already below the variable cost of fossil fuel-based power generation in others[7].

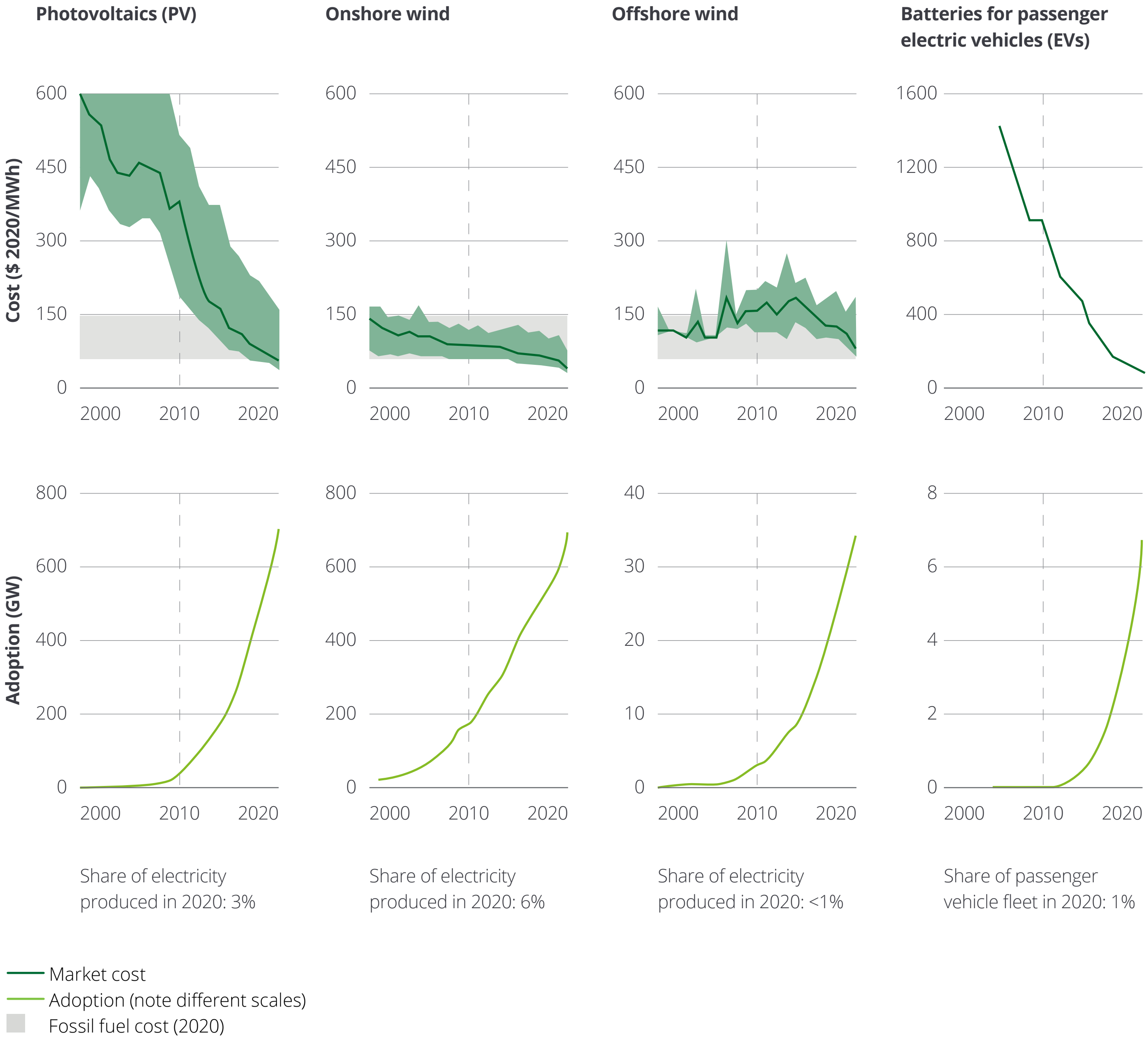
- The cost of generating onshore wind power fell by 70% between 2010 and 2020 (Ritchie and Roser, 2021). Here, too, the average costs in many regions of the world are at least below the full cost of fossil fuel-based or nuclear power generation[7].

- Although market penetration of offshore wind energy is still at a relatively early stage, its costs have fallen by 30% over the last 10 years, with more massive cost reductions to be expected (Ritchie and Roser, 2021).

- Progress in battery storage is another critical success factor in ramping up electric mobility and converting power generation to zero-emission energies. The cost of battery storage fell by 90% between 2010 and 2020, resulting in a breakthrough for electric mobility[8]. Here, too, further cost reductions on a significant scale are expected over the coming years.

Not only in terms of different power generation options, but also on the demand side far-reaching technology advances and cost reductions have occurred. LED technology, for instance, has revolutionized the lighting industry. This technology can save approximately 80% of the electricity required for lighting. At the same time, costs here dropped by more than 80% in the years between 2014 and 2019[9].

Fig. 6 – Trends in the levelized cost of electricity generation (for onshore and offshore wind and solar PV) and storage (for batteries) for key climate neutrality technologies



Source: Contribution of Working Group III to the 6th assessment report of intergovernmental panel on climate change (IPCC, 2022b).

However, the progress described above is only market-driven to a certain extent. Much of the technological progress and cost reductions in many sectors are the result of lead markets initiated through the policy decisions of the public sector and industry. There is a strong correlation between the rapid market ramp-up for climate neutrality technologies and the cost trends based on so-called learning or experience curves. With each doubling of the cumulative installed capacity, the cost declines by a certain average percentage called the learning rate (See box on the right). These cost reductions come as the aggregate result of technology improvements, increases in production efficiency and capacity and, in many cases, also from increasing plant capacity.

- For photovoltaic plants (global installed capacity of 40 GW in 2010 and 843 GW in 2021), there is a typical learning rate of 39% (on an LCOE[10] basis) with every doubling of capacity based on the corresponding analyses (IRENA, 2020, 2021b, and 2022).
- For onshore and offshore wind (global installed capacity of 178 and 3 GW, respectively, in 2010 and 769 and 56 GW respectively in 2021), the corresponding learning rates (on an LCOE basis) are about 32% and 15%, respectively (IRENA, 2020, 2021b, and 2022).
- For different types of batteries, the learning rates have been in the range between 20% and 31% (Ziegler & Trancik, 2021).

Learning and experience curves

Learning by doing is a concept in economic theory by which the overall cost of a technology decreases thanks to cumulative experience in production, productivity and mass production. The learning or experience curve illustrates this process, a technology-specific curve that shows how the cost of a technology develops as its production (for energy sources, the 'installed capacity') increases. If the cost of a technology is C_0 at the time t_0 and the production level P_0, we can calculate its future cost at time t (and production level P_t) as follows:

$$C_t = C_{t0} \times \left(\frac{P_t}{P_{t0}}\right)^{\varepsilon}$$

Where ε is the experience parameter, the learning rate (LR) relates to the experience parameter as follows:

$$LR = 1 - 2^{\varepsilon}$$

This means that with a positive experience parameter, the average cost of a technology decreases as its installed capacity increases.

For instance, a 20 percent learning rate implies an experience parameter of log0.8/log2 (equal to 0.322). With this learning curve, for every doubling of the installed capacity of a technology during a certain period, its cost will fall by $1–2^{-0.322}$, or 20 percent.

Similar developments are expected for other technologies that promise to play a rapidly increasing role in the coming years. In particular, hydrogen production from low-carbon electricity is expected to increase massively. Current estimates assume a learning rate of around 12% (Hydrogen Council, 2021), which means that the production cost of electrolysers is likely to fall by 65% if the global electrolysis capacity increases as forecasted over the next decade. With additional cost breakthroughs in the long-distance transport of hydrogen, an increasingly globalized hydrogen market can ramp up rapidly, similar to the development of liquified natural gas (LNG).

Finally, digitalization also promises to play a decisive role in the transition to climate neutrality. Thanks to the extensive use of digital measurement and control techniques, software technologies and very comprehensive modeling techniques for investment and operating decisions, huge opportunities are opening up for energy and resource-efficient technologies and modes of operation as well as massive cost savings. This does, however, require sophisticated software solutions, a large and readily available supply of semiconductors and other information and communication technologies.

Attractive prices for low-carbon fuels

The recently observed emission reduction trends in some countries are largely due to favorable price developments for lower carbon-intensive fossil fuels, primarily natural gas. Narrowing spreads between coal and natural gas prices have played a significant role in reducing the GHG emissions from power generation in some countries, particularly the U.S. and the U.K. (Figure 7). Thanks to fuel switching, a very economically attractive option in the past, GHG emissions from coal-fired power plants have declined significantly, which has, however, been offset by a significant increase in emissions from natural gas-fired power plants. The energy-related CO_2 emissions from power generation in the US, the UK, Germany and Japan have developed as follows:

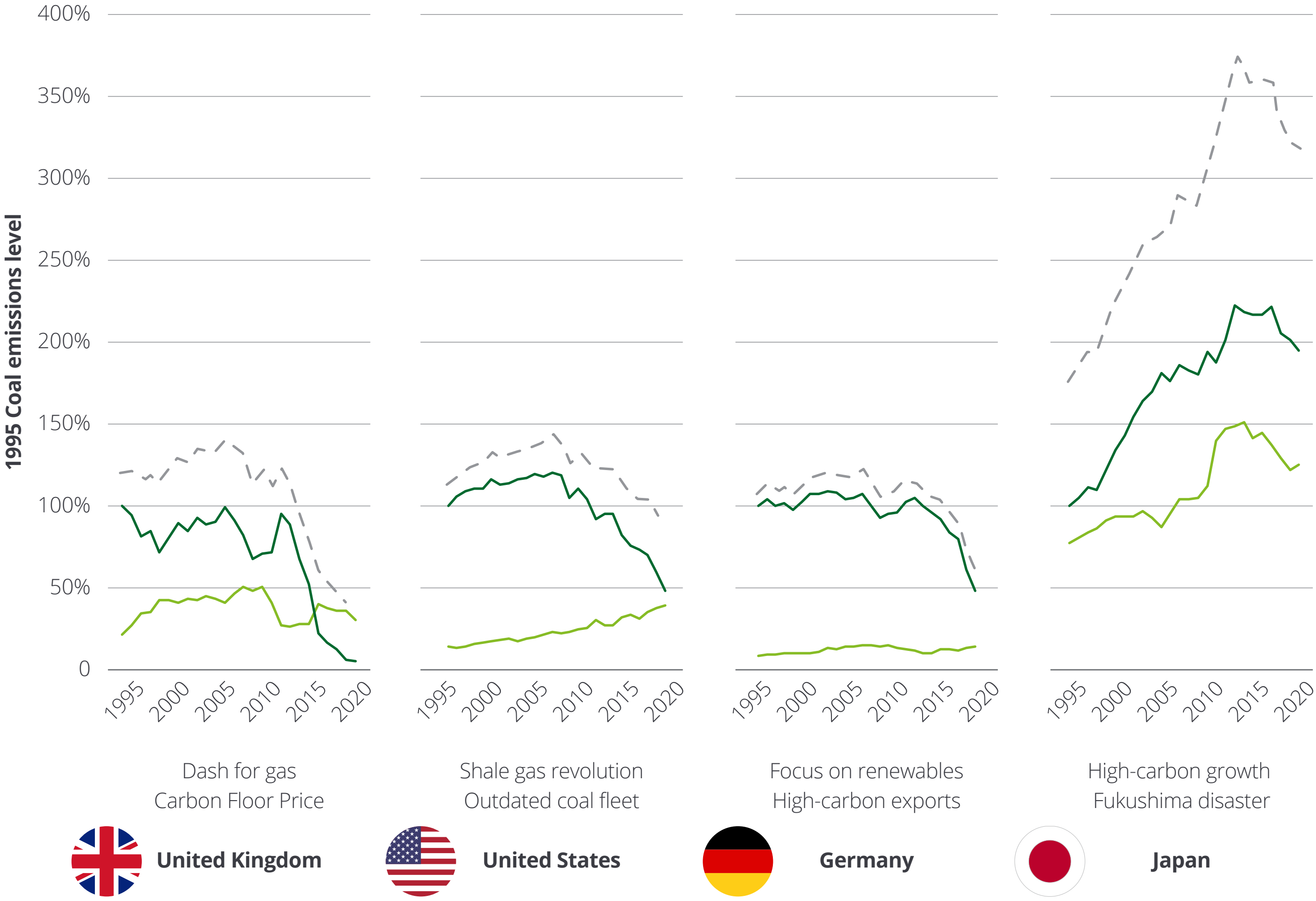
- In the years immediately following 1995, the UK reported declining emissions from coal-fired power plants that were in part offset by an increase in emissions from natural gas power plants. More recently, however, there is only a slight correlation between the decline in emissions from coal power stations and the increase in those from gas power plants. Following the implementation of a carbon tax on the power sector, the electricity generated from renewable energies and the electricity imports from Continental Europe increased, neither of which contribute to the overall CO_2 emissions in the UK, are playing a much more significant role here (Leroutier, 2022).

- From 2010 on, the significant decline in CO_2 emissions from coal-fired power generation in the US was linked to the rise in CO_2 emissions from natural gas-fired power plants. Fuel switching from coal to natural gas power plants, i.e., between two fossil fuels, was obviously a significant factor here[11].

- In Germany, gas-fired power plants played only a very small role in the sharp drop in emissions from coal-fired power plants as of 2015. The decline in carbon-intensive electricity exports and the massive expansion of electricity generated from renewable sources are much more decisive factors. Overall, both in the past and in the present, electricity generated from natural gas only plays a secondary role in Germany[12].

- For Japan, the pattern is completely different once again. Here, the rise in electricity consumption correlates with an expansion of both coal and natural gas power generation and the corresponding emission trends. After the Fukushima-Daiichi nuclear disaster, emissions from both natural gas and coal-fired power plants increased significantly. There were no shifts in emissions between coal and natural gas power plants as of 2015 (Kharecha and Sato, 2019).

Fig. 7 – CO_2 emission trends from public power and heat production, 1990–2020



CO_2 emissions from coal power plants
CO_2 emissions from natural gas power plants
Combined evolution of CO_2 emissions from coal and gas power plants

Source: National Inventory Reports under the United Nations Framework Convention on Climate Change (UNFCCC).

The macroeconomic and trade environment

Since 2000, the macroeconomic environment in many regions of the world has created favorable conditions for capital-intensive investments. This goes hand-in-hand with the second wave of globalization that started accelerating in the late 1990s with the introduction of the internet and declining transport costs (Ortiz-Ospina et al., 2018). As the trade in goods and services intensified, so did global financial flows, particularly foreign direct investment (FDI). Between 2000 and 2016, the share of FDI stock in global GDP increased from 22% to 35%. The global financial and economic crisis led to a noticeable shift that made emerging market economies more and more attractive. Over 50% of total FDI inflows in 2013 went to emerging economies (Carril-Caccia and Pavlova, 2018). With large amounts of investment capital readily available and interest rates very low, investment in clean technologies, which typically account for a disproportionately high share of investment costs, also became much more attractive.

Between 2000 and 2019, private investments grew at a rate[13] of 4.3% per year. The private capital stock almost doubled in the same period, rising from $113,045 billion (in constant 2017 international dollars, adjusted for purchasing power parity) to $221,105 billion in 2019 (IMF, 2021). Different regions of the world are starting to catch up with others in economic terms. Private investment in developing countries has increased at a rate of 8% per year over the past two decades, while the rate was 2% per year in advanced economies. Global inequality has declined over the past two decades as emerging economies outperform their advanced counterparts in terms of GDP growth (Roser and Ortiz-Ospina, 2016).

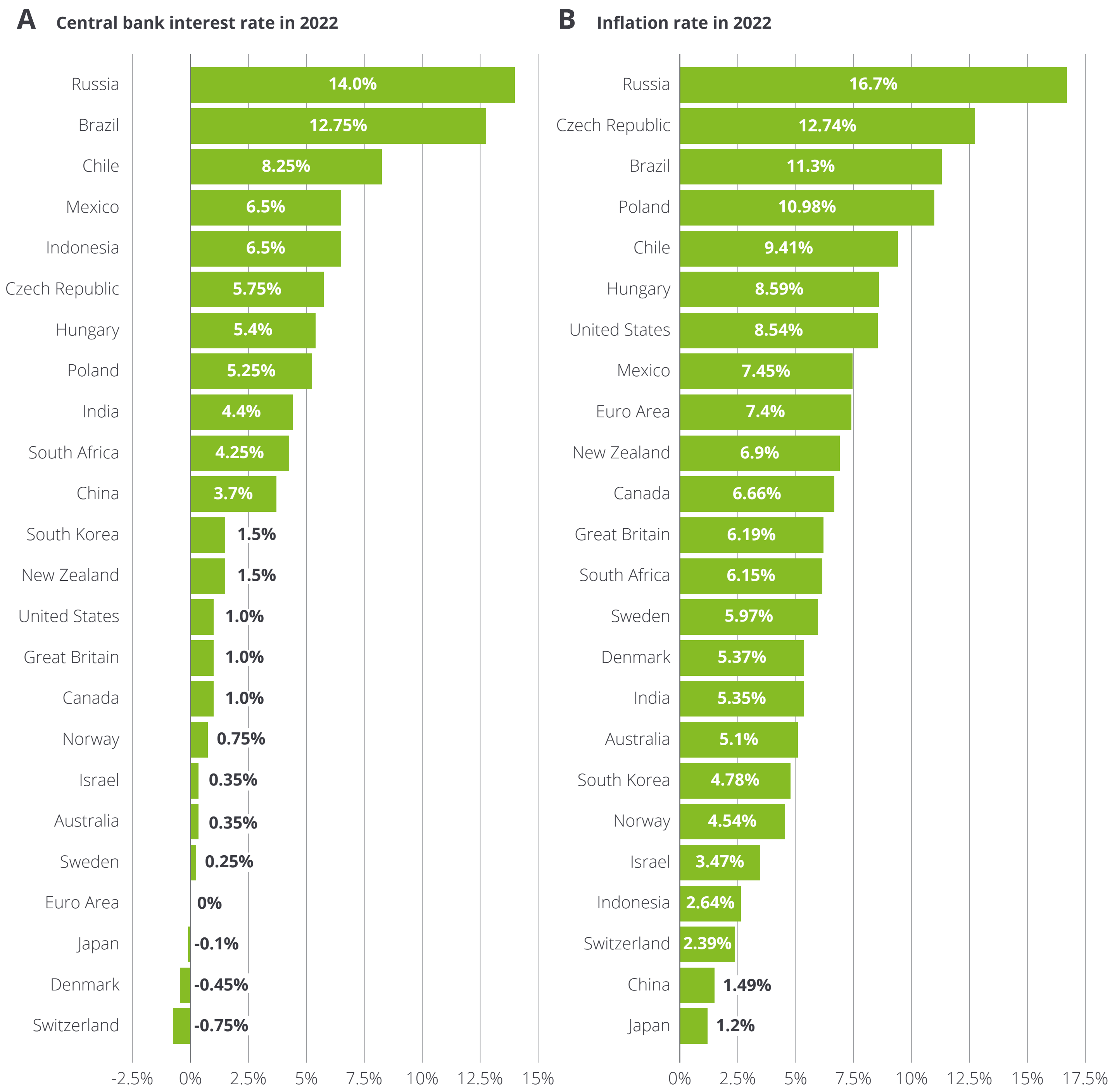
With the globalization of trade, industry is increasingly relocating to emerging economies, particularly their production facilities to the locations with limited environmental regulation. This has raised the standard of living for citizens while also increasing the demand for fossil fuels in these economies, which in turn has caused emissions to rise. When emerging economies increase export of goods to their advanced counterparts, the imported emissions increase as well. Emissions from the production of traded goods and services increased from 4.3 Gt CO_2 to 7.8 Gt CO_2 between 1990 and 2008. The net emission transfers via international trade from developing to developed countries increased from 0.4 Gt CO_2 in 1990 to 1.6 Gt CO_2 in 2008 (Peters et al., 2011).

After the 2008 financial crisis, GDP growth and inflation were at a very low rate in the advanced economies. Central banks, including the Federal Reserve (FED), the Bank of England (BoE) and the European Central Bank (ECB), intervened and lowered interest rates to encourage investment. The COVID-19 crisis has led to a global shock that affected both supply and demand, but as lockdowns and restrictions ended, demand recovered very quickly. Global supply chains have struggled to keep up with demand due to difficulties in the supply of raw materials and a rise in the price of energy, which drove prices higher.

The vast majority of the world's economies are feeling the impact of inflation, and central banks are responding to rising prices by raising interest rates. However, the impact has not been the same for all regions of the world (Figure 8). There appears to be a strong disparity between interest rates at the global level. Higher inflation rates and risk profiles have increased the cost of investment in developing economies. In advanced economies, by contrast, even though inflation and central bank interest rates are on the rise, the cost of investment is lower. This presents a good opportunity to invest in low-carbon technologies.

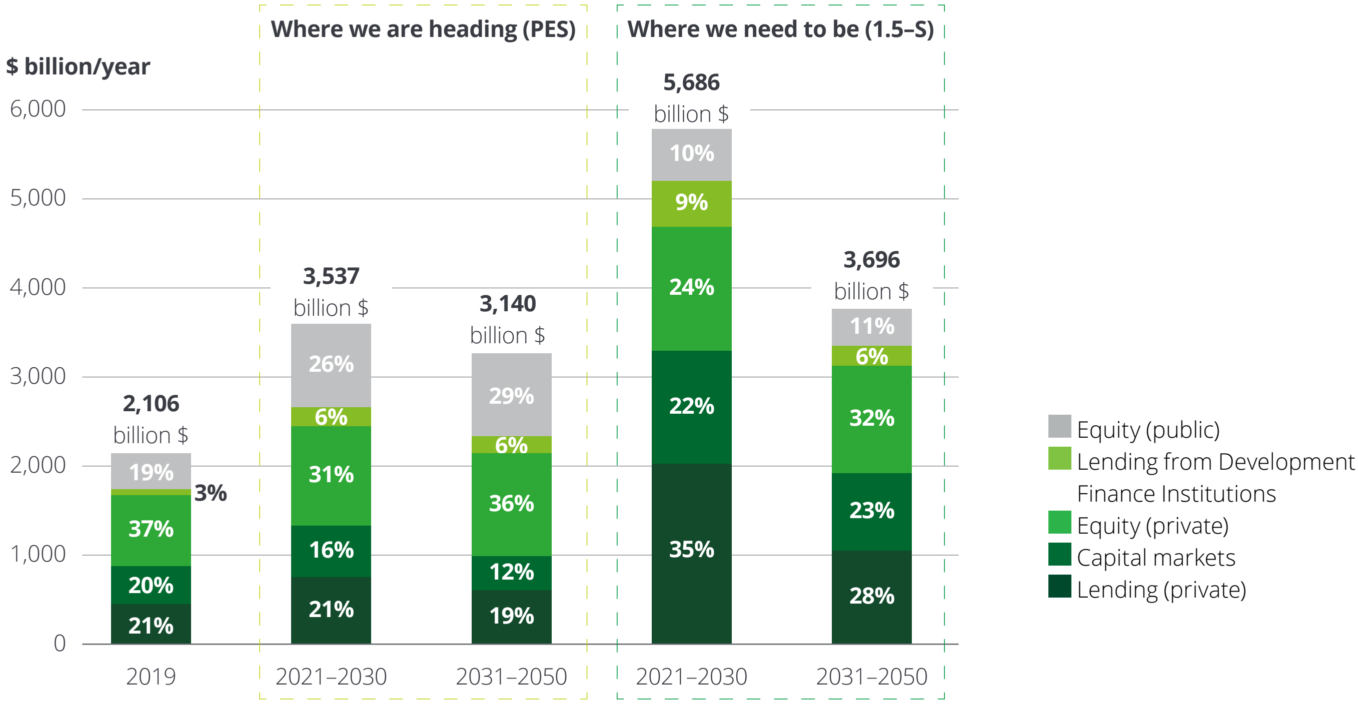
Between 2005 and 2020, global investment in low-carbon technologies increased from $60 billion to $524 billion. However, the investment made in green technologies so far – as well as those in the pipeline – are insufficient to reach the 1.5°C target (Figure 9). Investments of $98 trillion are earmarked for the period from 2021 to 2050. However, to limit global warming to 1.5°C, IRENA estimates an additional investment of $33 trillion over the same period; in other words, an average annual investment of $4.4 trillion instead of the $3.3 trillion in current forecasts (IRENA, 2021a). Even though these investments are significant in scale, the financial capital to implement the transition exists. Financial resources from the private and public sectors must be mobilized (Figure 9), with public funding acting as a guarantor and bearing the risks when necessary to attract private investors wary of the increased risk.

Fig. 8 – Annual inflation and current (2022) central bank interest rates



Source: Global rates.[14]

Fig. 9 – Total average yearly investment by source and type of financing: 2019, current trends and IRENA's 1.5°C Scenario (for the periods 2021-2030 and 2031-2050)

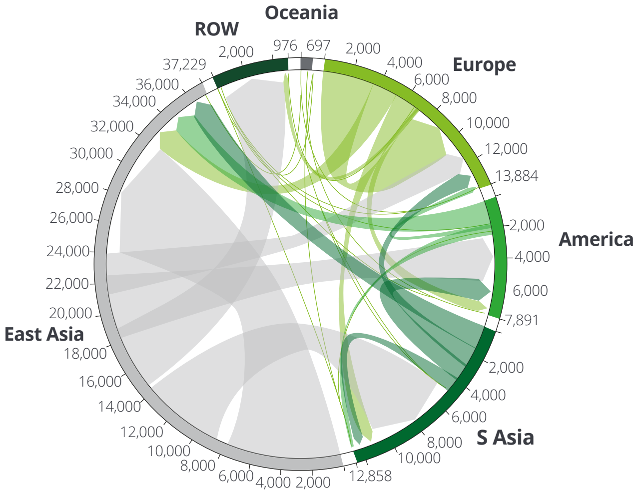


Source: IRENA (2021).

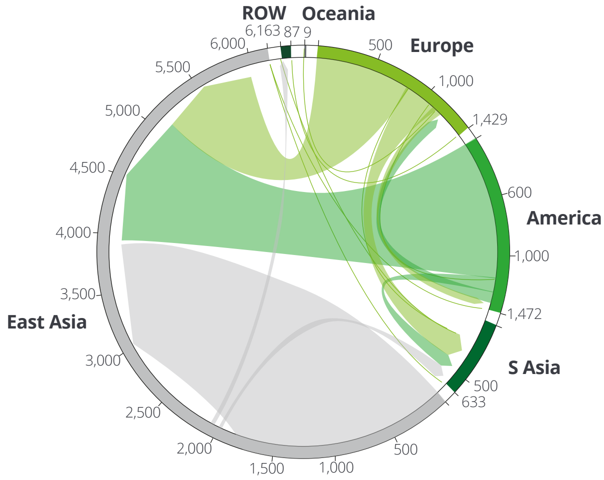
The increase in global trade, despite the rising emissions that came with it, has also allowed new low-carbon technologies to proliferate at a relatively low price. With prices relatively low, these technologies have even become accessible to low-income populations and countries. The strong increase in demand for new technologies as well as the policy priorities of industry (e.g., in China) have allowed many climate-neutral technologies to go global very quickly, which has played a huge role in advancing technological progress and reducing costs. A prominent example is China's role in the global supply of PV modules (Figure 10).

Growth in global trade has pushed CO_2 emissions upwards, nevertheless, it has also brought down the cost of clean energy technologies.

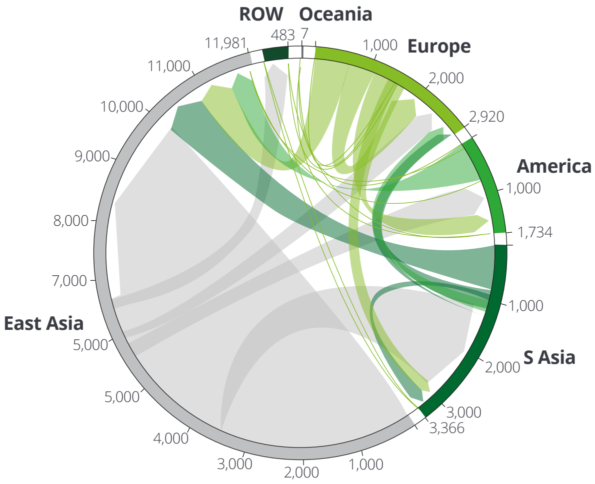
Fig. 10 – Global solar PV trade flow



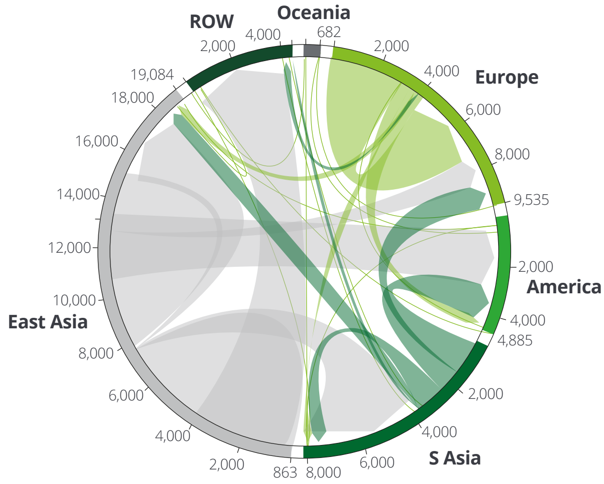
Global PV trade value flow in 2017 ($ million)



Global silicon trade value flow in 2017 ($ million)



Global wafer trade value flow in 2017 ($ million)



Global solar cells and modules trade value flow in 2017 ($ million)

Source: Wang et al. (2021)

Increasing globalization has, however, had a significant impact on the policy framework for emission reduction, and not only in the area of goods. The huge expansion in the transport infrastructure for liquid natural gas (LNG) has massively increased the global availability of this low carbon-intensive energy carrier, even as methane emissions pose an additional challenge for some extraction technologies in the supply regions relevant for LNG transport (Sakmar and Kendall, 2009).

Efforts for greening the value chains

The observed changes in the transition to a more climate-friendly energy system are not only a result of government policies, technological developments, the energy market or the macroeconomic environment. In recent years, corporate activities not primarily driven by these factors or only as a result of soft regulations have proven to play a role, which is likely to increase moving forward.

Initially, efforts to reduce the environmental footprint from production and upstream supply chains usually come within the context of a company's corporate responsibility initiatives. Many companies today are, on a voluntary basis, investigating and evaluating their value chains, which in many cases are becoming much more complex and globalized, for optimization potential in environmental (and social) terms. An important aspect here is that companies can often achieve cost savings with more environmentally friendly process chains.

In addition to these purely voluntary and in part altruistic measures, investor-driven efforts to reduce the environmental and social impact of a company's own production and upstream process chains play an increasingly important role. Environmental, Social and Governance (ESG) criteria are also among the decision factors in the investment decisions of many investors, especially institutional investors. As such, they have a substantial impact on the cost of raising capital from a corporate perspective. The ESG criteria are based in principle on the environmental responsibility (environmental), good corporate citizenship (social) and accountable management (governance), however, the respective certification systems still vary widely, and they are mainly used as an information instrument for the responsible investors. Countries, groups of countries or even supranational entities are making considerable efforts to increase transparency in the area of sustainable financing (e.g., under the EU Taxonomy Regulation). Although complex and in some cases controversial in nature, these efforts are expected to be a key driver in the trend towards investor-driven value chain greening.

Another key factor is the consumer-driven demand to green the value chain. In many sectors of the economy, consumers are making clear demands not only in terms of the quality of products and services, but also in terms of reducing the overall environmental footprint of the entire value chain. A rapidly growing market segment is developing in this area, particularly in the mobility sector. The launch of transformative products (e.g., battery electric vehicles) offers a significant opportunity to expand and market this forward-looking strategy with respect to the value chain (green steel for electric vehicles, recyclable production materials, etc.).

Finally, the introduction of carbon tariffs, such as the EU's proposed Carbon Border Adjustment Mechanism (CBAM), creates considerable incentives for value chain greening and prevents competitive distortion in the markets protected by these mechanisms.

Tracking greenhouse gas emissions in the context of ESG criteria

Scope 1
This covers greenhouse gas emissions generated by a company's own facilities or by the facilities controlled by a company. This includes boilers, vehicles, etc.

Scope 2
This tracks emissions that are generated through the use of energy sources such as electricity but are not under the direct control of the company. The carbon footprint of the power supply is of outstanding importance in this context.

Scope 3
This includes all emissions that are not generated by the company itself or in the context of Scope 2, but rather emissions caused indirectly by the company. This relates to upstream process chains on the one hand, and to the use (and disposal) of products brought to market (downstream) on the other.

The main characteristics of a clean energy system and its implications

Many of the specific characteristics of the future climate-neutral energy systems, industrial structures and consumption patterns are yet to discover. Relying on a number of studies by governmental and non-governmental organizations, international and national authorities, scientific communities and consulting companies, certain trends that will likely shape the carbon-neutral systems of the future can be identified.

There is a clear consensus among the scientific community that renewables will dominate the future of carbon-neutral energy systems (Olauson et al., 2016, Brown et al., 2018, Zhu et al., 2019, Daggash et al., 2019, Shirizadeh and Quirion, 2021, Brown and Botterud, 2021, Fattahi et al., 2022, Shirizadeh and Quirion, 2022, etc.). The findings of the International Energy Agency's 'Net Zero by 2050' study (IEA, 2021a) and the latest Assessment Report (AR6) of the IPCC's Working Group III (IPCC, 2022b) come to the same conclusion. The Paris-compliant scenarios in the 'Future of Power' study (Deloitte, 2021), for instance, posit that renewables will expand quickly in the European power system and drive the rapid reduction of CO_2 emissions. Similarly, according to the recent 'Hydrogen for Europe' study (Hydrogen for Europe, 2021), Europe could require some 100 million tons of low-carbon hydrogen, mainly from renewable hydrogen over the long-term, to achieve a carbon-neutral energy system by 2050. An energy system like this would be largely renewable for both electricity and hydrogen production.

As the share of renewables in the energy system increases, so does the demand for storage options. The marginal cost of renewables such as wind and solar power is very low, while flexibility options such as thermal plants and storage options come with a relatively high price tag. As a result, there will be a lot of price variability associated with this type of power generation but also lower average electricity prices thanks to extended low-cost periods (Sensfuß et al, 2008, Seel et al., 2018, Deloitte, 2021, Shirizadeh et al., 2022, etc.). These factors present specific challenges of their own, which are key for the transition processes above all, but also with a view to the status quo, that must be addressed at an early stage.

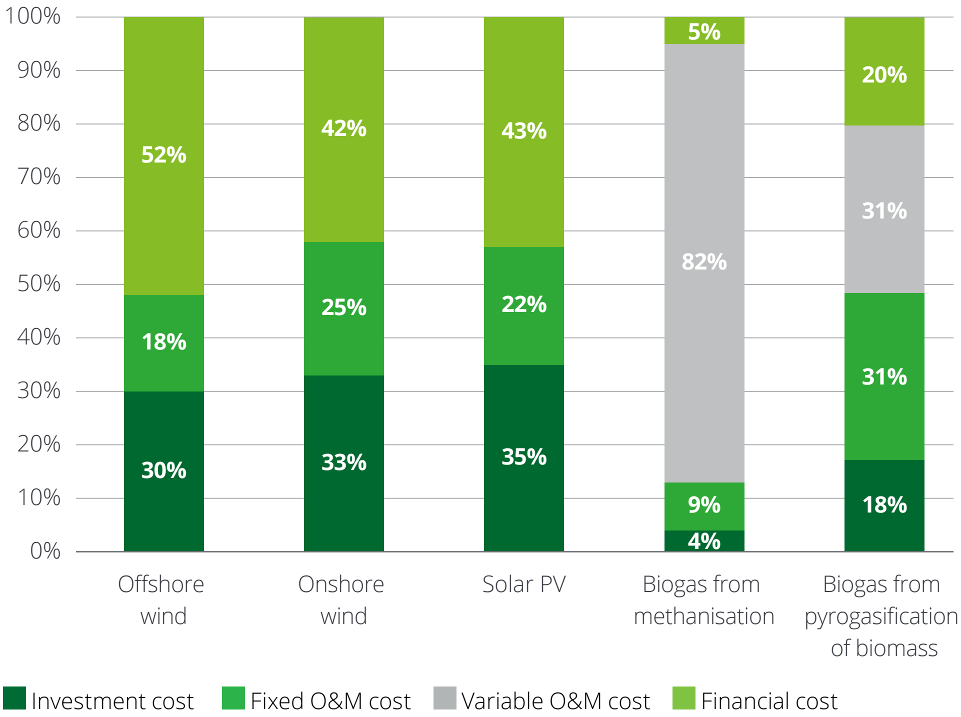
First, future systems are expected to take a lot more coordination than current systems, due in part to the much larger role that decentralized options will play in future power generation. While many countries have typically operated with a few hundred power plants, future energy systems are likely to contain several million solar and wind power plants. Moreover, as the share of wind and solar power generation increases, the need for flexibility will be vital, and with it the ability to coordinate between various production and consumption systems. These complex coordination tasks will require markets and undistorted price signals as well as the necessary framework for certifying new market-ready green products. Similar to price signals, the necessary (non-technical) infrastructure for the related information flows will be required.

Compared to the current energy system (for instance gas- and coal-fired and nuclear power plants for the electricity sector), the vast majority of future systems will require much more capital expenditure but operate at significantly lower operating costs than before (Figure 11). As upfront expenses increase, the role of capital costs and financing will expand on the one hand, calling for new project financing solutions and in some cases new market models. On the other hand, capital-intensive systems tend to be socially regressive. The transition of energy systems to climate-neutral alternatives will raise some tough yet important questions in terms of mechanisms for social compensation and tailored solutions for those sections of the population with difficult access to investment funds or financing solutions.

Infrastructure will be a much more critical factor for the systems of the future than it is today. With new applications such as electric vehicles or heat pumps as well as other electrification options and changing spatial patterns, it will be essential to expand the power transmission and distribution networks. The introduction of renewable and low-carbon hydrogen for industrial processes and its long-distance transport will require building robust hydrogen infrastructure or repurpose existing gas grids. Finally, the appropriate CO_2 networks for the technical CO_2 sinks (or the carbon capture and storage process chains) will be needed. Rail infrastructure will play an increasingly vital role in the transport sector. As a cross-cutting issue, the rapid expansion of digital infrastructure will also be extremely important as the energy sector and industry continue to transition. There are extremely long lead times for infrastructure construction or conversion projects, and there are strict regulatory standards for many of these projects. That means that dealing with the associated uncertainties requires setting the course at a very early stage in many areas and finding the right procedures accordingly.

Innovation is critical in developing future systems. The rapid advances in various types of technology will require continuous revision and correction of the prevailing policy framework. The key challenge here is

Fig. 11 – The cost breakdown of renewable electricity and gas supply technologies for a unit of final energy production in Europe (in €/MWh_e for electricity and in €/MWh_{th} for gas)



Source: Deloitte analysis based on technology investment, operation and variable costs and lifetime duration assumptions of European Commission's Joint Research Center (JRC, 2018), with construction time estimate of 6 months for solar PV, 1 year for onshore wind, 2 years for offshore wind power plants and 2 years for biogas production plants (with 80% capacity factor) for a weighted average capital cost (WACC) of 7%.

to find or maintain a balance between the implementation options currently available while also keeping the window of opportunity open for future innovation.

Some of the future low-carbon energy systems are expected to require significantly more resources than today (e.g., for electric mobility or energy-efficient buildings). As a result, circular systems might gain massively in importance on the one hand. On the other hand, however, additional resources and the corresponding value chains will be unavoidable early on, especially in the build-up phase, and funding for them must be secured, also through contributions from extractive industries. Smart solutions will be required for the business side and for the regulatory framework to manage the tension between the increasing demand for resources during the ramp-up phases and the increasing share of resources managed in a more or less closed cycle.

Overall, the new systems are expected to be a lot more sensitive to consumer acceptance than before, particularly the many consumer-related elements will rely on broad consumer uptake. Given the increasing shift towards decentralized options for power generation and the changes in the spatial patterns of energy systems, acceptance by the local population will make or break success.

The changing environment after the Russian invasion of Ukraine

Russia's invasion of Ukraine and the subsequent international response may lead to significant changes on very different levels of national and international policies and politics:

- At a very fundamental level, this war has called into question the orientation of both the economy and the various policy areas towards a global rule-based system. The concept of resilience will play an important role in the future in terms of economic relations and dependencies, but also in the area of international relations and security policy.

- The sanctions against Russia will impact a significant share of the resources and production volumes of fossil fuels and other strategic resources. This may lead to physical shortages, mainly in Europe, and will definitely generate significant price effects. These effects will be felt at the macroeconomic level as well as the individual company level and will probably remain relevant beyond the short-term time horizon.

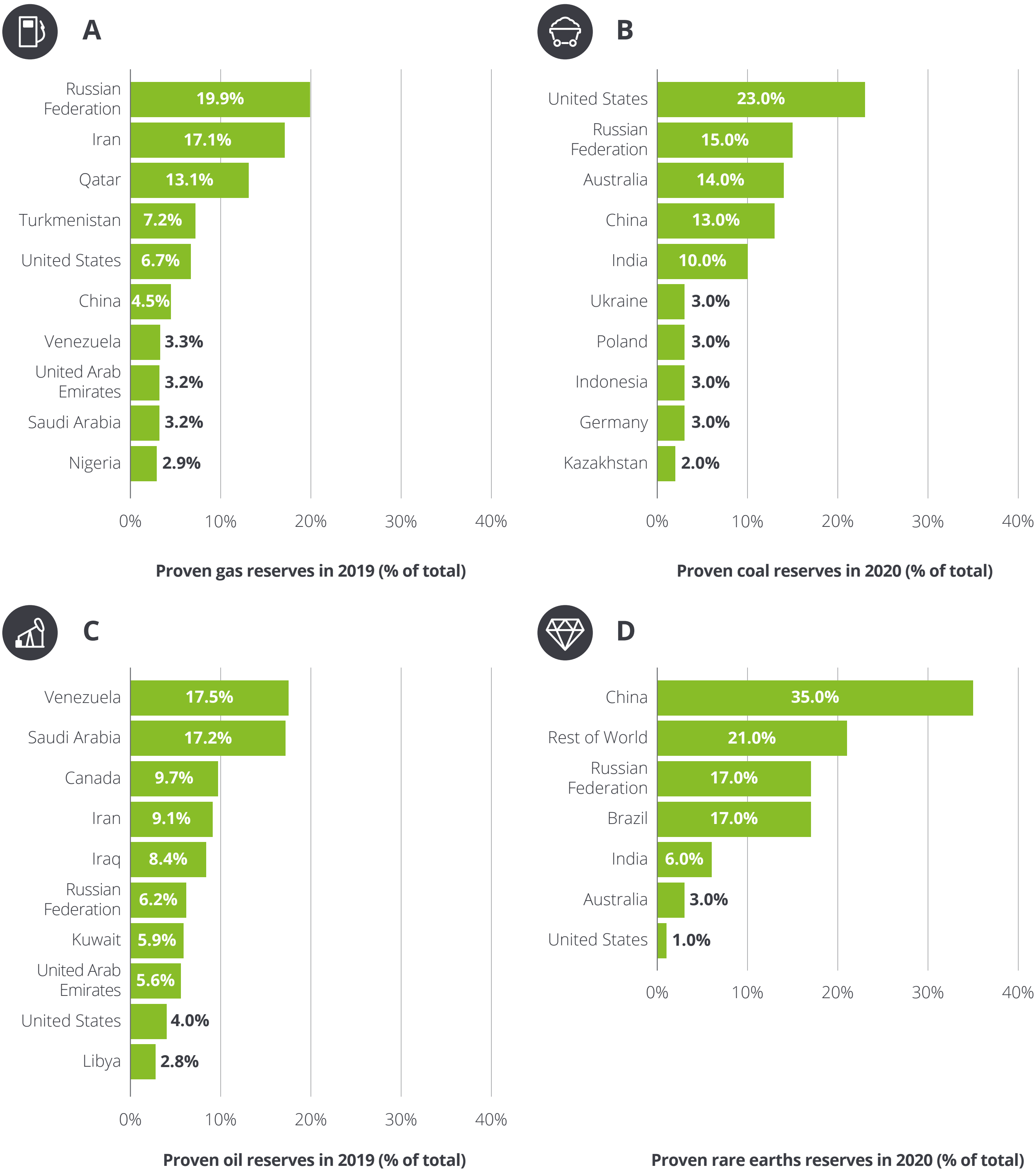
- Sanctions also have a massive impact on value chains beyond the supply of raw materials. Identifying and reorganizing sanctions-sensitive value chains is a serious short-term challenge.

- In the future, at least the democratic societies will form their views about the transition to a climate-neutral economy based on whether and to what extent transition measures also contribute to increasing resilience.

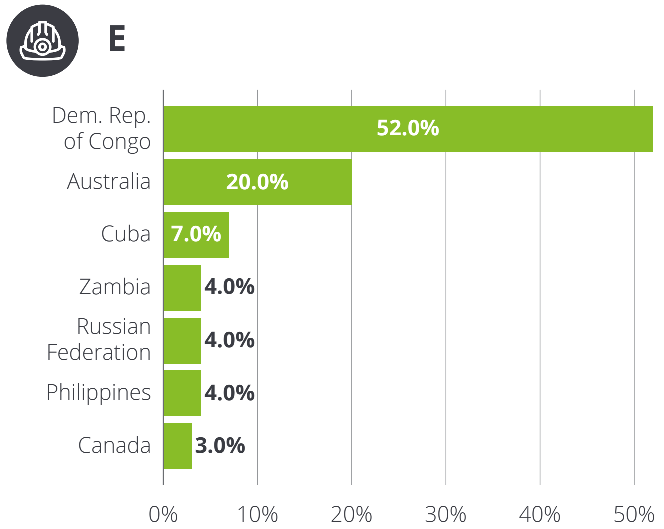
Initially, the sanctions against Russia will significantly tighten the world markets for strategic raw materials. Russia has significant fossil fuel resources: the world's largest natural gas reserve, the second largest coal reserve and the sixth largest oil reserve (BP, 2021). But it is also an important source for raw materials as the fourth largest resource of rare earths in the world, the fifth largest in terms of graphite and the sixth largest in terms of cobalt (BP, 2021). As these raw materials are essential to the production of electric batteries, wind turbines and electric cars (IEA, 2021b), the sanctions against Russia are likely to put additional pressure on world markets. This could result in short-term price hikes in those resources that are essential for the energy transition (see Figure 12).

The Russian invasion of Ukraine brought a new dimension to the energy transition policies: resilience.

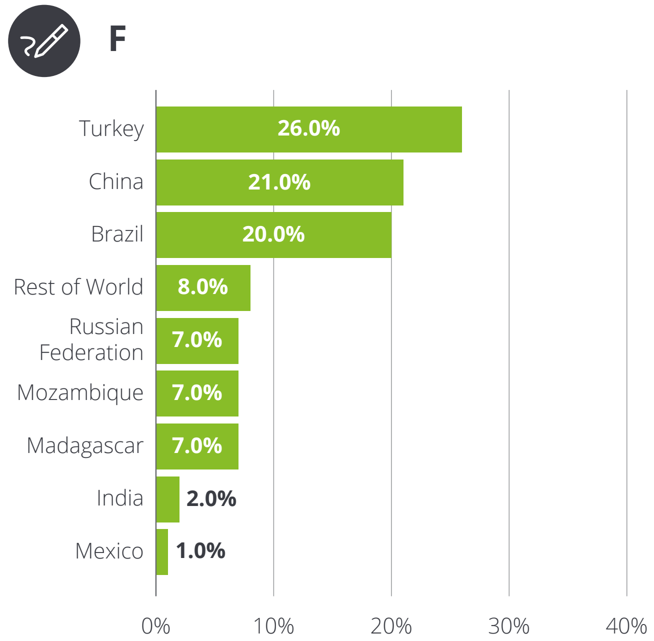
Fig. 12a – Geographical distribution of world reserves of natural gas (panel A), coal (panel B), oil (panel C), rare earths (panel D), cobalt (panel E) and graphite (panel F)



Source: BP (2021).



Proven cobalt reserves in 2020 (% of total)



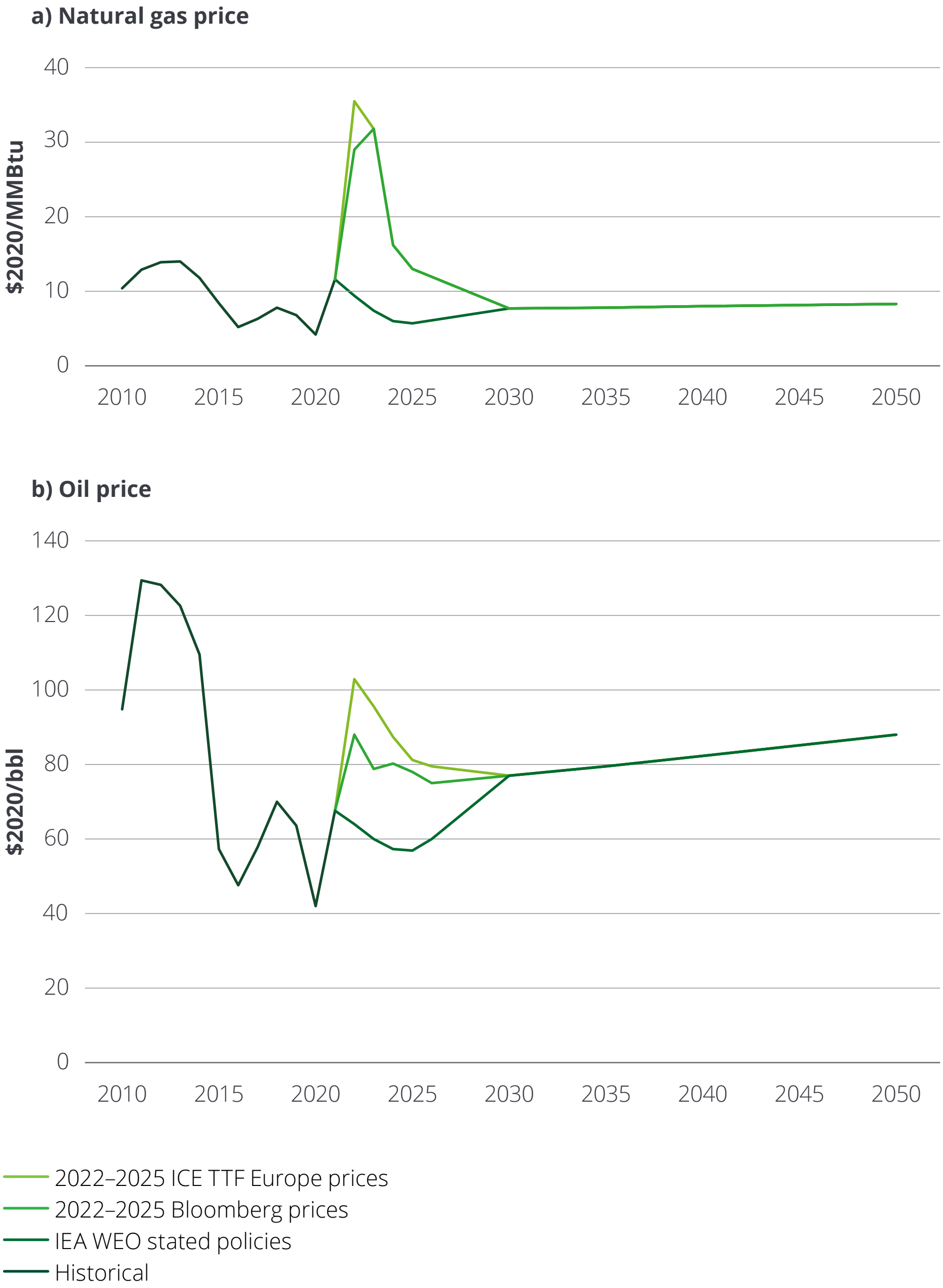
Proven graphite reserves in 2020 (% of total)

Source: BP (2021).

In the short term, prices for many strategic raw materials are surging as a late consequence of the post-pandemic recovery and the Russian invasion. The current price volatility is a result of the changing supply situation, which could lead to considerable risk premiums. Even if the prices are expected to ease over the medium term, it is virtually impossible to predict where prices will settle in the future. Figure 13 shows the future prices for crude oil and natural gas based on different sources in Europe and the long-term trends for oil and gas prices on the European market based on IEA's Stated Policies Scenario (IEA, 2021c). Even if the future prices might converge to the IEA forecasts over the long term, these prices are likely to remain high throughout the 2020s, at least relative to pre-crisis levels.

Fossil fuels remain by far the largest source of energy in the EU. Oil accounts for 38% of primary energy consumption ahead of natural gas at 23%, coal, nuclear and non-hydro renewable energy each at 11%, and hydroelectricity at 5% (BP, 2021). The EU is an important trading partner for Russia, with a large share of Russian fossil fuels exports going to EU member states. 20 of the top 30 importers of Russian fossil fuels (natural gas, oil and coal combined) are in the EU and account for 43% of the exports in this context. The EU is a net importer of fossil fuels, with Russia accounting for 18% of these imports[15]. A rise in fossil fuel prices due to sanctions could have serious short-term consequences for energy-intensive sectors in the EU, in particular those dependent on natural gas and oil.

Fig. 13 – Historical prices and future contract prices for strategic commodities



Source: Deloitte analysis based on European ICE and Bloomberg prices, IEA's 2021 world energy outlook and historical market data.

EU countries and companies are strongly dependent on Russian natural gas based on longstanding trade relationships and the long-term contracts that go with them. Natural gas trade between Russia and Europe is almost entirely transported in dedicated pipelines. Indeed, in 2019, Europe imported 356 billion cubic meters (bcm) of natural gas, 67% of which was via pipeline and 33% in the form of liquefied natural gas (BP, 2021). Of the 237 bcm imported by pipeline, more than 80% came from Russia. The total natural gas imports from Russia to Europe dropped to 155 bcm in 2021, but Russia was still the biggest natural gas exporter to Europe, providing 45% of European natural gas imports (IEA, 2022).

By comparison, it is much easier to find alternatives to the Russian coal and oil supply, because these energy carriers are not subject to the inflexibilities of bilateral trade in gas delivered via pipeline. Finding an alternative supply of natural gas is more complicated in the short term. A large share of the global LNG supply is contracted, and only a minor share of the supply is traded on short-term markets, so LNG is not an adequate substitute. Moreover, LNG regasification terminals – and the pipelines evacuating the gas from the terminals – are at risk of running out of capacity.

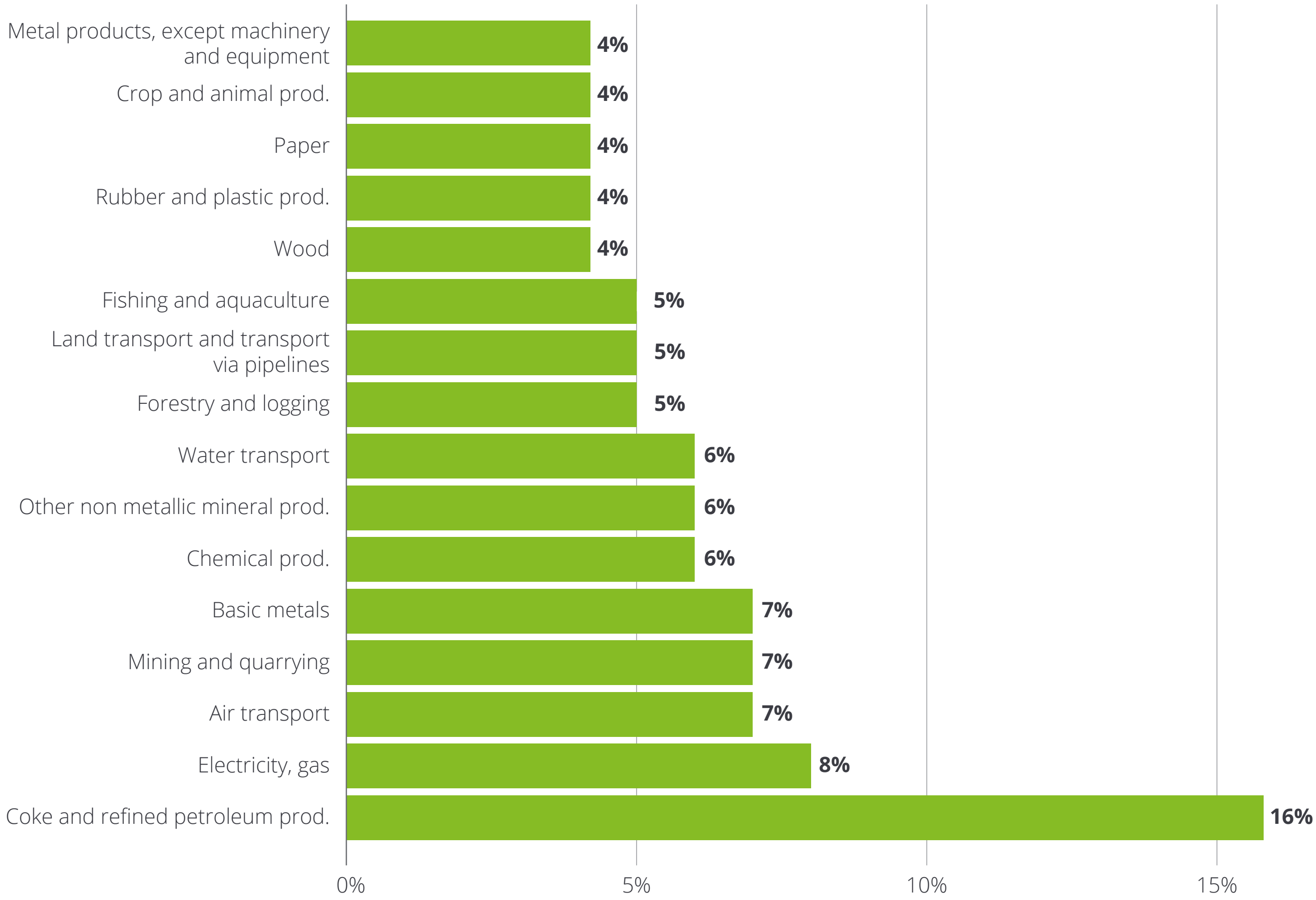
The EU is in a position to rapidly (within one year) reduce its gas imports from Russia by one third without increasing its territorial GHG emissions (IEA, 2022). To do so, Europe will have to accelerate investments in new solar and wind energy capacities, maximize electricity generation from bioenergy and nuclear power plants, replace Russian natural gas with alternative suppliers, replace gas boilers with heat pumps and increase both energy efficiency and sufficiency by lowering the thermostat for heating buildings. It would even be possible to reduce the EU's dependence on Russian gas by more than half within a year. This would require Europe to replace natural gas demand with coal, thereby limiting the GHG emissions reduction potential (IEA, 2022). There are, however, certain sectors that are highly exposed to a disruption in the oil and gas supplies from Russia with little chance of finding an adequate substitute in the short term.

The sectors most exposed to a cut in energy imports from Russia are those that directly use Russian energy as intermediate goods. However, indirect users may also be exposed if they consume Russian energy through the value chain, i.e., if intermediate goods used in the production process rely on Russian energy. With nearly 8% of Russian fossil fuels in overall intermediate consumption, it is no surprise that refineries and coke ovens[16] in the EU would be the most exposed to the effects of a cut in Russian gas exports. This is followed by mining and quarrying (3.8%), aviation (3.6%), electricity and gas[17] (3%) and road freight (2.7%) (see Figure 14).

The most exposed sectors in the EU are either those that use fossil energy to transform it into secondary energy or those that are highly energy intensive, such as the transport or metals sectors. Identifying these sectors and how they adapt to disruption in the Russian oil and gas supply raises the question of whether these GHG emitting energies can be substituted with green alternatives. In the short-term, high energy prices may prevent substitution of more expensive energy sources with cheaper ones, but in the long term this substitution is not only feasible but also probable (Labandeira et al., 2017). This suggests that the most exposed sectors are actually in a position to adapt and avoid GHG emissions through transformative investments in less energy-intensive processes or decarbonized and resilient energy.

Thus, in the absence of possible substitution in the short term, capturing the energy savings from households and sectors that are able to do so would reduce the pressure on fossil fuel demand and limit price increases. This would allow sectors that are reliant on use of fossil fuels in production to mitigate the negative impact of a decrease in supply and the associated short-term price increases. At the same time, a decrease in consumption by those economic agents in a position to do so would offset the growth in GHG emissions.

Fig. 14 – Total EU exposure to Russian oil and gas sanctions by sector (% of added value)



Source: Deloitte analysis based on World Input Output Database (Timmer et al. 2015).

The new geopolitical and energy market environment will not only have a significant impact on all aspects of the energy supply and its implications for countries, companies and the public. Further challenges might appear that are in some cases linked to the energy issues and, in others, largely independent of them as outlined in the following:

- Skyrocketing energy prices, the impact of sanctions and value chain disruptions have exacerbated inflationary trends. In the wake of the macroeconomic counter-strategies as well as huge uncertainty in the markets and in politics, the cumulative cost of financing might increase. This can compound the challenges for the transition to climate neutrality as a project that is particularly investment and capital-intensive.

- Russia and Ukraine are among the main suppliers on the international agricultural commodity markets. Food prices are soaring due to the sanctions against Russia on the one hand and the massively restricted Ukrainian crop farming and the disruption of transport links from Ukraine on the other. There was a 20% increase in prices for many agricultural products traded on global markets in the first quarter of 2022, and a 30% increase in wheat prices (World Bank 2022a and 2022b). Together with the fertilizer price increases (also as a result of the rise in gas prices), the situation is likely to remain challenging for the next few years. Developing and emerging economies are set to suffer disproportionately from these price hikes.

It is vital to take these new challenges for energy, food and finance into account and to address them with an integrated strategy, especially when it comes to coordinating international efforts and managing the energy transition.

In addition to the short and medium-term effects on energy costs as well as economic structures, following strategic consequences can occur:

- Energy supply diversification and the resulting resilience in value and delivery chains (the "n–1" principle[18]) will increase in importance in the foreseeable future. Markets will be looking to diversify their supply of strategic raw materials and goods in order to mitigate the potential loss of the largest supplier in each case both geopolitically and economically. This does not mean pursuing a self-sufficiency strategy, but it would substantially change the structure of economic relations and value chains. It will be key to focus on resilience right from the beginning in consideration of raw materials and strategic goods that come to the fore during the transition to climate neutrality.

- In many areas, the supply of strategic raw materials and goods can become truly resilient if energy and resources become significantly more efficient and circularity principles are implemented at an early stage.

The new geopolitical and energy order calls for international cooperation to accelerate the energy transition.

The transformation to climate neutrality in the new geopolitical environment

Gaining a new perspective on resilience requires a critical review of some, but by no means all, of the past and future strategies for the transition to climate neutrality.

- Natural gas has played an important role in many strategies for the transition to climate neutrality, whether it is replacing coal-fired power generation, converting steel production from the blast furnace to the direct reduced iron or electric arc furnace route or supporting other industrial sectors. Here, it should be clarified whether it is possible, from a resilience perspective, to meet the increasing demand in these sectors for a certain transition period and what impact potential changes in the price and cost environment for natural gas will have on transition strategies or any additional measures needed to support them.

- The emergence of low-carbon hydrogen from Russian production is a key factor in some hydrogen strategies. Under the new geostrategic conditions, it is unlikely that this will continue in the same way.

- If intermediate options such as natural gas and/or blue or turquoise hydrogen are not available to the extent originally expected, the transition to other transformative options (e.g., renewable hydrogen) will need to speed up . This will have massive consequences for the development of technology and infrastructure, for the ramp-up of value chains and for changes in technology on the application side – and higher upfront costs could, in some areas, come as a result (for instance, see the REPowerEU plan[19]).

- Skyrocketing prices for fossil raw materials are increasing incentives to expand production capacity in fossil fuels. With a view to the current climate neutrality goals, this could result in large-scale stranded assets or lock-in effects.

- If energy prices continue to rise over the longer term, so too does the risk of carbon leakage, as production is forced to be relocated to regions with a higher CO_2 footprint in order to guarantee supply.

The sanctions against Russia have given rise to a new global trade paradigm as well as changing cost structures, resulting in a call for decisive and concerted action by corporate executives, public policymakers and members of civil society.

- Companies will have to closely analyze and restructure their trade relations and value chains in order to comply with the various sanctions in place[20]. There is an opportunity to explore synergies with the Sustainable Development Goals here as well.

- The sharp rise in fossil energy costs in the near term and the potential of higher upfront costs for the transition to climate neutrality increase the need for compensation initiatives.

These new challenges and calls to action at the national level can be addressed to a limited extent. International cooperation is vital, though the current shifts in geopolitical realities make it much more complex.

The way forward

What governments can do

Russia's invasion of Ukraine has radically changed both the geopolitical arena and the energy markets. Even though the uncertainties and the turmoil are likely to diminish over time, it is highly unlikely to return to the status quo ante. This does not mean that the associated challenges will supersede the existing problems or the urgent need for action, particularly but not exclusively in the area of climate policy. On the contrary, the governments will have to adopt measures in energy, industrial and security policy that go beyond current climate initiatives. This may in some cases require additional funding and a considerable investment of political capital.

Governments and political decision-makers must commit to vigorously pursuing a path to implement and increase ambitious climate policies moving forward, even under the new geopolitical conditions. Significant synergies can be created by integrating climate action policies with the efforts to strengthen the resilience of energy systems and national economies. This applies to both more short-term crisis management and to medium or long-term adjustments on the road to climate neutrality:

- Ambitious increase in energy and resource efficiency and electrification play a central role here. There are many low-cost technologies and options available in the short and medium term. Improving the regulatory environment, market conditions and political support can make a significant contribution in terms of optimizing both climate policy and the resilience of the society, the economy and companies.

- Transformative technologies and systems will have to play a prominent role in the transition of energy and industrial systems as well as production and consumption patterns. Renewable energy, renewable and low-carbon hydrogen and a circular economy for raw materials are of central strategic importance in the quest to diversify the energy supply as quickly as possible.

- Clear and accountable public policies focused above all on driving innovation are required in an effort to achieve technological advances and further reduce costs. In some cases, fundamental changes in prevailing market models will be essential to ensure that the most cost-effective options are also competitive in the market in terms of both LCOE (levelized cost of electricity) and TCO (total cost of ownership).

- Last but not least, it will be crucial to speed up targeted adjustments to the current energy infrastructures (roll-out, adjusting, repurposing, decommissioning), especially when it comes to climate-mitigating and transformative measures and strengthening resilience. To develop effective resilience policies, the planning and regulatory systems need to be adapted or created more quickly. The same applies to non-technical infrastructure for other transformative options in the energy transition, such as certification of renewable and low-carbon hydrogen or green products (green steel, green chemicals, etc.).

In the past, certain transformational measures were expected to play a significant role in the transition, for example, replacing coal with natural gas in the power generation sector or in the steel industry to achieve relatively large emission reductions. It may be time to subject these measures to a critical review in terms of resilience, particularly in those regions that rely strongly on Russian imports. Although there might be a lack of alternative in many cases, there could be an opportunity to significantly shorten the transition period. A case in point is the use of natural gas during the transition of the electricity system, the district heating supply or some basic industries (e.g., the steel industry). Demand for natural gas might increase in certain sectors during these transition periods. To meet the additional demand in these sectors, governments should also put political safeguards in place to address limited availability of natural gas or price volatility. At the same time, new climate-neutral commodities (especially renewable and low-carbon hydrogen and hydrogen derivates) can be allocated to the relevant sectors with a targeted and accelerated approach to help shorten the transition period.

There might be considerable price volatility over the next few years, but this may be overshadowed by continued uncertainty about the development in prices for fossil fuels, electricity and strategic raw materials.

- These uncertainties pose a significant threat to the timely start of the transition process. Smart compensation packages to bridge these unsettled phases will be increasingly important over the next few years. That said, under current conditions, de-risking measures for essential large-volume investment campaigns are likely to increase in importance as well.

- It is important to limit the social burden associated with price volatility in a way that mitigates or prevents social disruption and hardship. A systematic approach is needed to ensure these instruments are designed to be used for future social compensation mechanisms related to emerging, very capital-intensive energy systems.

- However, the design of all offset and social compensation measures should limit as far as possible any distortion of markets and price signals. It is extremely urgent that efforts to strengthen CO_2 pricing are maintained (as an incentive, revenue or coordination mechanism).

In terms of strengthening resilience, governments might have to adjust their priorities: not only shifting the energy supply away from fossil to climate-neutral energies, but also diversifying and restructuring the existing fossil energy supply. Massive price increases in fossil fuels are making extractive industries, the associated processing industries and the corresponding infrastructures an attractive field for investors once again.

- Governments should adopt clear communication strategies and regulatory frameworks to ensure that they minimize stranded assets in the fossil energy sector as far as possible. Significantly tougher regulations in the area of sustainable finance can play a huge role in this regard.

- Governments should keep the conversion of state-regulated or subsidized fossil energy infrastructures to an absolute minimum in the context of supply diversification, providing the public with clear perspectives on how it intends to shift toward climate-neutral energy sources.

- Energy companies stand to massively increase their windfall profits, and governments and international organizations should carefully examine the extent to which these companies are investing these additional revenues in clean technologies.

Governments need to step up their international cooperation efforts in an aim to link and/or achieve synergies between climate change and resilience policies:

- Existing international climate action initiatives and institutions, e.g., within the UN or the G7 and the G20 frameworks, should be maintained and stabilized. Blockages in these areas could lead to delays that would be unacceptable in terms of either protecting the environment or strengthening resilience.

- International climate policy instruments need to be strengthened gradually. There is a wide range of options here, from sectoral agreements to climate clubs and border adjustment mechanisms.

- Bilateral bodies like the US-EU Trade and Technology Council (TTC) should expand to include climate and energy technologies as well as additional like-minded countries. For example, Germany could also broaden and deepen its energy partnerships to accelerate the transformation towards climate neutrality and boost the resilience of societies, economies and companies.

- As the transition proceeds, rapid and in some cases fundamental changes to the global trade flows can be expected. Focusing on resilience as one of the new priorities may present some new challenges. In many areas, it will be vital to create a new policy and regulatory framework as well as corresponding support measures.

- International financial transfers and financing mechanisms will play an important role, both in view of the turbulence in today's commodity markets and over the long term. Being able to fulfill financial commitments and secure further funds can make or break the success of global climate protection policy, but the same applies to achieving synergies with the strategies and measures adopted to increase resilience.

What companies can do

Industrial and commercial enterprises are the central players and enablers of the energy transition. On the one hand, their actions depend on the policy framework; on the other hand, companies have the power to significantly speed up the transformation with proactive action.

In the short term, many companies face the challenge of restructuring their value chains due to the sanction regimes and the changing economic conditions, but also the vulnerabilities that have become apparent in recent months and years. Corporate leaders should make the greening of the value chain an integral part of the corresponding analysis and restructuring process in an effort to unlock major synergies. A company-specific resilience roadmap could become an interesting management tool in this process.

To increase security of supply or to strengthen resilience, companies might also need to take comprehensive restructuring and diversification measures that go beyond the energy sources (coal, oil and natural gas), i.e., for other strategic raw materials and goods. Conducting vulnerability analyses, identifying alternative supply structures as well as collecting and publishing the data and information for future political and regulatory requirements will be important tasks for companies moving forward.

Companies might need to seriously step up their efforts to improve innovation processes in key technologies for the transition to climate neutrality, but also to strengthen their resilience in terms of energy carriers and other strategic raw materials and goods. Industry-driven initiatives have the ability and the responsibility to drive and accelerate progress in the area of renewable energies, electrification, renewable and low-carbon hydrogen and hydrogen derivatives as well as in the circular economy.

The modernization cycles with a transformative impact on industry are relatively long. That is why it is so important to use the corresponding modernization windows effectively and to align all investment decisions with long-term sustainability goals. Financial market players could also make a significant contribution here by placing their focus more on impact investments (Busch et al., 2021).

The ability to quickly roll-out transformative technologies or systems will depend not only on the basic availability of these technologies and/or systems, but also on the timely development of value chains with the capacities needed for a successful transformation. That means creating a sufficiently robust development environment ranging from technology development to the availability of sufficient capital and skilled labor. Companies should play a proactive role here, particularly when it comes to reducing macroeconomic and microeconomic vulnerabilities and making decisions on the location of industries and businesses on that basis. Companies can and should pursue more industrial policy projects that rely on collaboration between the public and the private sectors in other key areas of transformation, such as those in European battery production. It is incumbent on the companies themselves to come up with these kinds of proposals and concepts.

Technical and non-technical infrastructure is central to a successful transition to climate neutrality, energy security and resilience. Governments and regulators have a key role to play in ensuring non-discriminatory access to such infrastructure. However, especially given the limited investment capacities of governments, joint ventures involving public and private sector players can play an important role in speeding up the transition process. The same is true for non-technical infrastructure (e.g., certifying renewable and low-carbon hydrogen, green steel, green chemical products). Here, strong corporate involvement in designing processes and making information and data available can help drive progress and scale at the needed pace.

As a result of rising commodity and goods prices, some sections of the economy are faced with significantly higher costs, while there are others generating extraordinarily high windfall profits compared to relatively stable markets of pre-crisis periods. These additional profits should – as a priority and for the long term – be invested in transformative technologies and/or systems to generate additional benefits for growth, jobs and social welfare.

References

- Bachmann, R., Baqaee, D., Bayer, C., Kuhn, M., Löschel, A., Moll, B., ... & Schularick, M. (2022). What if? The economic effects for Germany of a stop of energy imports from Russia (No. 36). ifo Institute-Leibniz Institute for Economic Research at the University of Munich.
- Baqaee, D., Moll, B., Landais, C., & Martin, P. (2022). The Economic Consequences of a Stop of Energy Imports from Russia. CAE Focus, 084-2022.
- Beltekian E., Ortiz-Ospina D., Roser M., (2018). Trade and globalization. Our World in Data.
- Bloomberg (2022), Flood of discounted LNG stretches Europe's Gas Terminals, April 2022
- BP (2021). Statistical Review of World Energy, July 2021, 70th edition
- Brown, T., Schlachtberger, D., Kies, A., Schramm, S., & Greiner, M. (2018). Synergies of sector coupling and transmission reinforcement in a cost-optimised, highly renewable European energy system. Energy, 160, 720-739
- Brown, P. R., & Botterud, A. (2021). The value of inter-regional coordination and transmission in decarbonizing the US electricity system. Joule, 5(1), 115-134.
- Busch, T., Bruce-Clark, P., Derwall, J., Eccles, R., Hebb, T., Hoepner, A., Klein, C., Krueger, P., Paetzold, F., Scholtens, B., Weber, O. (2021). Impact Investments: a call for (re)orientation. SN Bus Econ (2021) 1, 33-46.
- Deloitte (2021). The Future of Power. Four scenarios for the European utility sector on its path to climate neutrality by 2050. May 2021. https://www2.deloitte.com/de/de/pages/energy-and-resources/articles/future-of-power-european-utility-scenarios.html
- Carril-Caccia, F., & Pavlova, E. (2018). Foreign direct investment and its drivers: a global and EU perspective. Economic Bulletin Articles, 4.
- Daggash, Habiba A., C. F. Heuberger, and N. Mac Dowell. "The role and value of negative emissions technologies in decarbonising the UK energy system." International Journal of Greenhouse Gas Control 81 (2019): 181-198.
- Fattahi, A., Sijm, J., van den Broek, M., Gordon, R. M., Dieguez, M. S., & Faaij, A. (2022). Analyzing the Techno-Economic Role of Nuclear Power in the Transition to the Net-Zero Energy System of the Netherlands Using the IESA-Opt-N Model.
- Hydrogen Council (2021). A perspective on hydrogen investment, market development and cost competitiveness. February 2021. https://hydrogencouncil.com/wp-content/uploads/2021/02/Hydrogen-Insights-2021-Report.pdf
- Hydrogen for Europe (2021). Charting pathways to enable net zero. https://www.hydrogen4eu.com/
- ICAP (2022). Emissions Trading Worldwide: 2022 ICAP Status Report. https://icapcarbonaction.com/system/files/document/220408_icap_report_rz_web.pdf
- IEA (2021a). Net zero by 2050. https://www.iea.org/reports/net-zero-by-2050
- IEA (2021b). The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions
- IEA (2021c): World Energy Outlook 2021, Paris, France: OECD/IEA https://www.iea.org/reports/world-energy-outlook-2021
- IEA (2022), A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas, IEA, Paris https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas
- IMF (2021). IMF Investment and Capital Stock Dataset, 1960-2019, May 2021
- IPCC (2018). Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24. doi:10.1017/9781009157940.001.
- IPCC (2021). Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf.
- IPCC (2022a). Summary for Policymakers In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf
- IPCC (2022b). Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf
- IRENA (2020). Renewable Capacity Statistics 2020. International Renewable Energy Agency. Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Mar/IRENA_RE_Capacity_Statistics_2020.pdf
- IRENA (2021a), World Energy Transitions Outlook: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.
- IRENA (2021b). Renewable Power Generation Costs in 2020. International Renewable Energy Agency. Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_Power_Generation_Costs_2020.pdf
- IRENA (2022). Renewable Capacity Statistics 2022. International Renewable Energy Agency. Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Apr/IRENA_RE_Capacity_Statistics_2022.pdf

- JRC (2018). Cost Development of Low Carbon Energy Technologies. Scenario-based cost trajectories to 2050. Publications Office of the European Union, Luxembourg. ISBN 978-92-79-77479-9. https://doi.org/10.2760/490059 (JRC109894)
- Kharecha, P. A., & Sato, M. (2019). Implications of energy and CO_2 emission changes in Japan and Germany after the Fukushima accident. Energy Policy, 132, 647-653.
- Labandeira, X., Labeaga, J. M., & López-Otero, X. (2017). A meta-analysis on the price elasticity of energy demand. Energy policy, 102, 549-568.
- Leroutier, M. (2022). Carbon pricing and power sector decarbonization: Evidence from the UK. Journal of Environmental Economics and Management, 111, 102580.
- Olauson, J., Ayob, M. N., Bergkvist, M., Carpman, N., Castellucci, V., Goude, A., ... & Widén, J. (2016). Net load variability in Nordic countries with a highly or fully renewable power system. Nature Energy, 1(12), 1-8.
- Ortiz-Ospina, E., Beltekian, D., & Roser, M. (2018). Trade and globalization. Our World in Data.
- Peters, G. P., Minx, J. C., Weber, C. L., & Edenhofer, O. (2011). Growth in emission transfers via international trade from 1990 to 2008. Proceedings of the national academy of sciences, 108(21), 8903-8908.
- REN21 (2021). Renewables 2021 Global Status Report. Paris. https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf
- Ritchie, H., & Roser, M. (2021). Energy. Published in Our World in Data. https://ourworldindata.org/energy
- Roser, M. and Ortiz-Ospina, E. (2013). Income Inequality. Published online at OurWorldInData.org. https://ourworldindata.org/income-inequality
- Roser, M., & Ortiz-Ospina, E. (2016). Income inequality. Our world in data. October.
- Sakmar, S. L., & Kendall Jr, D. R. (2009). The globalization of LNG markets: historical context, current trends and prospects for the future. In Proceedings of the 1st Annual Gas Processing Symposium (pp. 32-43). Elsevier.
- Shirizadeh, B., & Quirion, P. (2021). Low-carbon options for the French power sector: What role for renewables, nuclear energy and carbon capture and storage? Energy Economics, 95, 105004.
- Shirizadeh, B., Perrier, Q., & Quirion, P. (2022). How sensitive are optimal fully renewable power systems to technology cost uncertainty? The Energy Journal, 43(1).
- Shirizadeh, B. & Quirion, P. (2022). The importance of renewable gas in achieving carbon-neutrality: insights from an energy system optimization model. Energy. 255(C) 124503.
- Solomon, S., Plattner, G. K., Knutti, R., & Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. Proceedings of the national academy of sciences, 106(6), 1704-1709.
- Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R., & De Vries, G. J. (2015). An illustrated user guide to the world input–output database: the case of global automotive production. Review of International Economics, 23(3), 575-605.
- Wang, M., Mao, X., Xing, Y., Lu, J., Song, P., Liu, Z., ... & Zusman, E. (2021). Breaking down barriers on PV trade will facilitate global carbon mitigation. Nature communications, 12(1), 1-16. https://www.nature.com/articles/s41467-021-26547-7
- World Bank (2022a). Commodity Markets Outlook. The Impact of the War in Ukraine on Commodity Markets. April 2022. https://openknowledge.worldbank.org/bitstream/handle/10986/37223/CMO-April-2022.pdf?sequence=3&isAllowed=y
- World Bank (2022b). The Impact of the War in Ukraine on Global Trade and Investment. Equitable Growth, Finance & Institutions Insight. https://openknowledge.worldbank.org/bitstream/handle/10986/37359/IDU0008eed66007300452c0beb208e8903183c39.pdf?sequence=1&isAllowed=y
- World Bank (2022c). State and Trends of Carbon Pricing 2022. State and Trends of Carbon Pricing. May 2022. https://openknowledge.worldbank.org/handle/10986/37455
- Ziegler, M. S., Trancik, J. E. (2021). Re-examining rates of lithium-ion battery technology improvement and cost decline. Energy Environ. Sci., 2021, 14, 1635-1651.

Notes

1 The gross domestic product (GDP) data referred to here is based on purchasing power parities in current international dollars (as reported by the World Banks's World Development Indicators database).

2 The greenhouse gas (GHG) emission data refers to the latest available data by the end of May 2022 for the different countries.

3 The commitments and pledges are based on different metrics, i.e., climate neutrality in some countries and carbon neutrality, decarbonization, zero emissions or net-zero emissions in others. The nature of the commitments vary as well, ranging from targets implemented by law and laid down in policy documents to those made in connection with pledges and declarations or currently under debate.

4 https://www.iea.org/topics/energy-subsidies

5 https://www.rystadenergy.com/newsevents/news/press-releases/blockbuster-year-for-public-eps-as-profits-set-to-soar-to-$834-billion-in-2022-smashing-record/

6 https://carbonpricingdashboard.worldbank.org/

7 https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen/

8 https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/

9 https://www.rapidtransition.org/stories/the-lightbulb-moment-the-rapid-shift-to-leds-and-ultra-efficient-lighting/

10 Levelized cost of electricity is the average unit cost of electricity production by a power plant that includes the levelized overnight cost, fixed and variable operation and maintenance costs, fuel costs and financial costs

11 https://www.weforum.org/agenda/2021/06/energy-us-market-shift/

12 https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets

13 At a compound annual growth rate.

14 Central banks, summary of current interest rates https://www.global-rates.com/en/interest-rates/central-banks/central-banks.aspx

15 https://comtrade.un.org/

16 This division includes the transformation of crude petroleum and coal into usable products. The dominant process is petroleum refining, which involves the separation of crude petroleum into component products through such techniques as cracking and distillation. This division includes the manufacture of gases such as ethane, propane and butane as products of petroleum refineries."

17 According to the NACE 2 classification, electricity and gas sector includes production of electricity, hot water, steam and natural gas through a permanent infrastructure if lines, mains and pipes.

18 The "n-1" principle is an interesting and productive approach in this context. Used mainly in the infrastructure sector today, this principle states that a system must be able to withstand the failure of an essential supplier or infrastructure component at all times to be considered sufficiently reliable.

19 https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3131

20 https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2802

Authors

Prof. Dr. Bernhard Lorentz
Managing Partner
Global Leader Climate Strategy
Tel: +49 151 14881437
blorentz@deloitte.de

Dr. Pradeep Philip
Partner
Head of Deloitte Access Economics
Tel: +61 7 3308 7224
pphilip@deloitte.com.au

Dr. Felix Chr. Matthes
Öko-Institut, Institute for
Applied Ecology
Tel: +49 30 40508 5381
f.matthes@oeko.de

Dr. Johannes Trüby
Partner
Deloitte France
Tel: +33 6 44 38 95 49
jtruby@deloitte.fr

Dr. Behrang Shirizadeh
Manager
Deloitte France
Tel: +33 6 70 26 84 19
bshirizadeh@deloitte.fr

Deloitte.

Issue 09/2022