G20 BRASIL 2024

BUILDING A JUST WORLD
AND A SUSTAINABLE PLANET

G20 Framework Working Group (FWG)
Note to Finance Ministers and Central Bank Governors (FMCBG)

MACROECONOMIC AND DISTRIBUTIONAL IMPACTS OF CLIMATE CHANGE AND TRANSITION POLICIES

October 2024

EXECUTIVE SUMMARY

Addressing climate change is crucial to achieving strong, sustainable, balanced and inclusive growth (SSBIG). 2023 was the warmest year globally on record, with annual average global temperatures fast approaching 1.5°C above pre-industrial levels.[1] From increasingly frequent and severe extreme weather events to shifting agricultural patterns and disruptions in supply of resources, climate change impacts, both chronic and acute, are increasingly visible, and more widespread than previously anticipated—with profound economic and social implications, especially for the most vulnerable.

The impact of climate change and the net zero and low-carbon transitions will be uneven across societies in every member country. The poorest households in society will tend to find it hardest to manage these shocks without government support. Millions of vulnerable people face disproportionate and multidimensional challenges in responding to extreme weather and slow onset events, negatively affecting health, energy, food, water, and livelihood security, and causing migration and forced displacement, loss of cultural identity, and other related risks.[2] While all countries will be affected, countries most disproportionately impacted by climate change are often the ones that lack the means to address it; in particular, they typically lack financing and institutional capacity.[3] Further, some countries most exposed to heat waves, droughts, desertification, land degradation, storms, floods and sea-level rise concurrently confront other pressing development needs.[4] Meanwhile, experiences of the transitions are likely to diverge substantially based on the vulnerability and exposure of different income and social groups and individuals within and across countries. At the same time, it will be important to harness the economic opportunities e.g., for economic growth, employment, technology spillovers and infrastructure enhancement, presented by a just and orderly transition that accounts for country-specific circumstances.

The Note emphasises the need to deliver transitions that account for the macroeconomic and distributional effects which are equitable and orderly, and suggests that in developing approaches that account for country-specific circumstances and maintain broad public support, policymakers should consider the use of:

- **Targeted and carefully designed support measures for vulnerable groups with a focus on those who stand to be negatively affected by the transition**

- **Structural and cross-cutting measures to increase economies' resilience to shocks and improve welfare**

Across these areas, credible and consistent policy sequencing of measures plays an important role in improving the efficiency and effectiveness of policy outcomes. Clear, transparent, and evidence-based communication of policies, including of their rationale and their impact, may also be a powerful and cost-effective way of securing public support.

1. WMO (2024).
2. World Bank (2023).
3. Georgieva et al. (2022).
4. Lenton et al. (2023).

The Note also reiterates the need for global co-operation in the areas of finance, capacity-building and technology transfer on voluntary and mutually agreed terms, which are critical to support developing countries, taking into account their needs and priorities. There are also clear opportunities for international cooperation in improving the distributional analytics and coverage of risks in the economic modelling available to policymakers, alongside knowledge sharing and capacity enhancement on countries' responses to physical and transition risks.

BUILDING ON THE G20'S WORK OF 2023

Based on the mandate from G20 Leaders in 2023, **the G20 Finance Ministers and Central Bank Governors under the 2024 Brazilian Presidency mandated the G20 Framework Working Group to assess the distributional implications of climate change and transition policies.** The present Note has been prepared in this context and draws from technical analyses provided to FWG from the Network for Greening the Financial System (NGFS), Organisation for Economic Cooperation and Development (OECD), UN Economic Commission for Latin America and the Caribbean (ECLAC), Inter-American Development Bank (IADB), and the International Energy Agency (IEA), as well as member-led FWG discussions held in the June and September 2024 FWG meetings, and wider analytical evidence from bodies including the International Monetary Fund (IMF) and World Bank.

This Note builds on the emphasis in the G20 New Delhi Leaders' Declaration that **"the macroeconomic costs of the physical impact of climate change are significant both at aggregate and country levels, and the cost of inaction substantially outweighs that of orderly and just transitions".** The Leaders also highlighted the importance of assessing and accounting for the short, medium and long-term macroeconomic impact of both the physical impact of climate change and transition policies, including on growth, inflation, and unemployment.

The views of the Leaders were underpinned by the G20 Report on Macroeconomic risks stemming from Climate Change and Transition Pathways**,** which was endorsed in the New Delhi Leaders Declaration. The Report highlighted the following:

- **The chronic physical risk imposed by climate change were estimated, based on existing models, to impact up to 6 percent of global GDP by 2050, rising to 18 percent of global GDP by 2100 in a 'current policies' scenario relative to prior trends.[5]**

5. NGFS (2022). These figures are based on damage functions developed by Kalkuhl & Wenz 2020; an updated damage function developed by Kotz et al. (2024) projects significantly higher global losses than those foreseen under the 2020 function. Specifically, in the '2050 Current Policies' scenario, the loss is 6% using the old function; this increases to 14% with the new function. On the other hand, for a 'Net Zero 2050' scenario, projected losses would rise from 2% to 7% by switching damage functions. Note that this shift also comes with a change in modelling assumptions. In previous vintages, NGFS scenarios employed 'high damage' estimates instead of median projections.

- The physical risks from climate change are transmitted to the economy through a range of different transmission channels, mainly due to their impact on factors of production like labour, land, capital, and damages to physical property and businesses.

- The macroeconomic impacts of transitions to low-carbon economies will **depend on the composition of a countries' transition policies** but can be manageable if the appropriate policy mix is implemented. This mix depends on country-specific circumstances.

- Transition risks may affect the economy and financial system through **a range of different transmission channels,** including via asset stranding as well as investment, productivity, and relative price channels.

- The transitions to low-carbon economies **may affect potential output and lead to a reallocation in labour markets.**

- While transition policies can have significant short-term costs, **the choice of mitigation policy measures can potentially have varied effects on growth, fiscal sustainability and inflation,** including positive and negative domestic and international spillovers.

THE MACROECONOMIC AND DISTRIBUTIVE IMPACTS OF CLIMATE CHANGE

The conclusions in this section are drawn from the most recent NGFS climate scenarios, which shed light on the potential macroeconomic impacts of climate change and transition policies through exploration of seven scenarios. Existing models do not capture all possible downside risk, and these scenarios are not forecasts—instead, they provide a starting point for policymakers to assess the potential impacts of climate change and low-carbon transitions, while recognising the scale of uncertainty around both sets of processes. Scenarios distinguish between "acute" and "chronic" physical risks based on the pace of their impact on the economy—while acute risks are most often associated with extreme weather events, chronic risks are driven by more gradual and longer-term changes in climate.[6]

Without the structural transformation necessary to lower emissions, modelling estimates that the impacts from chronic and acute physical risks driven by climate change will impose increasing economic costs every year for all countries and regions.

The GDP costs of chronic physical impacts, before accounting for extreme weather events, are projected to be almost double under a 'Current Policies' scenario compared with a 'Net Zero 2050' scenario.

6. FSB (2021a).

Chronic physical impacts may also undermine price stability. As discussed in the 2024 G20 note 'A menu of policy measures and recommendations to address inequality pressures', inflationary pressures are likely to disproportionately affect low-income households.

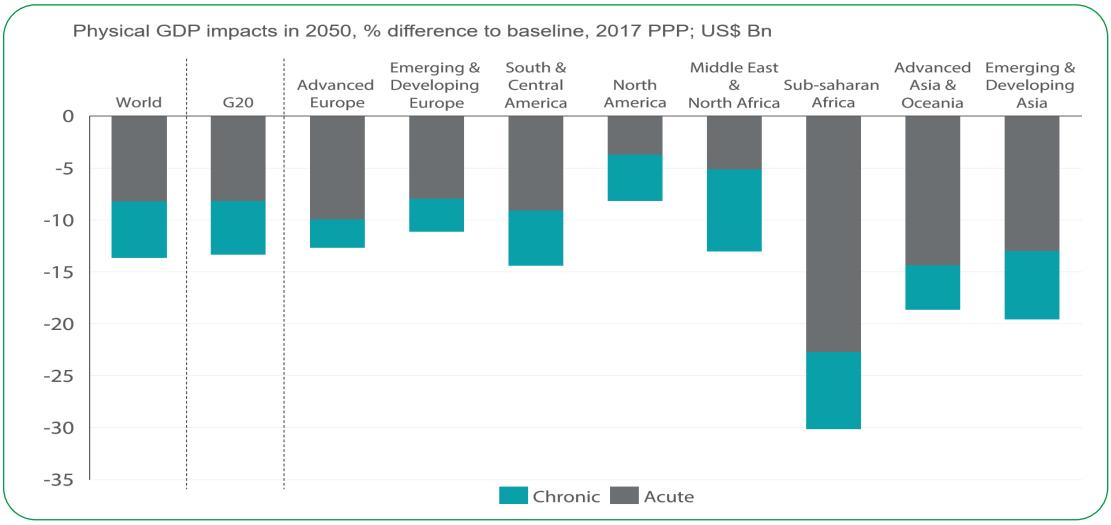
The most substantive effects of chronic physical risks are expected in the Middle East, Africa and Asia—more than double the magnitude of the impacts expected across European economies. There is considerable uncertainty about the magnitude and distribution of these effects, with substantial risks of worse outcomes than presumed under the 'current policies' scenario and 'net-zero 2050' scenario.[7, 8, 9]

On top of this, acute risks such as extreme weather events will become increasingly frequent and severe, generating economic losses and adding to macroeconomic volatility. Droughts and heatwaves pose the largest overall risk to GDP, with impacts varying considerably across regions. According to the World Meteorological Organization (WMO), 91% of deaths related to weather, climate, and water extremes between 1950 and 2019 occurred in developing countries.[10] Climate change poses increasing risks to financial stability, in turn affecting wider macroeconomic conditions; the manifestation of physical climate risks such as extreme weather events, rising sea levels or prolonged heat waves, amongst other events, could lead to sharp falls in asset prices, disruptions in supply chains, higher insurance claims, and greater uncertainty in financial markets, and could have a destabilizing effect on the financial system (including in the relatively short term).[11]

As shown in Figure 1, the GDP losses estimated to result from acute and chronic physical risks together vary substantially across regions, and by much more so than would be suggested by considering only G20 and global aggregates.[12]

7. As per ECLAC (2024) by 2030, per capita GDP losses due to temperature increases in Latin America countries could reach 6.3%, for example. Considering the worsening of acute climate shocks by 2050, recent estimates for six highly exposed countries in the region show that GDP could be between 9% and 12% lower than that corresponding to a trend growth scenario.
8. GDP losses caused by chronic impacts are calculated in each scenario using country-level damage functions as set out in Kalkuhl and Wenz (2020). The methodology does not include damage impacts related to extreme weather events, sea-level rise or wider societal impacts from migration or conflict and therefore should be considered a lower bound estimate.
9. Although the Net Zero 2050 NGFS scenario is used throughout this note as illustrative of the impacts of ambitious transitions, commitments on the scale and pace of national climate action vary among G20 members.
10. WMO (2021).
11. FSB (2020).
12. NGFS (2024). In 2022, NGFS modelling of chronic physical risks was improved to account for model uncertainty. However, it is certain that NGFS scenarios still underestimate the impact of physical risks on the macro-economy, as many hazards and transmission channels are not modelled yet, and understanding of the links between climate change and the economy remains partial. NGFS scenarios will continue to evolve as common knowledge is expanded.

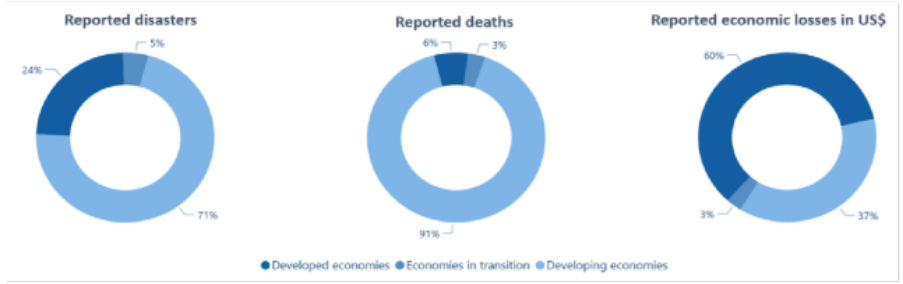
Figure 1. Acute & chronic impacts of climate change by 2050 under 'Current Policies' scenario[13]



Source: NGFS scenarios, 2023, NiGEM model based on REMIND inputs

The direct and indirect impacts of climate change are unevenly distributed across countries, regions, sectors and households. While one in five people globally are estimated to be at high risk from climate-related hazards,[14] the extent to which a specific group of people is affected by the impacts of climate change is determined by exposure, vulnerability, and adaptive capacity which vary significantly across countries, regions, and socioeconomic groups.[15] Looking across countries, reported deaths and relative economic losses to date from climate change have been concentrated in developing countries; economic losses in absolute terms have been larger in developed economies.[16]

Figure 2. Disasters, deaths and economic losses linked to climate change, 1970-2021



Fuente: WMO Atlas of Mortality and Economic Losses from Weather, Climate, and Water Extremes (1970–2021).

13. NGFS (2024); for chronic physical risk the scenario uses damages linked to the 95th percentile of the temperature profile to account for tail physical risks. These figures are subject to significant uncertainty, and are not forecasts.
14. World Bank (2024).
15. Another reason for the heterogenous impact of extreme weather events is the lack of comprehensive insurance coverage. Reducing the insurance gap is essential for enhancing resilience against climate risks; effective insurance mechanisms could also provide support to vulnerable households and contribute to overall economic stability. For further detail see ECB/EIOPA (2023).
16. ECLAC (2024).

In relative terms (i.e., damages as a share of GDP), the physical risk impacts of climate change will be disproportionately high in developing countries. Future climate change exposure is heavily geographically concentrated, with developing countries most affected by physical climate change impacts;[17] in terms of specific physical risks, Europe and Asia appear most exposed to heatwaves, while Africa and North America, are primarily exposed to droughts.[18] Conversely, Latin American countries are historically exposed to storms and floods.[19] Overall, exposure to a given set of physical risks is distributed unevenly both between and within countries. Exposure to any type of climate hazard is highest in low-middle-income countries, followed by upper-middle-income countries.[20] Market and credit risks could also be concentrated in certain sectors of the real economy and geographies. Some emerging markets and developing economies more vulnerable to climate-driven risks, especially those where mechanisms for sharing financial risk are less developed, may be particularly affected.[21]

Due to financial, institutional, or technological barriers, developing countries often have lower levels of adaptive capacity than more advanced economies, increasing their vulnerability.

Unevenly distributed climate impacts will also interact with trends in migration. While estimating future patterns of climate-change induced migration remains challenging, there is increased evidence that climate hazards act as direct drivers of involuntary migration and displacement and indirect drivers through deteriorating climate-sensitive livelihoods.[22] Since 2008, an annual average of over 20 million people are estimated to have been internally displaced by weather-related extreme events. The largest absolute number of people displaced by extreme weather events each year has occurred in South Asia and Sub-Saharan Africa.[23]

In terms of differential impacts across groups within countries, low-income groups tend to be more vulnerable given lower ability to invest in adaptation, poorer health, and more limited access to high-quality services and infrastructure and less capacity to relocate during transitions. This is especially acute for those most reliant on natural resources for their livelihoods.[24] Alongside limited financial buffers to offer protection from financial losses associated with acute events, this can lead to a vicious circle across these groups whereby successive climate-driven shocks lead to increasingly severe income and asset losses, compounding vulnerability. Differential vulnerabilities may also influence internal migration trends, with poorer households more likely to either be forced into low-agency migration as a means of adaptation or be trapped in deteriorating circumstances where migration would be a preferred response.[25, 26]

17. Kozluk and Hodok (2024).
18. NGFS (2024).
19. Between 1970 and 2019, floods were the most frequent cause of disaster, accounting for 77% of deaths and 59% of economic losses in South America. Droughts were responsible for the second-highest percentage of economic losses (28%). ECLAC (2023).
20. World Bank (2024).
21. FSB (2020).
22. IPCC (2022).
23. IDMC (2022).
24. OECD (2024).
25. Leichenko and Silva (2014).
26. In Latin America and the Caribbean, more than 50% of the population is poor or at high risk of falling into poverty as a result of economic or climate shocks. Moreover, poor households are often located in areas more prone to disaster risks, such as hill slopes subject to landslides or riverbanks subject to flooding. ECLAC (2024).

Heterogenous impacts across industries and workers should also be expected. Workers in construction, agriculture, and casual work in urban areas—often characterised by substantial informal employment—are likely to face higher losses in productivity from heatwaves, while industries more reliant on ecosystem services—such as agriculture, fisheries and tourism—will be especially vulnerable to output losses from extreme events and climate-driven biodiversity loss.

In addition, **the uneven distribution of impacts extends beyond income or employment groups.** Marginalised segments of society are structurally vulnerable to climate change.[27] For example, climate change impacts men and women differently, largely due to relative influence, roles, responsibilities and decision-making power at the household and community levels. Climate hazards are also associated with increased violence against women, girls and vulnerable groups.[28]

The macroeconomic and distributional impacts of low-carbon transition efforts

Efforts to transition across members will have direct and indirect effects on key macroeconomic fundamentals. In the NGFS 'Net Zero 2050' scenario, GDP is higher globally, across the G20 as a whole, and across almost all G20 members by 2050 compared to a 'Current Policies' scenario.[29]

The transitions present significant direct economic opportunities for members, through the scaling of new industries and the reduction in energy costs, as well as the development of efficient transport and infrastructure network at the domestic and global levels.[30] Estimates suggest 15 million net additional jobs could be created globally by 2050.[31] These impacts would be additional to the substantial economic benefits of avoiding more extreme climate change scenarios, and the very significant economic, social and political costs that these would impose.[32]

The investment needs of transitions will require significant provision from a range of public and private sources. Estimates of the capital investment needs range from $3.5tn to $5.6tn annually, with significant divergences in the scale-up required across countries and regions;[33] a substantial proportion of investment required consists of flows to the energy and transport sectors. Despite requiring higher capital investment in the short term, the overall cost of using renewable energy is lower in the medium- to long- term due to lower operational costs, suggesting efficiency and cost-effectiveness benefits from transition to cleaner energy sources.[34] However, meeting these investment needs will be challenging in the face of rising public debt and limited fiscal space. As such, delivering transitions in the

27. OECD (2024).
28. IPCC (2021).
29. NGFS (2024) – NGFS scenarios are not forecasts and continue to evolve as common knowledge is built across the academic and central banking communities.
30. IEA (2021); IEA (2024); IADB (2024).
31. McKinsey Global Institute (2022).
32. IMF (2022).
33. Energy Transitions Commission (2023) estimate $3.5tn of global capital investment needs, 70% of which is required for energy investment; Climate Policy Initiative (2023) estimates global needs of $5.6tn annually in an average scenario.
34. IEA (2024) Strategies for affordable and fair clean energy transitions.

most efficient and cost-effective way, with the optimal use of public and private capital, will be critical—as acknowledged by the G20 Sustainable Finance Working Group (SFWG) and its work on overall efforts to enhance the role of the private sector in addressing climate change, in a manner that complements public funding and ensures scaled-up financing from a wide variety of sources. Further, the G20 Infrastructure Working Group is focused on fostering private investment, including by (i) laying out key steps to develop infrastructure as an asset class and promote bankable infrastructure projects; (ii) exploring innovative financial instruments, blended finance, and strengthening project pipelines and infrastructure plans to attract private capital; and (iii) facilitating direct engagement between the G20 and private investors.

Some policies may add to the costs of transition. The United Nations Framework Convention on Climate Change (UNFCCC) acknowledges that land use can contribute significantly to the mitigation of climate change, including through the promotion of sustainable management of forests and oceans as well as other terrestrial, coastal and marine ecosystems.[35, 36] However, adopting unsustainable agricultural or mining practices can cause additional negative impacts on ecosystems, especially in developing economies. Similarly, moving unsustainable extractive policies elsewhere, such as to the world's oceans, risks harm to marine ecosystems, e.g., through deep sea mining.[37] Poorly located wind farms or hydroelectric dams can affect ecosystems and wildlife at scale while presenting domestic and international societal and political risks.

Transition policies may also pose significant real economy, fiscal and financial stability risks, particularly if transitions prove abrupt, disorderly, poorly designed, or lacking in international coordination and signalling.[38] Variation in the stringency and coverage of the transition policies across countries may also generate competitiveness impacts, and can lead to shifts in trade patterns. This can generate international spillover effects, some of which may dilute the climate mitigation benefit of the original national-level policies. At the same time, there can be positive cross-country spillovers both from ambitious climate mitigation through lower costs of climate change globally and from transition investments through technology and growth diffusion to other countries.

Sudden shifts in carbon pricing, unanticipated regulatory changes, or rapid technological advancements could lead to risks including asset stranding, greater market volatility, and sector-specific financial losses. Despite the increasing efforts to better understand the financial consequences of climate change, many issues remain largely unexplored. With significant climate risks locked in, and in places already impacting the global economy, it is vital members collaborate and maintain momentum on addressing risks in this area via coordinated actions across the four areas highlighted in the Financial Stability Board's G20-endorsed Roadmap for Addressing Climate-related Financial Risks: firm-level disclosures, data, vulnerabilities analysis, and regulatory and supervisory practices and tools.[39]

35. UN (1992).
36. World Economic Forum (2022).
37. Niner et al. (2018).
38. FSB (2020); Shui Tang Wu & Shing Wan (2023).
39. FSB (2021b).

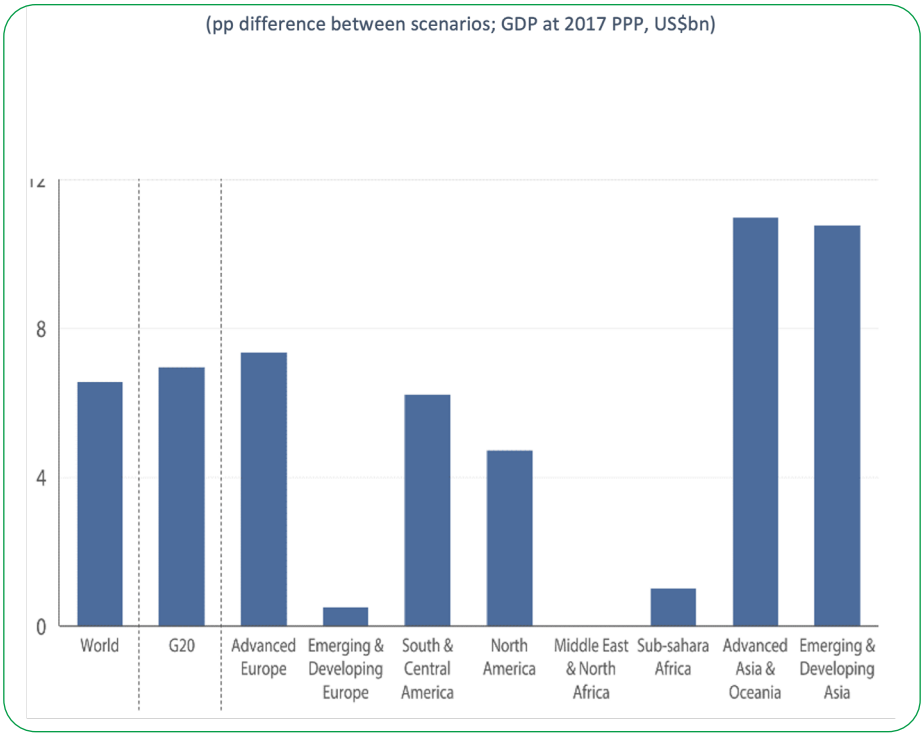
Near-term macroeconomic effects of efforts to transition to a low-carbon global economy depend on a range of factors. This will include the starting point of each economy, access to adequate amounts of affordable financial resources, the pace of technological innovation and access to low-cost technologies, the policies deployed (including their design and sequencing), how any revenues generated are recycled, and the credibility of policy. The structure of markets and their supply-demand dynamics will also play a role—for example, over the past decade, innovation, learning and economies of scale have pushed down the costs of key energy technologies significantly. However, this trend also means that the costs of raw material form a larger element of the total cost of clean energy technologies.

Transitions will impact economic aggregates. For example, modelling suggests that immediate and coordinated transitions under a 'Net Zero 2050' scenario may lead to a substantive increase in inflationary pressures across G20 members before reducing over a five-year outlook.[40] As any transition pathway will increase demand for key inputs, there is uncertainty over whether supply will expand quickly enough to meet the demand implied by transition plans. Anticipated volatility in energy, commodity and other input prices, and shortages of critical minerals, semiconductors and other components could spill over to consumer prices. The impact on actual inflation will depend on a number of factors, including the specific design and phasing of mitigation policies. Moreover, the broader macroeconomic context in which the transition occurs, including initial inflation levels and the anchoring of expectations, also plays a role. Against this backdrop, central banks are strongly committed to achieving price stability in line with their respective mandates. Credible and predictable climate policies would make it easier for central banks to achieve these goals during the transition phase and it is important to highlight that, in the long term, the impact of mitigation policies on inflationary pressures is lower in the "Net Zero 2050 scenario", than in "Current Policies" or "Delayed Transition" scenarios.

Overall, the net effect of climate policies on GDP remains uncertain in the medium-term, with estimates ranging from slightly negative to significantly positive effects. Some models predict a significant increase in GDP by up to 7 percent by 2050, while others forecast a decrease of up to 2 percent, relative to current prices.[41] In the long run, the physical costs of climate change dominate such that action is clearly preferred to inaction.

40. NGFS (2024). To note, the assumptions of monetary response behaviours to inflation impacts are based on a dual mandate to target inflation and nominal GDP and may not capture accurately the monetary response of inflation-targeting central banks.
41. NGFS (2024); Wood Mackenzie (2022).

Figure 3. GDP deviation of 'Net Zero 2050' versus 'Current Policies' scenarios in 2050



While critically important for economies and societies in the short- and long-term, transition pathways also present major distributional challenges, both domestically and internationally. Depending on the policy tool, the sector addressed, the design of the policy, and initial socio-economic conditions in a country, transition policies can have very different distributional effects.[42] To combat increasing inequality and improve the political acceptability of decarbonisation, these distributive effects should be recognised and addressed.

The effects of climate change mitigation policies on employment will vary significantly across sectors and population groups. The distributional effects of climate policies through labour market can be assessed i) from a sectoral perspective, as some sectors will be more affected than others by climate policies; ii) from a skills perspective, as skills profiles will shift over the course of transitions and across industries; iii) from a spatial perspective, as jobs at the local level could be displaced as a result of structural changes in the economy resulting from climate policies and; iv) from a temporal perspective, as jobs may be lost before new jobs are created.[43] These distributional effects can intersect with existing inequalities; for example, women are under-represented in green jobs.[44]

42. Bruegel (2018).
43. OECD (2024).
44. IMF (2024).

Labour market shifts are expected to be geographically concentrated, particularly in areas centred around fossil-fuel based production sectors and other hard-to-abate industries, depending on the transition pathways followed. This is likely to lead to significant regional shocks beyond direct job losses in specific sectors, as some members have previously experienced in historical episodes of 'de-industrialisation'. Low-skilled workers and those with lower educational attainment may be most negatively affected, as they have higher adjustment costs and face greater barriers to reskilling and job mobility. From a spatial point of view, carbon-intensive jobs destroyed tend to be concentrated in certain areas, such as around production sites. Therefore, the negative effects at the local level could be significant from both economic, social and political perspectives. This should be taken into account while designing policies.

Responses to the macroeconomic and distributional risks of climate change and the transition

As conveyed in detail in the G20 Report on Macroeconomic risks stemming from Climate Change and Transition Pathways in 2023, there is a clear case for orderly and just transitioning to a low-carbon economy to mitigate the macroeconomic impacts of climate change.

The optimal macroeconomic policy mix for transition will vary by country and sector. An inclusive, swift, cooperative and customised approach, built on sound macroeconomic fundamentals, will be essential to limit the costs and risks associated with the transition while integrating country-specific circumstances and approaches. Common across members will be the importance of sound macroeconomic and fiscal fundamentals, to create an enabling environment for more and better investment and ensure better quality and composition of public finance. Recognizing that resources are limited, governments need to work towards achieving their climate targets in a cost-effective way.

Depending on their specific circumstances, countries may choose among a range of transition policy options including carbon pricing, non-pricing approaches, public investment, employment initiatives, incentives, feebates, regulation and subsidies. Policies that ensure a simple and effective regulatory environment can facilitate the efficiency of resource allocation during the transition, while policies promoting green skills and employment, for example employment initiatives and structural changes in the education system,[45] can support labor markets through transitions. Implementing an optimal mix of country-specific policy interventions to respond to climate change will maximise benefits and requires increased cooperation due to the global nature of the risks and potential for spillovers. A mix of policies will be needed to accelerate low-carbon development, given their varying strengths and weaknesses. Each transition policy instrument comes with macroeconomic benefits and costs, and the overall choice of mitigation and adaptation policy measures may have varied impacts on growth and inflation.

While non-revenue-based measures such as regulations may be easier to implement and will be required to address emissions, particularly in less price-sensitive sectors, tools that generate a revenue stream, such as carbon pricing, can provide a means to fund green investments.

45. OECD (2024).

The distributional challenges arising from transitions to low-carbon economies should be managed in a way that maximises the effectiveness and fairness of transition policies, while exploiting the opportunities of international cooperation to minimise negative spillover effects, especially in high-emissions sectors, and maximise positive effects.

The design of the transition policy instruments chosen will be a key driver of distributional impact. Countries will choose from a range of policy instruments that align effectively with their specific circumstances, alongside their commitments under the Paris Agreement and wider UNFCCC processes.

Climate policies which result in **changes in relative prices**, such as carbon taxes or fuel economy standards, **will affect households differently across the income and spatial distribution** as they consume different baskets of goods—for example, with rural households spending more on fuel than urban counterparts.[46] The ability of households and businesses to adjust their behaviour in response to pricing is also key. While design matters for impacts, the overall effects of carbon and energy taxation may diverge between income groups across countries.[47] For instance, policies that affect the price of energy will be regressive if the share of energy consumption decreases with income, in the event that revenues from pricing policies are not recycled in a progressive manner. Some members, and low-income groups within members, are particularly exposed to the risk of energy affordability with even small increases in the price of energy potentially aggravating energy poverty[48]—as evidenced by the acute and distributionally divergent impacts of the recent global energy price spike. Similar considerations apply in respect of agri-food. Monetary and fiscal authorities should take steps where necessary and as per their institutional mandates to deliver on price stability objectives, as appropriate.

To deliver transitions which are economically sound, fiscally sustainable and equitable, and account for country-specific circumstances, policymakers may consider the use of:

- **Targeted and carefully designed support measures for vulnerable groups with a focus on those who stand to be negatively affected by the transition,** to make the overall policy mix more equitable. Policies may consist of fiscal, market and regulatory mechanisms. The most effective and efficient set of measures will depend on country context—for example, in some countries a reduction in personal income taxes would not reach vulnerable groups that are not in formal employment, while lump-sum transfers may be less efficient than reducing specific taxes. A mix of measures, including the use of social protection systems, may maximise welfare gains and create support for a green tax reform across the distribution; though implementing transfers efficiently may require innovations in transfer mechanisms.[49] Support measures may also include active labour market policies and regulations supporting reallocation, upskilling and reskilling programs, and reforms to education and training, alongside targeted social protection measures to support affected workers during sectoral transitions. Reform and expansion of public transportation and targeted place-based policy can also provide support.

46. Vona et al (2021); OECD (2021).
47. Douenne (2020); Immervoll et al. (2024); Dorband et al (2019); Steckel et al. (2021).
48. Immervoll et al. (2024); Greenstone (2024).
49. OECD (2022).

- **Structural and cross-cutting measures to increase economies' resilience to shocks and improve welfare.** At the national level, strong productivity growth and robust macroeconomic frameworks will provide governments with resources to support the mitigation of distributional risks of transitions. Governments should look to structural reforms with these objectives in mind. Maintaining price stability and financial stability will also be a necessary basis for resilience. Further, improving administrative capacity, design and coverage across social welfare systems could support members to target state revenues in an efficient and fiscally sensitive way—boosting the ability to effectively mitigate shocks. Alongside this, judicious and coherent use of industrial policy in order to transform production systems and consumption patterns can provide support for an equitable transition.

Across these areas, credible and consistent policy sequencing plays an important role in improving the efficiency and effectiveness of policy outcomes. Policy certainty is critical for investment in low-carbon technologies and infrastructure. Therefore, policy makers may also consider the introduction of policies that set direction for future actions, as and when appropriate subject to country-specific circumstances. In this context, as across the transitions as a whole, coordinated whole-of-government approach will be highly beneficial to making ambitious progress and minimising economic and social risks.

To enable governments to design and deliver transition policies, finance, capacity-building and technology development and transfer on voluntary and mutually agreed terms are critical enablers, with public and private finance playing a significant role. There is a need for increased international collaboration and support, including with a view to scaling up climate finance and investment in developing countries for both mitigation and adaptation efforts, accelerating broadly accessible technological innovation, enhancing resilience and low-greenhouse-gas emissions pathways and supporting ambitious green industrial planning and strategies. Under the Brazilian Presidency, the SFWG has developed a set of high-level G20, voluntary, and non-binding principles for transition plans to advance their design and implementation.

Effective distributional analysis can substantially enhance these efforts—members with expertise in this should work through the G20 and bilaterally to share knowledge and frameworks. Alongside this, wider efforts to accelerate the integration of non-linear and complex macroeconomic and distributional impacts of climate change and transition policies into economic modelling and analysis will be of considerable benefit to authorities and are welcomed.

Finally, **further work should be undertaken to strengthen knowledge capacity on the responses of public authorities to climate change and transition risks**. This can include further analysis on ways to mitigate inflationary pressures from the transition, and knowledge sharing and capacity building on central bank responses between G20 members. It is important to continue and build on work already underway, including through the NGFS.

As member experiences highlight, the political acceptability of climate mitigation and adaptation policies is closely linked to perceived costs and their distribution, and their impacts on one's own households. Support for climate change policies

increases if they are perceived as effective and progressive. Given this, mainstreaming the consideration of distributional equity into national transition policymaking may enable members to further increase the ambition and effectiveness of their transitions by mitigating the risk of a negative public response to policy mixes deemed unfair or distributionally insensitive. Effective public engagement and communication may also deliver significant value in increasing the political acceptability and the legitimacy of climate policies. Clear, transparent, and evidence-based communication of mitigation and adaptation policies, including of their rationale and their impact, may be a powerful and inexpensive way of securing public support.

Annex. Member experiences on the macroeconomic and distributional impacts of climate change and transition policies

Experiences shared by members on heterogenous within-country impacts of climate change

Australia

Australia is one of the most vulnerable developed countries in the world to the impacts of climate change, with extreme events like drought, heatwaves, cyclones and floods affecting production and value chains. Population centres have seen declines in rainfall during cooler months; including a 15% decrease since 1970 in the south-west, and a 10% drop since the 1990s in the south-east. Cooler months in these regions make up the main growing season for most crops. Severe droughts are expected to become more frequent, especially across southern Australia. The Millennium Drought (2001 to 2009) reduced farm production by 25 per cent, reducing GDP growth by one percentage point and agricultural sector employment by 70,000 (a 15% fall).

Brazil

Recent extreme weather events in Brazil, such as the severe flooding in the state of Rio Grande do Sul, have highlighted the vulnerability of certain regions and the urgent need for adaptation measures. This event caused significant damage to infrastructure, agriculture and livelihoods, underscoring the importance of coordinated efforts to reduce risk and build resilience. However, the impacts of climate change are not uniform across the country. While some regions are experiencing heavy rainfall and flooding, others are facing extensive drought, which has led to a record number of fires in several regions, with environmental and economic impacts.

European Union

The European Commission JRC Territorial Risk Assessment of Climate in Europe (TRACE or PESETA V) project is conducting a regional climate risk assessment, considering fifteen climate impact areas for around 1400 regions in Europe. Preliminary results indicate large asymmetries across regions, with a clear north-south divide; southern European regions could undergo GDP losses higher than 1.5% (some regions surpassing 3%), much higher than those in central and northern European areas. These findings highlight the scale and distribution of economic impacts (% GDP) by 2050 under a 2C global warming scenario.

India

India is experiencing full range of climate change impacts, ranging from floods and droughts to heat waves and glacier melt. The fundamental prerequisite of the country's development is adaptation, especially reducing vulnerability and exposure. The Initial Adaptation Communication submitted to UNFCCC mentioned the cumulative need of expenditure for

adaptation to be ₹56.68 trillion up to 2030. An increase in the flow of international finance to India will play a crucial role in meeting its long-term sustainable development and low-emission growth goals.

Mexico

Banco de México is committed to better understanding the macroeconomic and distributional impacts of climate change and transition policies. The bank's Financial Stability Report periodically analyses vulnerabilities associated with climate change and transition risks. The Bank's Regional Report further examines socioeconomic indicators across regions, as geographic differences may lead to divergent implications for transition policies. Previous examples have included analyses of vulnerability to droughts across different elements of the financial sector, and the impact of tropical cyclones on food prices across regions. This has shown that adaptation measures could be increasingly necessary to mitigate the distributional effects of extreme climate events, and the public sector and financial system must actively finance the necessary investment, particularly for SMEs and more vulnerable regions.

Experiences shared by members of transition impacts on employment and policy responses

Australia

The Australian Government is establishing the Net Zero Economy Authority to ensure that Australia's regions and workers benefit from the transition to a net zero economy. Place-based policy responses will play an important role in ensuring a just transition as impacts will differ across regions. The NZEA will support workers through transition, including through the Energy Industry Jobs Plan, supporting workers at closing coal- and gas-fired power stations.

Sustainable and equitable solutions require inclusive policy making, emphasising broad social dialogue and participation, including Indigenous Peoples. Avenues such as the First Nations Clean Energy Strategy ensure the inclusivity and equitability principles of just transition are embedded in Australia's national efforts. This includes the Carbon Farming Outreach Program, where First Nations groups offer culturally appropriate carbon farming information. Further, the Australian Renewable Energy Agency has mechanisms in place to enable Indigenous groups to provide evidence of consent and governance arrangements to support renewable energy developments.

Brazil

Brazil is committed to addressing climate change by leveraging its unique energy matrix, while recognizing the uneven impacts of climate change across its diverse territory. In response to recent events and urgent actions, the Brazilian government has adopted several measures to address the flooding in Rio Grande do Sul, such as mobilizing support from citizens and other regions, direct income transfers to vulnerable groups, implementing fiscal and credit measures to support local government, micro and small enterprises and

farmers. In addition, due to the high number of recent fire outbreaks, the government has opened an extraordinary credit of R$ 514 million to combat forest fires in the legal Amazon.

In a more structural context, Brazil's Ecological Transformation Plan (Plano de Transformação Ecológica) is part of its commitment to a just transition to a low-carbon economy. This plan prioritizes strategic sectors such as low-carbon hydrogen production and reinforces Brazil's commitment to a sustainable future. The development of the Brazilian Sustainable Taxonomy, based on international experience, to encourage investment in more sustainable sectors and technologies to address climate issues, stands out. The establishment of a Climate Fund (Fundo Clima) further demonstrates this commitment by providing a national climate fund to finance adaptation and mitigation actions. Continued diversification of the energy matrix and investment in new low-carbon technologies are central to Brazil's sustainable development strategy, driving the creation of green jobs. Brazil is committed to ensuring a just transition, taking into account the socio-economic impacts on different regions and sectors, and creating opportunities for all. This underscores the country's potential to lead the global energy transition.

Canada

Canada is pursuing a just transition domestically through climate policies and frameworks which are inclusive in their development and make efforts to reduce negative socioeconomic impacts in their implementation. This includes the Canadian Sustainable Jobs Act, which was based on over two years of extensive consultation with provinces, Indigenous Peoples, workers and unions, industry, environmental & civil society organizations, and interested Canadians. A key element of this approach is the establishment of a Sustainable Jobs Partnership Council that will, via social dialogue, provide independent annual advice on measures to foster the creation of sustainable jobs and support workers and communities. This advice will inform a Sustainable Jobs Action Plan, to be released every 5 years starting in 2025, outlining the actions the Government of Canada is taking to support workers and communities in the net-zero transition.

European Union

Shaping the green transition in such a way that economic opportunities are fully reaped and employment risks are mitigated is a key priority of the EU. Overall, policy impacts from the EU's "Fit for 55" climate policy package are expected to be up to +0.5 percent of current employment or 1 million additional jobs by 2030. To ensure that all citizens and territories profit from the new economic opportunities and that no one is left behind in the transition, the EU provides targeted support through the Just Transition Mechanism. The Mechanism is expected to mobilise EUR 55 billion between 2021 and 2027 and will protect citizens notably by facilitating employment opportunities in new and transitioning sectors, offering re-skilling opportunities and creating new jobs in the green economy and supporting companies in their transition to a low-carbon economy. Moreover, the Social Climate Fund (expected to mobilise EUR 86.7 billion over 2026-2032) will support energy efficiency, renovation, clean heating, and zero- and low-emission mobility for vulnerable households and micro-enterprises. The EU also provides technical assistance and facilitates knowledge sharing via the Just Transition Platform, the Initiative for Coal Regions in Transition and general Structural Reform Support through the Technical Support Instrument (TSI).

India

India has been progressively decoupling economic growth from greenhouse gas emissions and is making steady progress towards achieving those commitments mostly based on domestic resources. The emission intensity of GDP reduced by 33 per cent in 2019 as compared to 2005, and the non-fossil fuel as a proportion of installed capacity is 45.8 per cent as of July 31, 2024. As per the updated Nationally Determined Contributions (NDCs), India stands committed to reducing the emissions intensity of its GDP by 45 per cent by 2030 from the 2005 level and enhance the non-fossil fuel as a proportion of total installed electricity capacity to 50 per cent. The Government of India is focused on putting in place appropriate energy transition pathways that balance the imperatives of employment, growth and environmental sustainability. As the lack of adequate storage technology is a hurdle to converting India's vast renewable capacity to generation and distribution, India is working towards promoting pumped storage projects to facilitate smooth integration of the growing share of renewable energy in the overall energy mix. India has a carbon pricing system in place through implicit carbon taxes and an ETS program through the PAT Scheme. Energy efficiency improvement in buildings and appliances is another priority for India. Presently, around 33 per cent of the total electricity consumption is in consumers' commercial and residential categories, estimated to grow to approximately 40 per cent of total electricity consumption by 2031-32. To ensure sustainable development at scale, emphasis has been placed on green energy, evident from the swift increase in non-fossil sources as a share of the total installed capacity of electricity generation. Towards nudging private participation in climate risk mitigation, India's capital market regulator has issued new sustainability reporting requirements under the Business Responsibility and Sustainability Report (BRSR), which are more granular with quantifiable metrics in line with the principles ensconced in the 'National Guidelines on Responsible Business Conduct'. India submitted its Long-Term Low Emission Development Strategy (LT-LEDS) to UNFCCC during COP27 on 14th November 2022. The strategy recognises that the transition to the low-carbon development pathway will entail substantial costs for the development of new technologies, new infrastructure, and other transaction costs.

People's Republic of China

Since setting dual goals in 2020 to achieve peak carbon emissions by 2030 and carbon neutrality by 2060, China has accelerated the development of green and low-carbon industries and a green, low-carbon and circular economy. By the end of March 2023, there were 1.87 million enterprises engaging in green and low-carbon industries. The demand for skills specializing in these fields has also continued to rise, creating a large number of green jobs that can further promote China's "environmentally friendly, low-carbon, and circular" development. The emergence of these employment opportunities has helped to mitigate the displacement of workers caused by the restructuring of traditional industries.

South Africa

The Just Energy Transition Investment Plan (JETIP), launched in 2023, is central to South Africa's shift away from coal dependency, with an investment requirement of around $98 billion over five years. The plan focuses on transitioning to renewable energy, decommissioning coal plants, and upgrading the grid. A core element of JETIP is the focus on an equitable transition, ensuring that workers and communities dependent on coal have access to reskilling and alternative employment. The Disaster Risk Financing Strategy, led by the National Treasury, underscores the need for financial resilience in the face of increasing climate risks. Recent studies indicate that climate-related disasters could cost South Africa between 1-2% of GDP annually over the next decade. Treasury's approach includes exploring innovative financial instruments such as sovereign risk pools and catastrophe bonds, which would provide much-needed fiscal relief in the event of extreme weather events.

United Kingdom

The UK's Net Zero Review,[50] was published to inform the UK Government's delivery of its legally binding target to reach Net Zero Greenhouse Gas (GHG) emissions by 2050. The Review found a range of factors affecting the degree to which a household in the UK is exposed to the macroeconomic and distributional implications of the transition, and the pace at which they may start to realise the benefits of a low-carbon economy. Within each individual technology transition, there are a range of factors that affect the degree to which a household is exposed to, and to which a household is able to manage, the costs of the transition; including, their level of income, geographical location, and consumption habits. One of the key findings of the NZR was that, in the UK context, there was *greater variance across income deciles than within them*.

Both the process and the outcomes of the NZR highlight several lessons for policymakers to consider. This included the need to develop a complete understanding of the distributional impacts of the transition to better design policy; novel and creative use of data to analyze distributional impacts; and ensuring government agencies and departments can collaborate smoothly with each other to assess and respond to issues.

United States

Through the passage and implementation of the Inflation Reduction Act, the United States has prioritised ensuring that transition investments don't just create new jobs, but that they create good-paying jobs. Rules have been established that multiply tax credits if clean energy developers pay good wages and use apprentices from registered programs. These credits make it a good business decision for employers in wind, solar, nuclear, hydrogen, and other clean energy technologies to pay their workers higher wages.

50. HM Treasury (2021).

REFERENCES

Armstrong McKay, D. I. et al (2022) "Exceeding 1.5C global warming could trigger multiple climate tipping points", *Science,* Vol. 377:6611.

Bruegel (2018) *The Distributional Effects of Climate Policies.* Bruegel Blueprint Series, Volume 28.

Cavallo, E. et al (2024) "Distributional impacts of transition policies", IADB analytical note for the G20 Framework Working Group.

Climate Policy Initiative, Allen & Overy (2023) "How big is the Net Zero financing gap?", September 2023.

Dorband, I., Jakob, M., Kalkuhl, M., & Steckel, J. (2019)"Poverty and distributional effects of carbon pricing in low- and middle-income countries – A global comparative analysis", *World Development, 115*, 246-257. doi:10.1016/j.worlddev.2018.11.015.

Douenne, T. (2020) "The Vertical and Horizontal Distributive Effects of Energy Taxes: A Case Study of a French Policy", *The Energy Journal,* Vol. 41:3, pp. 231-54.

Economic Commission for Latin America and the Caribbean (2024), "*Distributional implications of climate change and policy recommendations for an inclusive, just and sustainable transition policy framework",* analytical note for the G20 Framework Working Group.

European Central Bank/EIOPA (2023), *Policy Options to Reduce Climate Insurance Protection Gap: Discussion Paper.* April 2023.

Energy Transitions Commission (2023) "Financing the Transition: How to Make the Money Flow for a Net-Zero Economy", March 2023 .

Financial Stability Board (2020) "The implications of climate change for financial stability", FSB publication.

Financial Stability Board (2021a) "Climate-related risk drivers and their transmission channels", *Basel Committee on Banking Supervision,* FSB publication.

Financial Stability Board (2021b) "FSB Roadmap for Addressing Climate-related Financial Risks", FSB publication. Released 7 July 2021.

Georgieva, K., Gaspar, V. and Pazarbasioglu, C. (2022) "Poor and Vulnerable Countries Need Support to Adapt to Climate Change", *International Monetary Fund,* Blog, March 23 2022.

Greenstone, M. (2024) "The Economics of the Global Energy Challenge", *AEA Papers and Proceedings,* Vol. 114, pp. 1-30.

Group of 20 (2023) *Macroeconomic Risks Stemming from Climate Change and Transition Pathways: A G20 Report.* July 2023.

HM Treasury (2021) *Net Zero Review: Analysis exploring the key issues.* October 2021.

Internal Displacement Monitoring Centre (2024) *Global Report on Internal Displacement.*

International Energy Agency (2021) *Net Zero by 2050: A Roadmap for the Global Energy Sector.*

International Energy Agency (2024) *World Energy Outlook Special Report: Strategies for Affordable and Fair Clean Energy Transitions.*

International Monetary Fund (2022). *Near-term Macroeconomic Impact of Decarbonization Policies*. IMF World Economic Outlook, October, chapter 2.

International Monetary Fund (2024) *Green Jobs and the Future of Work for Women and Men*. IMF Staff Discussion Note.

Immervoll, H., O'Donoghue, C., Linden, J., & Sologon, D. (2023) "Who pays for higher carbon prices?: Illustration for Lithuania and a research agenda", in *OECD Social, Employment and Migration Working Papers*. OECD Publishing, Paris. doi:10.1787/8f16f3d8-en.

Institute and Faculty of Actuaries; University of Exeter (2023) "The Emperor's New Climate Scenarios".

Intergovernmental Panel on Climate Change (2021) *Sixth Assessment Report: Impacts, Adaptation and Vulnerability*. Chapter 7: Health, Wellbeing and the Changing Structure of Communities.

Jones M. W. et al. (2023) "National contributions to climate change due to historical emissions of carbon dioxide, methane, and nitrous oxide since 1850", *Scientific Data,* Vol. 10:155.

Kalkuhl, M. and Wenz, L. (2020) "The impact of climate conditions on economic production. Evidence from a global panel of regions", *Journal of Environmental Economics and Management,* Vol. 103:C.

Kotz, M., Levermann, A. and Wenz, L. (2024) "The economic commitment of climate change", *Nature,* Vol. 628, pp. 551-557.

Kozluk, T. and Hodok, J. (2024) "The macroeconomic and distributive impacts of alternative energy transition pathways and climate change", OECD analytical note for the G20 Framework Working Group.

Leichenko, R. and J.A. Silva (2014) "Climate change and poverty: vulnerability, impacts, and alleviation strategies", Wiley Interdiscip. Rev. Change, 5(4), 539–556, doi:10.1002/wcc.287.

Lenton, T. M., et al. (eds) (2023), *The Global Tipping Points Report 2023*. Exeter, UK: University of Exeter.

Network for Greening the Financial System (2022) "NGFS climate scenarios for central banks and supervisors", September 2022.

Network for Greening the Financial System (2024) "Macroeconomic aspects of climate change: Main results from the latest NGFS climate scenarios and initial perspectives on the monetary policy implications of climate change", analytical note for the G20 Framework Working Group.

Niner, H. J. et al. (2018) "Deep-Sea Mining With No Net Loss of Biodiversity – An Impossible Aim", *Frontiers in Marine Science,* Vol. 5.

Ohlendorf, N., Jakob, M., Minx, J., Schröder, C., & Steckel, J. (2020). "Distributional Impacts of Carbon Pricing: A Meta-Analysis", *Environmental and Resource Economics,* Vol. 78:1, pp. 1-42.

Organisation for Economic Cooperation and Development (2021) "The inequalities-environment nexus: Towards a people-centred green transition", *OECD Green Growth Papers*, No. 2021/01, OECD Publishing, Paris.

Organisation for Economic Cooperation and Development (2022) "Why governments should target support amidst high energy prices", *OECD Policy Responses on the Impacts of the War in Ukraine*, OECD Publishing, Paris.

Shui Tang Wu, G. & Shing Wan, W. T. (2023) "What drives the cross-border spillover of climate transition risks? Evidence from global stock markets", *International Review of Economics & Finance,* Vol. 85, pp. 432-47.

Steckel, J., Dorband, I., Montrone, L., Ward, H., Missbach, L., Hafner, F., … Renner, S. (2021) "Distributional impacts of carbon pricing in developing Asia", *Nature Sustainability,* Vol. 4:11, pp. 1005-1014.

United Nations (1992) *UN Framework Convention on Climate Change.*

UN Commission on Trade and Development (2023) "Technical note on critical minerals: Supply chains, trade flows and value addition", Working paper UNCTAD/DITC/MISC/2023/14.

Vona et al (2021) "Managing the distributional effects of environmental and climate policies: The narrow path for a triple dividend", In *OECD Environment Working Papers*. OECD Publishing, Paris. doi:10.1787/361126bd-en.

Wood Mackenzie (2022) "No pain, no gain: The economic consequences of accelerating the energy transition" Insight Papers, Edition 12.

World Bank (2023) "Social Dimensions of Climate Change", updated on April 1st 2023, https://www.worldbank.org/en/topic/social-dimensions-of-climate-change.

World Bank (2024) "Poverty, Prosperity, and Planet 2024: Pathways Out of the Policycrisis".

World Bank (2020) *Poverty and shared prosperity 2020: Reversals of fortune.*

World Economic Forum (2022) *Global Risks Report 2022.*

World Meteorological Organisation (2021) *The WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970-2019).*

World Meteorological Organization (2024) *State of the Global Climate 2023*. Published 19 March 2024.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