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Emerging Markets Forum

Climate Change Policy for Developing Countries[1]

Chapter 9

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Introduction

This chapter attempts to take stock of what has been achieved in the COP 26 meetings held in Glasgow in November 2021 and suggests the course of action that developing countries should follow in subsequent negotiations. Ultimately, there was progress in several areas, but many critical issues remain unresolved. Developing countries need to evolve a constructive approach that can carry the dialogue further and fill in the remaining critical gaps.

The chapter is organized as follows. Section 1 presents a brief review of climate change negotiations to show that despite apparently irreconcilable differences between developed and developing countries in the early stages, the negotiations were successful in narrowing these differences very considerably over time. Section 2 summarizes the findings of the Intergovernmental Panel on climate change (IPCC) on the impacts of a rise in global temperature of 2°C and above, which was a critical input into COP 26. Section 3 reviews the outcomes of COP 26 and indicates the areas where more remains to be done. Section 4 presents an assessment of what developing countries have to do to implement their COP 26 commitments. Section 5 discusses the scale of financial support developing countries will need to achieve climate-related goals. Finally, Section 6 gives recommendations on how developing countries should now proceed.

Narrowing Differences over Time

Scientists have been worrying about climate change for well over a century.[4] However, it was only in 1988 that the issue first surfaced on the international stage when the UN General Assembly recognised it as a global problem and set up the IPCC to provide scientific guidance in this area. This was followed by the Earth Summit in Rio in 1992, which discussed several aspects of the environment and sustainability and formally acknowledged that global warming, which is caused by rising concentration of CO_2 and other greenhouse gas (GHGs) in the atmosphere, was a threat to life on

1. The work on this paper has been carried out at the Centre for Social and Economic Progress (CSEP), New Delhi. An earlier version of this chapter was published as a CSEP working paper. We are grateful for very helpful comments received from Amar Bhattacharya, Anne O. Krueger, Harinder Kohli, Jagadish Shukla, Laveesh Bhandari, Lord Nicolas Stern, Raavi Aggarwal, Rahul Tongia, Rajat Nag and Rakesh Mohan. Needless to say, the errors that remain are entirely ours.

2. Distinguished Fellow, CSEP, and former Deputy Chairman of the erstwhile Planning Commission of India.

3. Associate Fellow, CSEP, New Delhi.

4. Irish physicist John Tyndall was the first to demonstrate in 1859 the absorption of heat by certain gases—what is now known as the greenhouse effect. Swedish scientist Svante Arrhenius claimed in 1896 that fossil fuel combustion may eventually result in enhanced global warming. One half of the 2021 Nobel Prize in Physics was jointly awarded to two climate scientists, Syukuro Manabe (US) and Klaus Hasselmann (Germany) for work done in the 1960s and the 1970s, respectively, on models linking weather with climate.

earth. The Rio Summit formally launched the UN Framework Convention on Climate Change (UNFCCC) as a negotiating forum on climate change issues for all countries of the world.

Developing countries originally took the view that since the higher concentration of GHGs in the atmosphere was primarily due to the burning of fossil fuels by developed countries as they industrialized, the burden of reducing emissions to halt global warming must fall on them. Developing countries were beginning their development process, which would involve an increase in energy use and therefore emissions. They should not be restrained from doing so, but they could be encouraged to undertake voluntary mitigation actions, for which they must be supported financially. In addition, developing countries would also need financial assistance to meet the costs of adapting to climate change which was not caused by them.

The Kyoto Protocol (1997)

The first international agreement on reducing emissions was the Kyoto Protocol signed in 1997. It enshrined an asymmetric approach, imposing emission reduction targets only on developed countries. The principle of financial assistance to developing countries was conceded, though no amounts were quantified.

The Kyoto Protocol was not successful. The first commitment period (2008–12) had very modest targets: a 6–8 per cent reduction in GHG emissions from 1990 levels. The US did not ratify the Protocol and other developed countries withdrew later, citing non-participation of developing countries as the reason. The Protocol never went beyond the second commitment period (2012–20).[5]

The Copenhagen Accord (2009)

COP 15 in Copenhagen in 2009 was an important step forward in climate negotiations. It was the first time the international community adopted the target that global warming should be limited to below +2°C. Developing countries as a group remained unwilling to commit to reducing emissions, but some developing and developed countries agreed that the way forward was for developing countries to adopt some mitigation measures that would reduce the 'emissions intensity of GDP'[6] and for developed countries to provide financial assistance reaching US$100 billion per year by 2020 for developing countries' mitigation and adaptation. This agreement, which was called the Copenhagen Accord, was finally adopted by over 130 parties in COP16 at Cancun (Mexico) in 2010.

The Paris Agreement (2015)

COP21 in Paris in 2015 was the next major advance. It saw progress in three critical areas:

- First, the global warming objective was restated to limit global warming to 'well below 2°C and ideally to 1.5°C'. This was a concession to small island nations reflecting the fact that a sea-level rise resulting from a +2°C global temperature increase would pose an existential threat to their inhabitants;
- Second, all parties, including developing countries, made commitments in the form of Intended Nationally Determined Contributions (INDC) to reduce emissions and mitigate

5. The US committed to a target but did not ratify it; Canada withdrew from the Agreement in 2011; Japan, New Zealand and Russia did not make further commitments beyond the first commitment period.
6. That is, keep the growth of emissions less than that of GDP.

climate change. This was the first time that all developing countries took on commitments on mitigation, although they were limited to reducing the emissions intensity of the GDP; and,

- Developed countries extended the promise of *additional* climate finance of US$100 billion per year by 2020 for developing countries, to continue up to 2024. The finance would be a mix of private and public flows, but neither was the composition specified nor were the criteria for determining the additionality stated.
- The universal acceptance of some mitigation obligations by all developing countries was seen as a positive outcome, even though they made no commitment to any reduction in absolute levels of emissions. However, it soon became evident that the totality of the commitments made by all countries was not sufficient to limit global warming to the level targeted. UNEP reported that even if the Paris commitments were achieved in full, global temperatures could rise by 3°C or more by the end of the century (UNEP 2016a).

The failure to ensure achievement of the global warming target was a direct consequence of relying only on voluntary commitments, with no overarching mechanism to ensure that the prospective CO_2 emissions would remain within the 'carbon budget'.[7] The decision to stay with voluntary commitments appears understandable in retrospect since developing countries until then had been unwilling to undertake any commitments.

The first reliable estimate of the carbon budget was provided by the IPCC Special Report on Global Warming of 1.5°C in 2018.[8] The report quantified the differences between warming of +1.5°C and +2°C and highlighted the adverse effects associated with +2°C, calling for lowering the global warming target to +1.5°C. It also indicated that given the limited size of the CO_2 budget available, global CO_2 emissions must reach net zero to halt the progression of global warming.

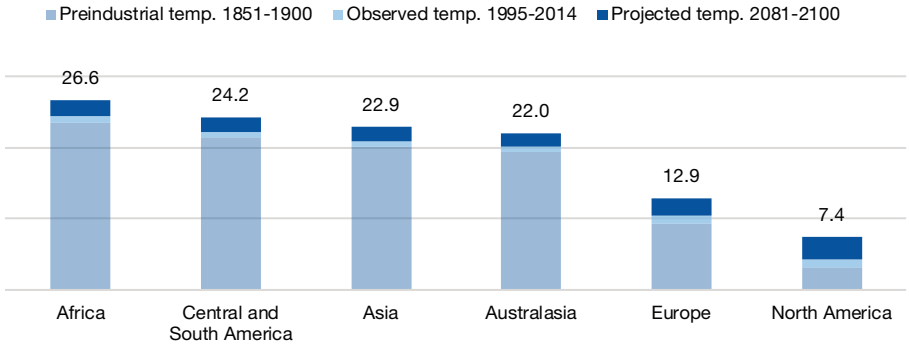
The Consequences of Global Warming of 2°C

The findings of IPCC (2021) on the consequences of allowing global warming to exceed +2°C are deeply disturbing. They need to be much more widely understood to develop public support for measures to combat climate change. The main point to note is that all regions of the world will experience global warming, but the extent of warming will vary across regions, with very different outcomes in terms of changes in precipitation, local temperature, and vulnerability to extreme weather events.

In a +2°C warming scenario, the average annual temperature in the northern regions, i.e., Europe and North America, could rise by 2.5°C and 3.1°C, respectively, by the end of the century. The rise in the warmer regions of the South would be in the range of 1.8–2.2°C (Figure 9.1). The increase in temperature is higher in Europe and North America than in Asia, Africa, and Central and South America, but since the latter are already at warmer temperatures, they would suffer more damage.

7. The carbon budget is the volume of net CO_2 emissions that can be released in the atmosphere which will keep its total atmospheric concentration at a level consistent with the warming target.
8. The IPCC's Fifth Assessment Synthesis Report (SYR AR5) in 2014 mentions the carbon budget, but the value was revised substantially in the IPCC Special Report in 2018 using more accurate methods that ensured that uncertainties in the model from the historical estimates do not get accumulated into future projections.

Figure 9.1: Rise (°C) in near-surface temperatures in a +2°C warmer world



Note: Asia excludes the Russian sub-continent of Serbia and Artic, Europe excludes Greenland.
Source: IPCC 2021

Impact on Productivity and GDP

The effects of climate change on GDP and income levels in different parts of the world are not easy to estimate. Several economic models have produced estimates, but the results differ depending upon the assumptions used, which are difficult to validate based on available empirical evidence. It is important to note that the extent of global warming currently being predicted takes us outside the realm of human experience, and non-linearities could make outcomes much worse than made out by naïve economic models so far.

Burke, Hsiang, and Miguel (2015) find that economic productivity increases with warming up to an optimum temperature and then starts to decline at an increasing rate with each unit rise in temperature. They estimate that climate change will reduce projected global output by at least 23 per cent by the end of the century, compared to a world without climate change.

A recent study by the Swiss Re Institute (2021) suggests that if no corrective action is taken and the temperature by mid-century increases to 2°C above pre-industrial levels, expected GDP in 2050 for the world as a whole will be 11 per cent lower than in the base case of no climate change. North America and Europe stand to lose 7–8 per cent of their expected GDP, while countries in the southern continents will lose in the range of 11–15 per cent. The report finds that the countries in Southeast Asia will be the hardest hit—losing nearly 17 per cent of their expected GDP (Swiss Re Institute 2021).

As expected, the agriculture sector would be the worst hit by rising temperatures and changing precipitation. Ortiz-Bobea et al. report that increased temperatures have reduced global average agricultural productivity by about 21 per cent since 1961 with impacts more pronounced in warmer areas like parts of Africa, Latin America and Asia (Ortiz-Bobea et al. 2021). Since a large share of the poor in these countries depend upon agriculture and manual labour for their livelihoods, the projected change is likely to reduce the pace of poverty reduction and widen income inequality.

Health- and Welfare-related Impacts

Climate change will also have adverse effects on health through various interactions. The WHO projects that between 2030 and 2050, approximately 250 thousand additional deaths per year,

from malnutrition, malaria, diarrhoea, and heat stress could be attributed to climate change (WHO 2021). Frequent forest fires in many parts of the world have caused wild animals to move to new places in search of habitats, threatening an increase in zoonotic infections. Melting of polar ice caps due to global warming poses the danger of pathogens, that existed in the past and were long isolated or thought of as extinct, being released from the permafrost.

The ongoing COVID-19 pandemic is an example of the large economic and human cost of diseases spread by new pathogens. Climate change will only increase the probability of such outbreaks with low-income countries, which have weak public health infrastructure and lack the resources to strengthen it, severely hit.

The UN High Commissioner for Refugees (2021) has estimated that between 2008 and 2016, an average of 21.5 million people were forcibly displaced each year due to weather-related events linked to climate change. Bangladesh, for example, is witnessing a movement of people from high-risk coastal areas and rural regions where agricultural lands have turned barren due to salinisation from rising sea levels, towards urban centres seeking safety and better livelihoods, which is putting pressure on cities that already lack access to public services (*The Economist* 2021).

The World Bank (2018) estimates that without concrete mitigation action, around 143 million people in Sub-Saharan Africa, South Asia, and Latin America—approximately 2.8 per cent of the combined population—would be forced to migrate internally to escape floods or drought-prone areas. This would exacerbate poverty and could trigger spontaneous cross-border movements which can potentially cause conflicts and regional instability.

The consequences mentioned above relate to a +2°C rise. By most projections we are likely to cross that threshold by the middle of the century and reach even higher levels of global warming by 2100. Developing countries will be the worst hit which means they have a strong interest in avoiding this outcome. However, they can only do so much on their own to affect the pace of climate change. They must work together with developed countries to produce an agreement on collective action that can moderate and ultimately halt global warming, while taking care of their interests.

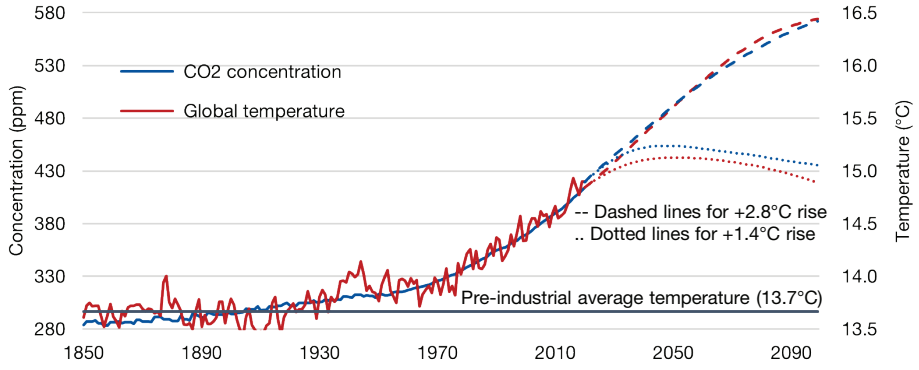
Outcomes of COP 26

The IPCC (2021) report, which warned that global warming was 'widespread, rapid, and intensifying' and would have potentially catastrophic consequences if not checked set the tone for the COP 26 meetings. UN Secretary General, Guterres, described the report as signalling 'Code Red'. There was unprecedented participation by civil society groups, environmentalists, philanthropic organisations, and private investors. The meetings were widely described as 'the last chance to save the planet'.

The hype was such that it is not surprising that the results fell short of the hopes raised. Many climate change activists described the meeting as a failure. Developing countries also expressed disappointment at the failure of developed countries to deliver on the financial assistance that was promised in the Paris Agreement. Despite this, one can argue that there was substantial progress.

The scale of the challenge facing COP 26 is summarized in Figure 9.2 which presents the IPCC's assessment of the prospects for global warming if the recent trend in CO_2 emissions continues (dashed curves) and compares it with what is needed to prevent global temperatures

Figure 9.2: Atmospheric CO_2 concentration and global surface temperature since 1850



Note: Pre-industrial temperature implies 1850-1900 average. The projections are based on IPCC (2021) SSP1-1.9 (1.4°C rise by 2100) and SSP2-4.5 (2.8°C rise) scenarios.
Source: Authors' calculations based on NOAA 2021, GCP 2021, and IPCC 2021.

from exceeding +1.5°C (dotted curves). It is clear that if global warming is not to exceed 1.5°C above the pre-industrial level by 2100, then atmospheric CO_2 concentration must peak by 2050 and subsequently decline. Peaking CO_2 concentration by 2050 implies that total emissions must be net zero by then. Furthermore, since the peak CO_2 concentration level projected for 2050 actually exceeds the threshold for +1.5°C, it is necessary to reduce the concentration level after 2050, by going net negative in terms of CO_2 emissions thereafter.[9]

Faced with this challenge, what did COP 26 come up with? The results of the negotiations, in terms of agreements reached, are summarized below.

- The global warming targets were tightened to 'not exceed +1.5°C' in recognition of the high costs of warming up to +2°C, indicated by the IPCC;
- 136 countries, representing 88 per cent of the total annual CO_2 emissions, including many developing countries, announced programmes to reduce emissions to net zero over time. Earlier unwilling to commit to reducing emissions, developing countries for the first time accepted the need to reduce the absolute level of emissions and to achieve net zero. The change in their position reflects a recognition that technology has made renewables—solar and wind—an alternative source of energy that could allow them to meet their increasing energy demands without emitting GHGs;
- Most countries have opted for 2050 as the target date, but some have announced later dates. Russia and many large developing countries like China, Indonesia, Nigeria, and Saudi Arabia have declared 2060 as the target year for net zero. India, which has much lower per capita emissions than other large emitters, has declared 2070 as its target year. Some developed countries have opted for target dates earlier than 2050: 2045 for Germany and Sweden, 2040 for Austria and Iceland, and 2035 for Finland. Nepal has announced 2045, making it an exception among developing countries for choosing a target earlier than 2050;

9. Net negative emissions imply removing CO_2 from the atmosphere by means of forest carbon sequestration, and carbon capture and storage technologies which are assumed to be viable at large scale by then.

- In addition to committing to reach net zero in the future, most countries have also indicated intermediate shorter-term targets for 2030, though not all on the same dimension (Box 9.1);
- The Glasgow Pact acknowledged that the promise to deliver additional financial assistance reaching US$100 billion per year by 2020, which was offered in Copenhagen in 2009 and was a key part of the Paris Agreement, has not been met. According to the OECD (2021a), the delivery reached only US$79 billion by 2019, though others have said it was lower (Roberts et al. 2021). Part of the reason for the disagreement is because it was never spelt out what would qualify as 'additional'. An OECD (2021b)

Box 9.1: Latest INDCs of the top emitters

China
- 65 per cent reduction in the emissions intensity of GDP from 2005 levels by 2030
- Peak emissions by 2030/reduce coal consumption starting 2025–30
- Increase the share of non-fossil fuels in primary energy consumption to ~25 per cent by 2030
- Increase the forest stock volume by 6 billion cu. metre from 2005 level
- 1.2 TW wind and solar electricity generation capacity by 2030
- Net zero by 2060

US
- 50–52 per cent reduction in emissions from 2005 levels by 2030
- Carbon pollution-free power sector by 2035
- Net zero by 2050

EU
- 55 per cent reduction in emissions from 1990 levels by 2030
- Net zero by 2050

UK
- 78 per cent reduction in emissions from 1990 levels by 2035
- Net zero by 2050

India
- 45 per cent reduction in the emissions intensity of GDP from 2005 levels by 2030
- 500 GW of non-fossil fuel electricity generation capacity by 2030; 50 per cent electricity generation capacity to be renewables-based by 2030
- Reduction of 1 Gt-CO_2e emissions over 2022–30
- Net zero by 2070

Russia
- 30 per cent reduction in emissions from 1990 levels by 2030
- Net zero by 2060
- Under discussion: peak emissions by 2030, 79 per cent reduction in emissions from 2019 levels by 2050

Japan
- 46 per cent reduction in emissions from 2013 levels by 2030
- Net zero by 2050

Indonesia
- 29 to 41 per cent reduction in emissions from BAU levels by 2030
- Peak emissions by 2030
- Net negative CO_2 emissions from the forest and land-use sector.
- Net zero by 2060

Brazil
- 50 per cent reduction in emissions from 2005 levels by 2030
- End illegal deforestation by 2028
- Net zero by 2050

analysis suggests that the full amount of US$100 billion would only be reached by 2023. The Pact has targeted doubling the amount for adaptation finance from 2019 levels by 2025 (UN Climate Change Conference UK 2021), but since this is part of the total financial commitment, it only affects the composition of the assistance;

- The pact also approved rules on government-led international carbon markets to implement Article 6 of the Paris Agreement, superseding the UN Clean Development Mechanism. The new rules would allow countries to partially meet their climate targets by buying offset credits that represent emission reductions by others, such as via forestry, and avoid double counting of credits. This is expected to financially benefit developing countries with large forest covers and also reduce deforestation; and,
- In addition to CO_2, the pact emphasized reducing non-CO_2 GHG emissions. Over a hundred countries have pledged to act on reducing methane emissions by 30 per cent by 2030, over the 2020 levels.

The willingness of developing countries to target an actual reduction in emissions reaching net zero at some future date must be counted as a major advance from the Paris Agreement. However, the new country targets announced in Glasgow remain inadequate to limit global warming to +1.5°C. Early assessments by the UNEP show that even if all countries met their targets in full—clearly an optimistic scenario given the record—we may still end up with global warming of +1.8°C (UNEP 2021). A more realistic assessment, which makes allowances for possible slippages in performance, suggests that the more likely outcome is a rise of up to +2.4°C.

The situation after COP 26 is therefore better than it was after Paris, but it is certainly not good enough. Recognizing this problem, the Glasgow Pact has asked all parties to raise their climate targets by the time of COP 27 in Sharm El-Sheikh in Egypt in 2022, instead of after five years as originally planned.

Modification of Country Trajectories

Since the emissions trajectories emerging from Glasgow are to be reviewed in COP 27, developing countries need to prepare for this review carefully. If total emissions must stay within the fixed carbon budget, it is necessarily a zero-sum game in the sense that high emissions by some countries must be offset by lower emissions by others.

In theory, the best way of solving the problem would be to divide the available carbon budget in a demonstrably fair manner into individual country budgets and then leave it to each country to define its own emission trajectory respective to its carbon budget.[10] The date by which a country reaches net zero is not important in this framework since the critical requirement is that countries stay within their budget. However, this approach requires some agreement on what a fair basis would be for distributing the budget, and this issue has never been discussed thus far.

This was not discussed in the run-up to COP 26, because developed countries focussed their efforts on getting all countries to commit to reaching net zero by 2050. This simple formula appeared to be justified by the 2018 IPCC report, which asserted that limiting global warming

10. The UK, for instance, under its 2008 climate change Act, sets for itself a five-year statutory cap on total GHG emissions. The carbon budgets are set twelve years in advance to provide sufficient time for businesses to align their activities. The emission targets are set per the UK's long-term goals of emission reduction—earlier 80 per cent below 1990 levels by 2050, and now net zero by 2050. See for reference the 6th Carbon Budget report of the UK climate change Committee (2021). Accessible at https://www.theccc.org.uk/publication/sixth-carbon-budget/

to +1.5°C will require global CO_2 emissions to reduce to 55 per cent of 2010 levels by 2030 and reach net zero by mid-century (IPCC 2018). Many developing countries were unwilling to accept a common goal of net zero by 2050, which was often criticized by developed countries and other critics as unreasonable. The subsequent announcement of net zero dates later than 2050 by many developing countries has also been criticized as being too weak.

This criticism must be viewed against the proposition that a common target date for net zero for all countries does not lead to an equitable outcome. It would have been so if all countries were at the same level of per capita emissions to begin with, but since the starting points are vastly different, in terms of both per capita incomes and development needs, pushing all countries to reach net zero by 2050 is highly inequitable. This can be seen in Table 9.1, which presents estimates of the net CO_2 emissions of the eight largest emitters, responsible for almost two-thirds of the annual emissions, under alternative assumptions.

Column 3a of the table shows our estimates of the outcome of the net CO_2 emissions associated with the Glasgow targets. The total claim of the top eight countries adds up to 113 per cent of the available carbon budget. Many of these countries end up claiming a share in the carbon budget nearly twice or more than their current population share. These trajectories are clearly not acceptable since they imply that if the carbon budget for +1.5°C is to be respected,

Table 9.1: Alternative estimates of prospective CO_2 emissions of the eight largest emitters

	Share in global emissions since 1990 (per cent)	2020 population share (per cent)	Estimated share in the CO_2 budget* (per cent)		
			Glasgow pledges	Common targets for 2030 and 2050	Population-weighted CO_2 budget distribution
	(1)	(2)	(3a)	(3b)	(3c)
China	18.9	18.5	50.4	25.5	19.8
US	16.8	4.2	13.2	14.1	4.5
Europe†	12.0	6.8	9.1	9.4	6.9
India	4.3	17.7	20.9	5.6	17.8
Russia	3.5	1.9	6.3	2.5	2.7
Japan	3.7	1.6	3.2	3.1	1.8
Indonesia	3.5	3.5	6.2	2.8	4.0
Brazil	4.2	2.7	3.5	3.9	2.9
Combined	67	57	113	67	60

** This relates to the CO_2 budget (starting 2021) for a 50 per cent probability of limiting temperature rise to +1.5°C. If a higher probability is chosen then the budget will be lower, and the emission rights appropriated get significantly larger.*

† Europe comprises the EU-27, plus the UK and EFTA nations

Source: Authors' calculations, WRI Climate Watch 2021, Global Carbon Project 2021, UN Population Division 2019, IPCC 2018, and IPCC 2021.

the other countries, accounting for 43 per cent of the world's population, would have to collectively contribute negative emissions.

Column 3b of the table shows the outcome of having all eight countries follow the common targets as given in the IPCC 2018 report. The resulting projections respect the carbon budget, but the outcome is clearly inequitable across countries.

The high emitting nations—China, the US, Europe, Russia and Japan—which together account for 33 per cent of the world's population, would claim almost 55 per cent of the carbon budget. The low emitters in the table—India, Indonesia and Brazil—which have 24 per cent of the world's population, would be limited to only 12 per cent of the available budget. Since these are countries with high growth potential, restricting them to low carbon budget shares is particularly inequitable.

The other countries not listed in the table are a mix of developed and developing nations. They account for 43 per cent of the population and would be left with only a 33 per cent share in the carbon budget. Since this group also includes African countries whose population share is expected to increase sharply, denying them even their existing population share cannot be justified.

Column 3c in the table presents modifications in the emissions trajectories emerging from Glasgow to bring each country's claim on the carbon budget much closer to its population share. For example, the US should aim at a sharper reduction in net emissions by 2030 and advance its net-zero date to 2040. Europe as a whole could follow the German/Swedish example and aim at net-zero by 2045, as should Japan.

China has announced that it intends to increase its emissions up to 2030 and then reduce them to net zero by 2060. But, as shown in column 3a of Table 9.1, this trajectory would lead to China pre-empting more than 50 per cent of the carbon budget—the largest absolute deviation from a country's population share among those analysed. Instead, it should be persuaded to keep net emissions at their current level for a few years and then rapidly reduce them to zero by 2050. Similarly, Russia with 1.9 per cent of the population is projected to pre-empt 6.9 per cent of the budget. It should be persuaded to stabilize the rising trend of net emissions and start declining thereafter to reach net zero by 2050.

The three other countries included in the table—Brazil, Indonesia and India—would also need to tighten their targets but to a comparatively lesser extent. For Brazil and Indonesia, 50 per cent of their emissions are caused by land-use change and forestry. Thus, they could make a substantial improvement by acting on this front. Indonesia has already set some ambitious targets conditional to the availability of adequate international finance. In the case of India, emissions would need to peak by 2035, instead of around 2040 as currently projected (Mint 2021).

The impact of the recalibration described above for each country can be seen in Figure 9.5 in the Appendix, which compares the recalibrated trajectory for each country (in green curves) with the trajectory based on the Glasgow commitments (in red). The cumulative carbon emissions from these recalibrated trajectories fall to 60 per cent of the budget, much closer to the 57 per cent population share of the eight countries in question. This raises the question whether approximating the population share is fair. Determining fairness is a complex issue and one can imagine that considerations other than population share should be relevant, but there is no doubt that population would be a very important consideration (Budolfson et al. 2021; Raupach et al. 2014; Tongia 2021).

Pushing developed countries to reach net zero before 2050 (including through measures of negative emissions, i.e., withdrawing CO_2 from the atmosphere) will impose additional costs. But these are precisely the countries that can bear those costs. Besides, there are developed countries that have opted to get to net zero well before 2050. Others should be willing to do so if saving the planet is at stake.

An important co-benefit of pushing developed countries to decarbonize faster is that it will accelerate the development of technologies that could help others achieve their own decarbonisation targets. Developing countries need to work towards evolving the criteria that could guide future negotiation on modifying the Glasgow trajectories.

What Developing Countries Must Do to Decarbonize

Setting an end date some decades ahead is only the beginning. The next step is defining an operational plan to achieve that target and then implementing it. Having committed to reducing emissions to net zero, it is thus logical for developing countries to take the next step of conceiving a specific plan of action. In this context, the plan of action for the next ten years should be spelt out in detail, while that for the subsequent years can be kept flexible at this stage.

In general, any developing country wishing to decarbonize would need to push forward in four areas:

- Increase energy efficiency in the economy;
- Electrify final energy consumption by substituting direct use of fossil fuels with electricity where possible, and replace fossil fuels in rest of the areas with synthetic or biofuels;
- Shift electricity generation from fossil fuels to non-fossil fuel-based sources, mainly renewables. This is an essential complement to (ii) above, since shifting from the use of fossil fuels to electricity in a particular sector will not reduce emissions unless the production of electricity is emissions free; and
- Deal with emissions from hard-to-decarbonize sectors by increasing the stock of forests and through carbon capture and storage technology, which will hopefully become economical in future.

The rest of this section discusses the scope for action in each of these areas along with a suitable elabouration of the complexities involved.

Increasing Energy Efficiency and Rational Energy Pricing

Increasing energy efficiency reduces the amount of energy needed by the economy without impacting output. Where the energy saved is derived from fossil fuels, there will be a corresponding reduction in emissions. If the energy saved comes from renewables there is no reduction in emissions, but higher efficiency is still desirable because the reduced demand for renewable energy implies lower energy costs.

One way of increasing energy efficiency is to impose mandatory energy efficiency standards that must be met before any product can be sold. The other is to ensure rational energy pricing. Both are important, and developing countries need to examine the scope of both.

Statutory minimum standards of energy efficiency help to raise the demand for energy efficient electrical appliances such as refrigerators, air conditioners, electric pumps, and petrol/diesel vehicles, etc. Since more efficient appliances/equipment tend to be costlier, government bulk procurement and distribution programmes and finance schemes can help to lower prices

and raise adoption rates of such products.[11] Similarly, building standards incorporating energy efficiency considerations will help to reduce energy consumption on account of lighting and heating/cooling. Developing countries are set to experience rapid urbanization in the next few decades, and this will involve a massive expansion in buildings. In India, for example, it is estimated that more than half of the building stock that will be needed by 2050 is yet to be built. Steps to incorporate energy efficiency standards provide a huge opportunity to leapfrog.

Standards set by law only establish the minimum level of efficiency required. They can be supplemented by a multi-star labelling system to signal products with higher levels of efficiency hoping that it will persuade consumers to move up the efficiency chain. However, more energy-efficient appliances and building designs are typically also more expensive. Thus, consumers will have to weigh the higher up-front cost against the lower running cost due to energy savings. This is where rational energy pricing comes in. If electricity is underpriced, as it is in many countries for certain categories of consumers, it will weaken the incentive to choose more energy-efficient products.

Rational energy prices can induce a behavioural change in consumers by incentivizing them to choose more energy efficient products, leading to very substantial energy savings. Ensuring rational energy prices requires removing subsidies on fossil fuels which are very common. The Glasgow Pact has endorsed a 'phase-out of inefficient fuel subsidies', but there is ambiguity over what subsidies would qualify as 'inefficient'.

Subsidies can be narrowly defined to refer to situations where the price charged for the fuel does not cover the full market cost of its supply. The difference is called an explicit subsidy, and this has fiscal costs either on the government budget or on suppliers (typically public sector entities in many countries) that are forced to bear the burden. There is also a wider definition based on whether the price charged covers both the market cost and the external cost in terms of the damage to the environment from using such fuels.

The IMF has estimated that on the narrow definition of energy subsidies, lower middle-income countries spent an equivalent of 2 per cent of their GDP in 2020 on subsidizing the supply costs of energy (Parry, Black and Vernon 2021). If the wider definition is used, the subsidy in these countries increases to 12 per cent. High-income countries also have the subsidies, but at 0.3 per cent and 3.1 per cent of GDP, respectively. The much higher share of subsidies in developing countries on the wider definition is because they are heavily dependent upon coal, whereas developed countries use natural gas which is much less polluting.

Raising energy prices is easier said than is politically done, and that is true not only in developing countries but also in developed countries.[12,13] One of the arguments often made in developing countries against raising energy prices is that it will hurt the poor. The point is certainly relevant, but not entirely correct. The poor do benefit from electricity subsidies, but the bulk of the benefit goes to better-off households which consume most of the subsidized energy. The poor could be easily compensated for the withdrawal of fuel subsidies through means such

11. See for example the UJALA LED bulb distribution scheme of the Government of India.
12. The Greens party in Germany contested the last election on an explicit platform of ensuring that energy prices will be made to reflect true carbon costs. The party is part of the government today, but there is no indication yet that its promise will be implemented.
13. The federal excise taxes on petrol and diesel in the US are ¢4.86/L and ¢6.45/L, respectively. These specific rates have not changed since Oct 1993 on the argument of not hurting the poor consumers.

as direct cash transfers, while allowing energy prices to be raised to a suitable level. These alternative mechanisms are being tried and have shown positive results.[14]

Political difficulties notwithstanding, developing countries would be well-advised to take on the challenge of eliminating energy subsidies, at least as narrowly defined, by 2030. The fiscal costs of these subsidies are substantial and even if the impact on the poor is offset by direct cash transfer, the net savings will help to support much-needed investments in other areas required to achieve the energy transition. Developed countries could lead the way by eliminating fuel subsidies of the wider definition in the same period, thus prompting developing countries to move in the same direction.

Promoting Electrification

Shifting from the direct use of fossil fuels to electricity is critical for decarbonization and the scope for electrification is considerable.

The industrial sector is the largest consumer of energy in most countries. Electricity generation, which is considered part of the industrial sector, is heavily reliant on coal in many developing countries. Shifting from electricity generation using fossil fuels to renewable sources is an important part of the transition and is discussed separately below. Excluding electricity generation, much of the energy demand in other industrial subsectors is met through electricity even today. However, there are certain industrial sectors, usually large industries, where fossil fuels continue to be used. This includes industrial processes requiring very high-temperature heat (e.g. smelting and cracking), involving chemical reactions which emit CO_2 (e.g. in cement manufacturing), or needing fossil fuels as chemical inputs (e.g. for steel and fertilizer production).

High-temperature heat needed in some processes can be generated using electric arc furnaces to replace coal-fired furnaces. However, in some other processes, fossil fuels cannot be replaced at present. This problem could be addressed effectively in the future as green hydrogen and CO_2 capture and utilization/storage becomes cheaper.

Transport is the second largest consumer of energy in the economy and is heavily dependent on fossil fuels such as petrol, diesel, and natural gas. Fortunately, the technology for switching to hybrid or pure electric vehicles (EVs) is now well-developed and two- and three-wheeler vehicles, passenger cars, light commercial vehicles, small industrial trucks, and city-buses, running partly or fully on electric batteries, are a reality. Hybrid EVs offer a pathway to drastically cut transport sector emissions in the short term and enable a transition to pure EVs subsequently.

Governments in developing countries can accelerate the switch to EVs in many ways. These include:

- Mandating that all government purchases of vehicles in the future will be only of hybrid or pure electric type (depending on national circumstances). These may be more expensive initially, but prices could be negotiated for bulk purchases;
- Accelerating the adoption of electric city-buses and urban metro railways for public transport and prescribing that eventually taxi licences will be given only to more efficient vehicles, including hybrid vehicles and pure EVs;
- Promoting public transport (both electric buses and urban railway/metros), with complementary measures to disincentivize private vehicle use through appropriate parking

14. See for example the PAHAL scheme of the Government of India, which provides direct cash transfers to cooking gas (LPG) consumers in India.

and congestion charges, will take some private cars off the road. This will help to reduce emissions and decrease traffic congestion and particulate matter pollution which has become a major problem in many developing countries;

- Announcing that from some date in the future, domestic manufacturers/importers will not be allowed to sell any internal combustion (IC) engine vehicles. If one wants the full automobile fleet to be electric by, say 2050, it would be necessary for all automobile sales to be of EVs much earlier, say by 2035, to ensure that the existing IC engine vehicles are fully phased out by 2050. An early announcement of the planned switch gives manufacturers sufficient advance notice of the change to ensure that production capacity is restructured to meet the EV demand. It is also necessary that an EV-charging network is developed in anticipation;
- Standardizing chargers and batteries to make them compatible across the different EV models would help in achieving the scale needed for mass adoption of EVs and bringing down the costs;
- Offering fiscal incentives to reduce the upfront cost of shifting to EVs. This can take the form of reducing or waiving registration charges, reduced toll fees, concessions or exception from sales tax, cheaper rates of financing, etc.

We cannot at present do without fossil fuels in areas such as long-distance road freight, earthmoving machinery, aviation, and shipping. However, there is considerable scope for reducing emissions from freight transport by shifting from road to rail or water, where possible, both of which have significantly high energy efficiency on per tonne-km basis. Besides, rail transport is already electrified in many cases and is anyway easily electrifiable. Technological advancements involving biofuels or green hydrogen-derived e-fuels, and hydrogen fuel-cell engines or high-density batteries may offer a solution to completely eliminate emissions from this sector in the future. Technology is developing rapidly in this area and the prospects seem brighter than they did even a couple of years ago. The fact that developed countries have strong interests in these developments increases the prospect of rapid technological development.

Shifting to electricity for transport would imply a gradual phasing-out of fossil fuels from the transportation sector. Taxes on petrol and diesel contribute disproportionately to the total government revenues in most developing countries and their elimination will adversely affect government budgets. However, in many cases, petroleum products are also imported, and a fall in consumption would save foreign exchange of the countries. Since developing countries can be expected to retain robust economic growth, it should be possible to offset foregone tax resources through other sectors of the economy. But this would need a restructuring of the tax system in anticipation of the decline in revenues from petroleum sales.

Buildings, both residential and commercial, already rely almost entirely on electricity for both lighting and cooling. Heating in colder regions often involves use of fossil fuels and wood, but this could be substituted by electricity over time, along with a shift to more energy efficient building designs mentioned earlier. The promotion of rooftop solar generation would further help in decarbonization, and the pace at which this occurs can increase greatly if suitable feed-in tariffs are fixed for the electricity supplied from these systems to the grid.

Cooking, especially in parts of Sub-Saharan Africa and rural areas of South Asia, is currently dominated by biomass, charcoal and kerosene, which have adverse health effects, especially for women and children. Households in India, for example, are currently moving towards using

liquefied petroleum gas as a safer and more reliable cooking fuel, and those in African countries are switching to modern biomass cookstoves which are more efficient and less harmful. As electricity access improves, whether through rural grid connectivity or decentralized micro-grids (based on solar photovoltaics (PV) modules and battery storage units), switching to electricity for cooking would be possible.

Shifting to Electricity Generation from Renewables

The push to electrification must be combined with shifting, as rapidly as possible, towards electricity generated from renewables. Hydropower and nuclear generation are two important methods of generating non-polluting electricity, but each has limitations. Capacity expansion in hydropower is limited by geo-physical factors, irrigation requirements, environmental concerns with submergence, and problems with displacing people in and around reservoir areas. Nuclear energy in developing countries has a very low share in total electricity generation compared to developed countries, and the scope for capacity expansion is limited due to the high cost of construction and concerns about the safety of nuclear waste disposal.

Solar and wind power are the most promising sources for clean electricity and their generation capacity is being expanded in many parts of the developing world. The ASEAN countries have set a combined target of achieving a 35 per cent share of renewables in total installed electricity generation capacity by 2025. India has set a renewable energy capacity target of 450GW by 2030, which will be half the projected total capacity by then.[15] South Africa aims at sourcing 25 per cent electricity from wind and solar sources by 2030.

Both solar and wind power pose problems of intermittency. Solar generation has large variations within the day. Wind also has intraday variation but also seasonal variations, which differ with location. Intermittent supply makes grid management difficult since the demand and supply of electricity in the grid must be always balanced. This is not a very serious problem in the initial stages when renewables account for a small share in total electric supply, because the rest of the system can be ramped up or down to offset intermittency. However, as the share of electricity from renewables rises, as it will to meet the target of net zero, special efforts would be needed to help manage the grid.

There are several ways of dealing with intermittency. Optimising the solar-to-wind capacity ratio to moderate the degree of variation in total supply is one option. Spatially spreading out wind turbine installations to locations that complement inter-seasonal peaks in wind is another. Strengthening cross-border interconnections and transmission networks can also help to trade power across regions as needed. Pumped-hydro projects that combine renewable generation with hydro-storage capacity, where available, can be a cost-effective power storage and balancing solution. Conventional hydropower projects can usually be upgraded with a facility to pump and recharge water and discharge as needed, however, the scope for expanding hydro capacity is limited for reasons mentioned above.

Battery storage at grid-scale could be the most viable solution in the longer run, with excess power generated at peak times being stored in a battery for use when generation tapers off. Grid scale battery storage is in operation in California and Australia, and similar experiments are underway or proposed in China, India, Morocco, and Saudi Arabia.

15. The share of renewable electricity in the total electricity mix will be lower than 50 per cent since the capacity utilization of wind and solar power plants is much lower due to their intermittent nature.

Green hydrogen, produced through electrolysis of water using renewable electricity, provides another solution. It can be safely stored and used to produce electricity by fuel cells when needed. Energy storage via hydrogen is likely to be costlier than batteries.[16] However, the cost of green hydrogen is expected to fall. A Bloomberg analysis of the levelized cost of green hydrogen in 2030 forecasts that Brazil, India, and many other developing countries would have the lowest cost of green hydrogen production in the world, thanks to falling costs of renewable electricity production in these countries (Bloomberg 2021a).[17]

Intermittency in supply can also be handled by efforts to shift demand patterns to align better with supply. Shifting agriculture load to solar peak hours, for example, is a low hanging fruit and this has already been done in some states of India.[18] Looking further ahead, time-of-day metering with sufficient variation in intraday prices, could discourage consumption of electricity during peak demand hours. This calls for sophisticated regulation aimed at developing an effective market for wholesale trading in electricity. Smart metres can optimize domestic electricity demand by triggering devices to operate when prices are low. Such options may be many years away in developing countries, but the transition to net zero is also long-term.

The shift to renewables will need to be supported by reforms in the functioning of wholesale electricity markets to facilitate expanded and flexible trading of renewable electricity at regional level. Electricity markets would need to allow for high frequency spot and futures trading of electricity from both renewable and conventional sources. Further, offering term-ahead contracts at energy exchanges will allow small private developers to sell power directly in open market, without entering into long-term power purchase agreements, making new investments in the energy sector more favourable. Market regulators in developing countries will have to gain the necessary capacity in order to plan for developing such practices.

Is Renewable Energy Cost Competitive?

In the end, a strategy of shifting to electricity generation based on renewables will only succeed if the electricity is cost competitive. Costs per unit of both solar and wind electricity have fallen drastically over the past ten years making them competitive with new coal-based plants. With the costs expected to fall further, they will soon be competitive even with older thermal power plants that generate electricity at marginal costs. This can be seen in Figure 9.3 where the shaded region represents the range of costs from different vintages of existing coal power plants.

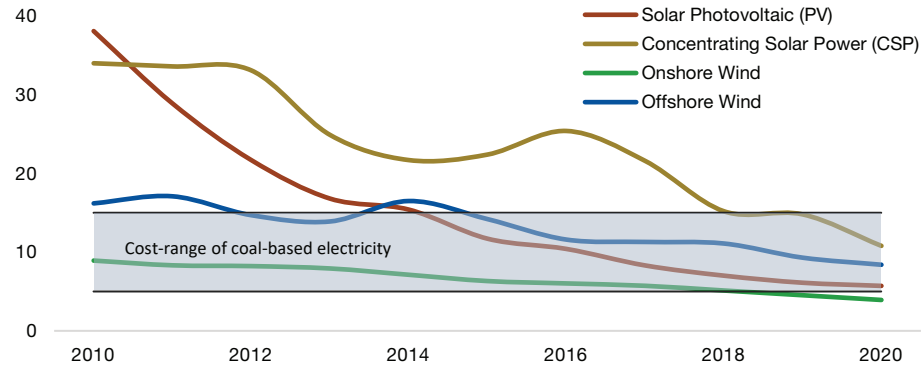
Developing countries such as India have been able to attract highly competitive low-cost bids from private sector generators of renewable power. But these bids are for variable (or intermittent) power and not for a steady supply over a longer period supported by an energy storage system. If the costs of storage needed to produce a steady supply are included, renewable electricity is not competitive, especially with electricity from older coal power plants.

16. Green hydrogen-based energy storage has poor round-trip efficiency—in the process of converting electricity into H_2 and back, nearly two-third of the energy is lost with the current technology (Sepulveda et al., 2021).

17. There are several large-scale green hydrogen projects planned or being constructed around the world including in developing countries such as Brazil and India.

18. This is possible by having segregated feeder systems for rural agriculture consumers. Starting first in the Indian state of Andhra Pradesh in 2001, electricity supply feeders for agriculture and non-agriculture consumers in rural regions were separated by phase to regulate the amount of power supplied to farmers for irrigation (which is usually free) while ensuring uninterrupted supply to non-agriculture consumers. Many states (e.g. Gujarat, Karnataka) have implemented the system since by having completely separate feeders.

Figure 9.3: Global average cost (US¢/kWh) of electricity from variable RE and coal



Source: IRENA 2021

This is because grid-scale battery storage is expensive at present, but costs are falling (Cole, Frazier and Augustine 2021). It is difficult to be certain about future trends in costs because much of the available mineral sources and refining capacity worldwide have been pre-empted by China, and reserves of many of these metals are also in conflict-prone regions of the world (e.g. Democratic Republic of Congo (DRC) and Afghanistan).[19] However, if the world is going to need much more battery storage, one can expect intensification of efforts at finding more reserves of these minerals in the years ahead.[20]

The competitiveness of renewable power will change dramatically if carbon pricing, in the form of a tax on fossil fuels to reflect the social and environmental cost of CO_2 emissions, is introduced. A recent IMF staff paper proposed a carbon price floor for the world's top emitters, differentiating by income levels—US$75 per tonne of CO_2 for high-income countries (e.g. the US and the EU), US$50 for upper middle-income countries (e.g. China), and US$25 for lower middle-income countries (e.g. India) (Parry, Black and Roaf 2021). Low-income countries are exempted from any such tax under the proposal.

India already has a tax on coal which was meant to promote the transition towards renewables,[21] but it is currently levied at the rate of US$3.5 per tonne of CO_2 (INR 400/tonne-coal). Indonesia has also taken a step towards carbon taxation by mandating that coal power plants emitting above 1 tonne of CO_2 per megawatt-hour of electricity have to purchase offsets or pay a tax of US$2.1 per tonne CO_2e (IDR 30 per kg of CO_2e).[22] They plan to raise the price to US$5.2 per tonne CO_2e, and to include the forestry sector by 2025 (Bloomberg 2021b).

Raising the existing carbon taxes to the levels recommended by the IMF would raise electricity prices considerably, and this is bound to be resisted by domestic consumer groups. There could be less resistance if developed countries also impose the taxes at the higher rate

19. See for reference, in the context of India, Chadha and Sivamani (2021).
20. We can also count on technological progress in identifying possible alternatives (such as cobalt-less Li-ion batteries), along with recycling. Redox flow batteries, for example, may be a potentially cheaper option than Li-ion batteries for long-duration grid-scale storage (Mongird et al., 2020).
21. Earlier clean energy cess, under the National Clean Energy Fund created in 2010; rebranded as a GST compensation cess since 2017.
22. CO_2e or carbon dioxide equivalent.

proposed by the IMF. Unfortunately, there is no evidence at present to suggest that developed countries are considering this option, though attitudes could change.

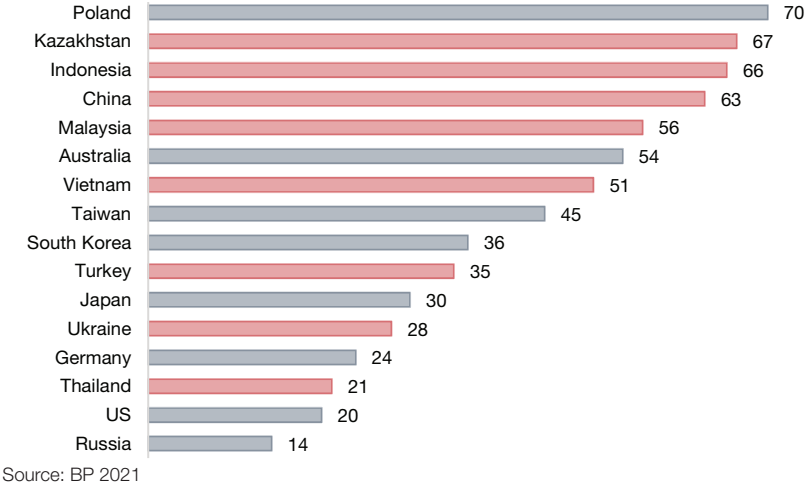
A factor that may lead developing countries to consider some form of carbon taxation is the legislation introduced by the EU to impose a Carbon Border Adjustment Mechanism (CBAM) by 2026 on imports to the EU from countries that do not have a carbon pricing mechanism comparable to what is in place in the EU (European Commission 2021). If duties are imposed on imports from developing countries to offset the effect of the implied tax on carbon in developed countries, it may make sense for exporting nations to levy an explicit carbon tax on the consumption of fossil fuels and avoid the border adjustment duty. Developing countries should be willing to engage in discussions to evolve an internationally accepted approach to carbon taxation in order to forestall moves that impose protectionist duties on them.

Phasing Down Coal-based Power

A contentious issue that was intensely discussed in COP 26 was phasing out unabated[23] coal-based power plants. Coal is the most polluting of all fossil fuels and developed countries argued strongly that coal power plants should be phased out. Their position is understandable since they have almost graduated out of coal power, though they remain highly reliant on natural gas for power generation. Several developing countries not dependent on coal-based power also took the same stand. However, there are many developing countries that are heavily dependent on coal for electricity generation (see Figure 9.4), and they could not agree to a phase-out. Since coal is expected to remain the cheapest base-load source of electricity in the short-term, a premature phase out also poses serious threat to energy security of many countries. The implications of any such decision must therefore be thoroughly studied by the electricity planning authorities before committing to decommissioning of coal power plants by a certain date.

The unwillingness of many developing countries to agree to a phase out was also because much of the coal-based generation capacity in developing countries is relatively new. The

Figure 9.4: Share of coal in electricity generation mix (per cent), 2020



Source: BP 2021

23. That is, without a CO_2 capture and storage system.

median remaining life of operational coal power plants in low- and middle-income countries is twenty-six years, compared to only five years in high-income countries (Global Coal Plant Tracker 2021). In these circumstances, phasing out coal power plants before the end of their life would incur a substantial economic burden on developing countries.

In the end, there was a compromise, based on a suggestion from India, whereby the Glasgow Pact called for a 'phasing down' rather than 'phasing out' of unabated coal-based power. This was seen in some quarters as weakening the pact. However, getting agreement on the need to phase down coal-based power was in fact a substantive step forward. Since coal power plants have a life of about forty years, any country aiming to reach net zero in the foreseeable future should not set up any more plants beyond the ones already under construction. All future electricity demand, that cannot be met by the presently operational coal plants plus those under construction, should be met by renewables. Implementation of this decision would prevent countries from getting locked into highly carbon intensive infrastructure.[24]

The gradual phasing down of coal-based power capacity also implies a phasing down of future coal production in coal-producing countries (e.g. China, Indonesia, India, South Africa, etc.). This has implications for future employment in coal mining and allied businesses. The loss of employment in coal mining could be offset by larger and better employment opportunities in the renewables sector, but since coal production is regionally concentrated, some compensatory measures would be required to ease the burden of the transition on the affected communities. It would also be necessary to re-skill the labour force for the new jobs demanded in the renewables sector, and this will be a major challenge that must be planned for well ahead.

Even though existing coal plants need not be retired prematurely, countries that expect to have coal plants operating for the next few decades should take steps to upgrade these plants through anti-pollution/emission control measures to mitigate some of the social costs involved. Strict enforcement of such measures may lead to situations where upgrading more inefficient or polluting plants may be uneconomical. It would then make sense to decommission such plants well ahead of their end of life.

Afforestation

Forests are natural carbon sinks that reduce the net CO_2 emitted by a country. Unfortunately, deforestation is occurring in many developing countries at a pace that makes the land use change and forestry (LUCF) sector a net emitter of CO_2. Brazil, DRC and Indonesia are respectively the most rainforest-covered countries in the world and are also the top three emitters in terms of LUCF emissions. Much of the deforestation in these countries is happening illegally.

There is a very strong case for reversing this process through afforestation. Leaders of 141 countries, covering more than 85 per cent of the world's forest area, pledged to do so in COP 26.[25] Several developing countries, including Brazil, India, China and Indonesia have plans for afforestation as part of their climate NDCs (see Box 9.1).

Protecting forests would pose a special challenge for countries that depend on the exploitation of natural resources. Indonesia, for example, is the world's largest exporter of palm oil and

24. This decision can be reviewed if the technology for carbon capture and storage, which has so far not yielded very encouraging results, sees some breakthroughs that will make it economical to set up coal-based power plants that do not emit CO_2.

25. Previous such declarations, notably the 2014 New York Declaration on Forests which aimed at halving deforestation by 2020 (and end by 2030), have failed to realize.

has planned to expand its nickel mining industry for EV batteries. All these activities require clearing of the forests (Reuters 2021). On the other side there are also substantial numbers of indigenous peoples and rural communities whose livelihoods depend on forests and are endangered by deforestation. Forest conservation initiatives should involve these communities in afforestation and forest protection through suitable modes of engagement with the government.

Estimating the Investment Requirement of the Transition

The strategy for decarbonization outlined above will require large investments in energy and in many other sectors in the economy. The need for such investments has been much discussed and several figures of the investment amount needed have been estimated by international institutions. Major developing countries would be well-advised to come up with their own estimates of the investments most urgently needed over the next ten years.

The major focus must be on quantifying the investments needed in electricity-related sectors to achieve the shift to renewable energy that is implied by net zero. It is particularly important to identify the public sector and private sector components of this investment. Since the electricity sector is subject to regulations, it is important to consider whether the incentive structure emerging from the regulatory system, including especially payment risk from unviable distribution companies and unexpected actions by governments, is consistent with stimulating private investment as much as would be needed.

In addition to the electricity sector, it would also be desirable to identify the investment needs of the following other areas:

- Developing new energy sources such as hydrogen and biofuels and creating relevant transport infrastructure for hydrogen. Industries like steel and fertilizers will also need to restructure to replace fossil fuel feedstocks with alternatives like hydrogen. The investments in all these areas will be largely private, though some government funding may be desirable to encourage the development of green hydrogen production;
- Restructuring the automobile sector to become fully electric by mid-century. The investment in manufacturing these vehicles, where there is a large domestic manufacturing sector, has to come from the private sector, but there may be a need for extending some public support for creating the EV charging and battery-swapping infrastructure, which will not yield returns in the short or even medium term, but which is essential for the transition to take place. Public sector oil companies could think of diversifying into these new areas to remain in business and utilize their public assets such as urban land;
- Building mass transit systems such as metro railways and electric bus systems. The investment involved in this transition could be largely public, or some combination of public and private, much of which will happen at sub-national/city levels;
- Agricultural research to develop crop varieties that are better able to cope with heat and water stress arising from climate change. This will involve public funding, though it could be combined with private resources where the private corporate sector is keen to get into research and development (R&D).
- Efforts to mitigate methane emissions from certain forms of crop production, e.g. introducing the system of rice intensification or direct-seeded rice cultivation instead of flood irrigation. Similarly, popularising special cattle feeds to reduce methane emissions from cattle. Both will likely involve public resources.

- Improving systems of water management in rural areas to deal with water stress, which is already evident in many areas and may increase because of changes in precipitation levels due to climate change. This will involve substantial public investment at the sub-national levels. It will also require rethinking on water pricing. At present, there is no willingness to charge for water even though it is increasingly a scarce resource. If pricing is not politically acceptable, it has to be replaced by some form of quantitative rationing but that is in many ways even more difficult.
- Forest development and protection to increase the area under forests, is by all accounts a very cost-effective way to reduce net CO_2 emissions for tropical countries. This needs additional public resources.
- Creating climate resilient urban infrastructure to deal with exceptional precipitation leading to floods and to protect against the likely rise in sea levels in coastal cities. This is another area which will require additional public investments, mainly at sub-national levels.

Planning for the structural change implied by net zero requires developing countries to get a good sense of the total volume of investment needed and how much of it must come from the public sector. Most developing countries have severe fiscal constraints, and they would be keen to shift as much of the funding requirement as possible to the private sector. But in that case, they should work in parallel to develop policies that will attract the private sector into these areas.

Since the transition envisaged involves large scale adoption of new technologies, like solar PV and wind turbines, batteries, EVs, hydrogen electrolyzers and fuel cells, the larger developing countries with significant domestic manufacturing capability will want to reorient their industries to produce many of the new products domestically. Encourageing domestic production capacity to meet the changing demand is logical, but it should be ensured that this does not lead to the development of inefficient production capacity, sheltered from competition behind tariff walls. The energy transition will involve new areas subject to rapid technological evolution, and it will be important to avoid getting locked into outdated production methods that are being replaced globally by better and more cost-effective technologies. Designing an industrial cum trade policy that avoids this problem while also encouraging R&D of efficient production methods in these new areas will be essential.

It is evident from the above that planning for net zero calls for wide-ranging transformation, not just of the energy supply sectors but also of all energy-consuming sectors. This has been described as a ‘whole of the economy approach’. It calls for the coordinated effort of many different ministries and, in a federal structure, also the active involvement of sub-national governments. It would also require the active involvement of independent regulatory agencies, such as those involved with fixing electricity tariffs, notifying building laws, granting automobile permits, etc.

Developing countries aiming for this transition should also keep in mind that the same is also taking place in the rest of the world simultaneously. This would make the transition easier because new technologies will evolve much faster. This would also increase the rate of transition as trade policies and policies enforced on private corporations will force a change in the supply chains.

Financing the Energy Transition in Developing Countries

Providing financial assistance to developing countries for mitigation and adaptation has long been a part of the agenda of climate change negotiations, and it is in fact a practical way of ensuring 'climate justice'. The Paris Agreement promised delivery of US$100 billion per year by 2020 and the failure to do so has been a source of much disappointment among developing countries, contributing to a considerable erosion of trust.

The full amount is now expected to be reached only by 2023. The Glasgow Pact has urged developed countries to act urgently to reach the promised US$100 billion and has also acknowledged that the level of assistance after 2025 will have to be much higher. It is important for developing countries to start working on determining the scale of financial support that will be needed and to make realistic assessments of what is feasible, with clarity on what is expected from different groups.

Investment Needs of the Transition

The first step must be to get a sense of the investment needs of the energy transition in developing countries. There is a variety of estimates to choose from. The IPCC (2018) estimated that to limit global warming to +1.5°C, the world (as a whole) would need to invest a total of US$2.8 trillion in 2020, or 2.5 per cent of the global annual GDP.[26] The IEA (2021) has made an even larger estimate of US$4 trillion annually by 2030, but this relates not just to energy but also to other related infrastructure. These are estimates for the entire world and the investment needed in developing countries will obviously be smaller.

There is also a need to recognise that the case for international financial assistance must be related to the additional investments required to make the energy transition, above the amount that would be spent on a business-as-usual basis. It is often difficult to determine what exactly is the additional requirement. For example, if a country shifts future electricity capacity from conventional to renewable sources, it is only the additional capital cost of such capacity compared with the cost of conventional capacity for the same amount of electricity that should be called additional. Financing for the conventional electricity capacity can be assumed to come anyway from the usual/existing sources.

McCollum et al. (2018) had estimated that the additional investments in the energy sector arising from mitigation efforts in non-OECD countries for a +1.5°C outcome would be around US$600 billion per year up to 2050 (in 2020 US$). Adding the cost of adaptation, which UNEP (2016b) had estimated as US$300 billion per year by 2030 and rising to US$500 billion by 2050, would suggest a combined additional cost of both mitigation and adaptation of about US$1 trillion per year.

Bhattacharya and Stern (2021)[27] have estimated that developing countries, excluding China, would need an additional US$800 billion per year by 2025, rising to US$2 trillion per year by 2030. This includes investments in energy and other infrastructure and the adaptation and restoration of natural capital. More recently, the McKinsey Global Institute (2022) has estimated that global capital spending on energy and land-use systems infrastructure would need to increase by US$3.5 trillion per year, over the period 2021–50, for achieving the transition to net zero by 2050.

26. The figure is updated from the original IPCC (2018) estimate of US$2.4 billion in 2010.
27. The paper was circulated during the COP 26 meetings.

These alternative estimates vary considerably but the important point is that the additional investment estimated in all cases is clearly enormous compared to the US$100 billion per year that has been promised for 2023. International estimates of investment needed could be usefully supplemented by country specific studies of the type recommended in Section 4 of this chapter. However, for the rest of this chapter we proceed on the assumption that US$1 trillion per year is a reasonable working estimate of the additional investment that needs to be made for the rest of this decade by developing countries excluding China. This would amount to approximately 4 per cent of the GDP of these countries.

Sources of Climate Finance

The gap between US$1 trillion and the estimated delivery of only US$80 billion in 2019, which is expected to increase to US$100 billion by 2023, highlights the extent of the gap in this area. The global community needs to jointly evolve credible targets of what can be expected, with greater clarity on the roles of different groups.

Developing countries will have to accept that some portion of the additional investments would have to be mobilized domestically, while the rest is sought from external sources. Assuming about 40 per cent of the US$1 trillion needed must be mobilized domestically (that comes to US$400 billion per year or about 1.6 per cent of the GDP of these countries), that leaves US$600 billion to come from external sources.

Is US$600 billion per year from external financing at all realistic? As in the past, external financing will have to consist of a combination of public and private flows. However, unlike in the past, separate targets should be set for these two components. Developed country governments can only be held responsible for ensuring that public flows, which consist of bilateral and multilateral flows, come up to the level targeted. Private flows will obviously depend upon market conditions and on government policies in developing countries seeking investment. Countries counting on large private investment flows must be willing to subject the appropriateness of their policies to critical review.

We also need to recognize that low-income countries are unlikely to be able to access private flows on commercial terms and they will have to depend almost entirely upon grants or near-grant flows such as International Development Association (IDA) credits. Greater clarity is needed on the extent of availability of such funds from bilateral and multilateral sources.

Middle-income countries do not need grant or near-grant funding. They can absorb long-term debt at reasonable interest rates and can also hope to attract non-debt private investment flows. The potential for private financing viewed purely in terms of available supply is very large. Private corporate investors present at COP 26 created the Glasgow Financial Alliance for Net Zero (GFANZ), a group with combined assets under management worth US$130 trillion. Investor sentiment among these institutional investors also favours ‘green financial investments’ and it is often pointed out that even if a small proportion of the managed assets could be redirected to climate financing in developing countries, it could contribute massively to the financial assistance expected for the required energy transition over the next ten years.

In reality, the flow of private capital to emerging markets is very limited and even that is disproportionately concentrated in a few countries. OECD estimates show that of the US$80 billion climate finance mobilized in 2019, private flows accounted for only about US$16.5 billion

(inclusive of export credits). Investors point out that this is because there are not enough well prepared projects and the risks associated with such investments are also unmanageably large.

The lack of 'shovel ready' projects is a genuine problem, but one can imagine that this can be overcome by special efforts at identifying projects at appropriate locations. The issue of risk perception is much more difficult. Energy projects can suffer from a variety of risks during construction and operations, and due to regulatory uncertainties. In addition, there are political risks because of unpredictable actions by government and these are magnified by poor legal redressal for non-performance of contract, especially if the disputes are with the government itself.

There is no doubt that these are genuine problems, especially if the investments envisaged are in highly regulated sectors, such as energy or transport, where governments may be compelled to take actions that are politically motivated. One can take the view that these deficiencies have to be addressed by developing countries themselves and countries that want to tap into the very large pool of global capital available must take the steps needed to overcome investor fears. However, this is also an area where, as Jeffery Sachs (2021) put it, there are market failures and expanded public financial flows can help correct these. Multilateral Development Banks (MDBs) can do a great deal in this area.

The Role of Expanded MDB Lending

Expanded MDB lending to climate change-related sectors could be structured to leverage a larger flow of private finance into these sectors than would happen otherwise. One way of doing this would be through co-investment in the same project. In that case, the involvement of an MDB would give comfort to private investors, especially passive investors like sovereign funds and pension funds, on both the extent of project preparation and the likelihood of the government taking a constructive approach in dealing with problems as they arise during development and operation stages. Apart from co-investments, MDBs can also leverage private finance in such projects by innovative forms of financing like offering first loss guarantees to private lenders.

MDBs can also leverage private flows into climate change-related areas by undertaking sectoral lending, which is linked to sector-specific reforms that will promote the economic viability of the sector and reassure investors. This is particularly important in the energy sector where governments in developing countries are heavily involved.

India, for example, has seen a surge of private investment in renewable electricity generation, but distribution is largely in the hands of state-owned companies which suffer from large losses for a variety of reasons. These include the inability to invest in the distribution system to reduce technical losses because of poor finances, the inability to collect bills because of political interference, and the toleration of unduly low consumer tariffs often encouraged by political leaders 'persuading' the utility not to revise tariffs. The financial condition of the distribution companies translates into a serious payments risk which would discourage private investors from investments in generation. Distribution companies must be sufficiently financially strong for generators to invest in new capacity without needing any guarantees.[28]

28. The Government of India has tried to solve the problem for investors in renewable generation capacity by setting up the Solar Energy Corporation of India, a public trading corporation which buys bulk power from generators and sells it to distribution companies, thus insulating investors from payments risk. This cannot be a sustainable solution in the long-term.

Mexico presents another example where there may be a reversal of the energy reforms of 2014, which opened the Mexican energy sector to private investment. The proposed reversal would restore the monopoly of the state electricity company to sell power to final consumers and allow it to prioritise purchase of electricity from the state-owned generation companies instead of going by the merit order. Large consumers that generate captive power or buy electricity directly from the private market would no longer be able to do so. If these changes are made, it would deter investment by the private sector in renewable power generation projects and perpetuate the dominance of natural gas in Mexico's electricity mix. An NREL analysis suggests that the proposed bill could potentially increase Mexico's annual GHG emissions by up to 65 per cent, derailing its climate ambitions, and raise electricity generation costs by up to 54 per cent (Bloomberg 2021c).

Institutional and political problems such as these can only be overcome by a systematic sectoral push for reforms. MDBs can help in doing this by lending conditional to policy reforms in the sector.

It is worth noting that developing countries have not pushed for larger flows from the MDBs because their climate change negotiators have traditionally preferred getting such flows routed through the Green Climate Fund (GCF).[29] This is possibly because MDB lending is seen to be associated with conditionality. However, the scale of financing available via the GCF is very limited. The latest funding available over a five-year period is only around US$10 billion, which is much less than could be channelled through the MDBs. GCF has the advantage of not prescribing the more onerous conditions associated with the MDBs, but on the other hand it is precisely the reforms related conditionality of MDB lending that will make investment in these sectors more attractive to private investors.

Bhattacharya and Stern (2021) have called for doubling bilateral finance between 2018 and 2025 (from US$32 billion to US$64 billion) and tripling multilateral finance (from US$30 billion to US$90 billion) in the same period.[30] These proposals would increase public funding by US$90 billion per year by 2025. That is certainly impressive, but it is unlikely that additional public flows of this magnitude could leverage private flows sufficient to yield a total of say US$600 billion in external financing per year for climate change.

Perhaps the aim should be at additional lending of about US$250 billion per year provided by all MDBs (the World Bank, IFC and the regional development banks). These institutions will be able to raise the sums required in international markets at much lower costs than individual private investors or even middle-income country governments. The proposed expansion in lending would require a substantial expansion in the capital of these institutions. This may be resisted because of the fiscal cost involved, but the cost in terms of paid-up capital would be a fraction of the increase in authorized capital and it would also be spread over time. The increase in capital needed would be even lower if it could be combined with higher leverage ratios enabling much larger volumes of lending for the same amount of authorized capital.

29. Proposed at COP 15 in Copenhagen, and established at COP 16 in Cancun, the Green Climate Fund is designed as an operating entity of the UNFCCC's financial mechanism to fund climate change mitigation and adaptation projects in developing countries.
30. Based on OECD (2021a).

Using SDRs for Climate Finance

Public funding from the MDBs can be supplemented by innovative use of the recently allocated special drawing rights of about US$650 billion (SDR 456 billion) to all IMF members. About US$375 billion (SDR 263 billion) of this allocation was to developed countries, and they are not likely to need it for balance of payments purposes. These SDRs could be transferred to a fund that would be used to channel resources to developing countries on the condition that they use it to undertake climate-friendly investments. Since SDRs do not have to be repaid within any pre-determined period, these resources could be lent for long-term at the relatively low interest rate that applies to the use of SDRs.

The finite availability of SDRs limits their contribution to international public flows over a longer period, but they can supplement MDB lending over the next few years until action is taken to expand the capital base of these institutions.

To summarize, the scale of financial flows needed to finance the energy transition developing countries have to make is very large. If the flow of climate finance from bilateral sources plus the MDBs can be expanded to US$250 billion per year for the rest of this decade (from about US$63 billion at present), about US$350 billion would still need to be mobilized from private flows to reach the target of US$600 billion. This would represent a massive expansion in private flows from a base of only US$16.5 billion in 2019. As pointed out above, the total availability of private capital is indeed huge, but it will require Herculean efforts to mobilize capital on the scale required from this source. Without the leveraging effect of MDB lending, a response on the scale required is unlikely.

Looking Ahead: An Agenda for Developing Countries

We now summarize our recommendations on what developing countries should do to come up with a credible global compact for managing climate change which protects their interests.

Managing Climate Change Requires Action in Multiple Areas

A central feature of managing climate change is that it requires interventions not in just one or two areas, but in many sectors like energy, including development of green hydrogen and other alternative fuels, industry and manufacturing, especially automobiles and associated sectors like battery production and charging infrastructure, buildings, public transport, agriculture, water management, forestry, etc. In other words, it calls for a 'whole of the economy approach'.

The ministries involved in the COP negotiations are typically the ministries of environment and foreign affairs. However, the evolution of a credible country strategy and its subsequent implementation will require the active involvement of many other ministries dealing with the sectors mentioned above. It will also require the active involvement of governments at sub-national levels. Developing countries need to keep this consideration firmly in mind.

Defining Domestic Strategies for Getting to Net Zero

Having committed to reaching net zero by a certain date, each developing country must define a domestic strategy to get there. It is not necessary to work out all the details of the longer-term strategy up to the end date because there is merit in retaining flexibility for later years as new technologies will develop and experience will be gained. However, it is important to outline

what needs to be done in the next ten years in sufficient detail to allow constant monitoring of progress.

The ten-year strategy would inevitably include some combination of the various measures listed in Section 4, though the exact mix will vary from country to country, depending upon country circumstances and endowments. While spelling out these components, the strategy should provide an indication of the time by when emissions are expected to peak and then start declining.

The respective roles of the public and private sectors in the energy transition over this period should also be clearly spelt out as this will help define the fiscal cost of the transition. Governments that are fiscally stressed may wish to rely on private investors to undertake some of the investments needed, and therefore, the policy environment should be one that is attractive for private players.

The progress of large developing countries in this ten-year period will be of interest to all developing countries. It should be closely watched so that successful efforts can be emulated by others. Keeping pace with what is happening in other developing countries would be an important indicator of competitiveness in a world determined to reduce emissions. Major corporations in particular would be keen to look good on these indicators both to attract investments and to gain global recognition.

Modifying the COP 26 Emissions Trajectories

An immediate challenge facing developing countries is the review of the COP 26 emissions trajectories to find ways of bringing them in line with what is needed to limit global warming to +1.5°C. Developing countries should resist any simplistic push to solve the problem by getting all countries to reach net zero by 2050. As demonstrated in Section 3 of this chapter, the approach of getting all countries to net zero by 2050 is not consistent with fair burden sharing.

An ideal way to proceed would be to tighten country trajectories of all the major emitters that claim much larger shares in the remaining carbon budget than their respective population share. The US, China, Russia, Japan, Australia, Canada, many European nations and rich countries in the Middle East are the most obvious cases that qualify on this criterion. These countries need to be persuaded to (a) accelerate the pace of emissions reduction up to 2030, and (b) advance their net zero dates. Concrete steps taken by these countries could be the prelude to a more comprehensive renegotiation of the net zero dates for all countries at a later stage.

Regional Cooperation

Climate change issues are normally discussed at the global level in COP meetings, but there may be instances where regional consultation can help. Interconnection of electricity grids is an obvious area of potential interest. Marine R&D is another area that would be of interest.

There are several regional and sub-regional cooperation arrangements already in place across all continents, which can take up climate-related issues. They could be used to forge common positions on global issues allowing the constituent nations to negotiate jointly on global platforms. They could also provide a useful forum for sharing experiences.

Penalizing Non-performance

The current framework of negotiations does not envisage any means of penalizing countries that fail to adhere to their promises. However, if we ever get to a global compact based on some agreed burden-sharing in the matter of emissions reductions, we will also need a mechanism to incentivise countries to honour their commitments. This is especially relevant because defaults on the part of developed countries are just as likely to arise as those on the part of developing countries.

This is not an urgent problem currently, as we have yet to come to an agreed set of trajectories consistent with the global warming target, but it will surface once we get to such an agreement. Perhaps a working group should be set up, representing both developed and developing countries, to recommend alternative ways of institutionalizing this problem.

International Finance to Assist Developing Countries

The financial assistance needed by developing countries to achieve the decarbonization envisaged is a major, and as yet unresolved, issue. Section 5 of this chapter elaborated that it is reasonable to plan for financing additional investment of about US$1 trillion per year for both mitigation and adaptation for developing countries excluding China. This is an order of magnitude larger than the US$100 billion that has been discussed so far and is now expected to be reached only by 2023.

Developing countries should consider carefully what is a realistic expectation in terms of international support for this target. A suggested 40 per cent of this amount may need to come from domestic sources, in which case the balance to be raised through international transfers is reduced to US$600 billion. Even this is several times larger than the flows achieved thus far.

The total international transfer will have to be a mix of public and private flows, but separate targets should be set for the two components. Developed country governments can then be pressed to deliver on the public component of the financial assistance through some combination of bilateral and multilateral flows.

The potential scale of private flows is much larger than public flows, but actual flows of private funds thus far have been much lower. This is because of the perception among investors that there are not enough viable projects on offer in developing countries and that the risks with undertaking the investments are too high. Section 5 argues that this problem can be dealt with by creative use of public bilateral and multilateral flows to leverage larger private flows into climate finance for middle-income countries.

The MDBs such as the World Bank, IFC, ADB, AfDB and the European Investment Bank could be particularly useful in this context. Expanded lending by the MDBs will require an increase in the authorized capital of these institutions which will allow them to lend a multiple of the capital contribution. These multilateral flows could be supplemented by innovative use of the SDRs allocated to developed countries, which these countries are not likely to need. capital increases would impose a fiscal burden on developed countries, but it would be small because only a portion of the authorized increase in capital has to be paid-in, which can also be spread over several years.

Combined bilateral and multilateral lending for climate finance can be raised from around US$63 billion at present to say US$250 billion a year over the next ten years, and it could be

used to leverage US$350 billion of private flows to make up the US$600 billion of international finance that is needed.

Activating the G20

The real constraint to expanding MDB lending on the scale that is needed is not the fiscal cost but the lack of political enthusiasm among developed countries for a greater role of multilateral institutions. This reflects a deeper move, in recent years, away from the earlier conviction on the merits of globalization and multilateralism, combined with the effect of growing geopolitical tensions. These trends have encouraged greater insularity and a fragmentation of global solidarity, which is evident in many areas. It is particularly ill-timed as the world tries to address climate-related challenges that call for much greater global cooperation.

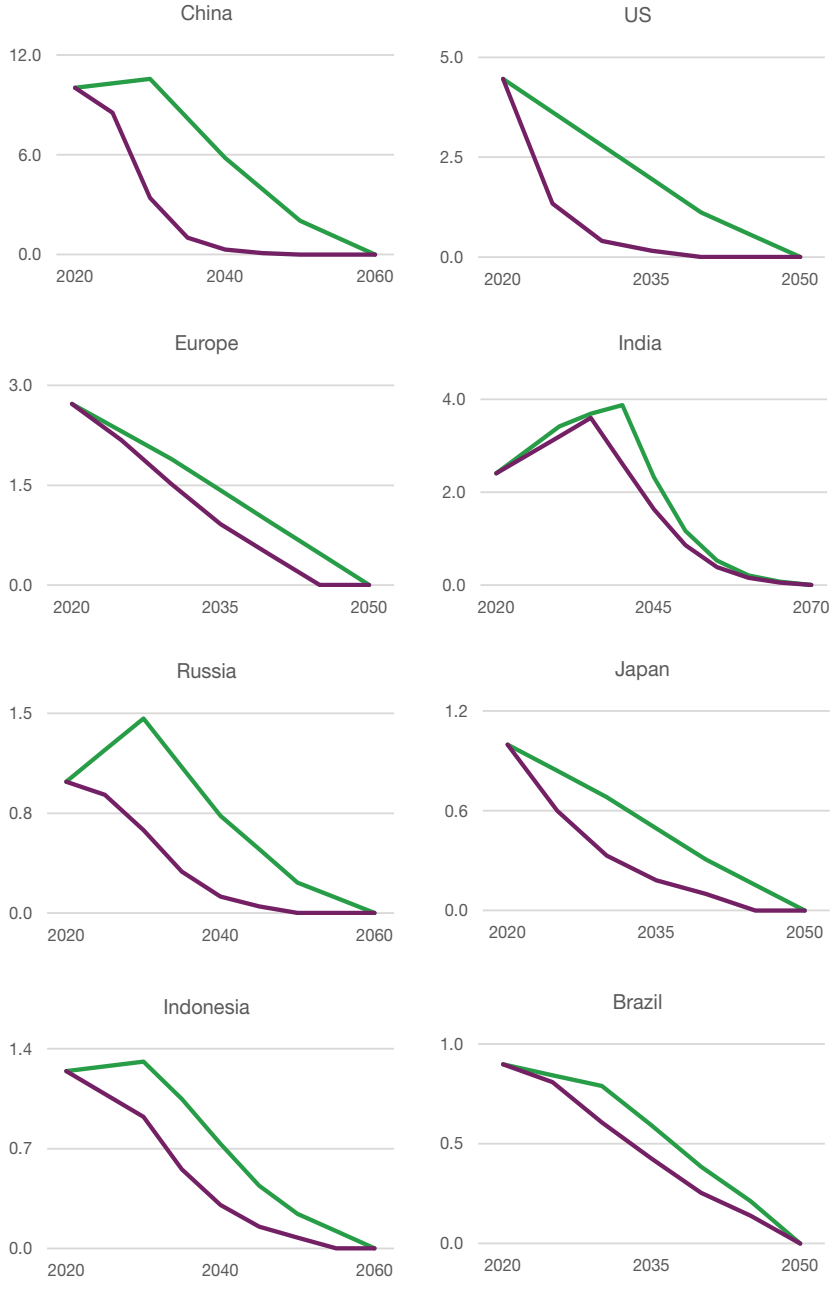
For all the frustrations expressed by many participants, COP 26 negotiations have succeeded in getting developing countries to accept the need to reduce emissions and reach net zero sometime around mid-century. The major developing countries are in a position where they should start spelling out a more specific ten-year strategy consistent with their longer-term emissions reduction targets. They would be best encouraged in this effort by reasonable assurance of international financial support.

The logical forum to provide this assurance is the G20. The group includes all the major developed and developing countries, and it is also the forum for taking decisions on policies relating to the MDBs. It was set up precisely to deal with issues of international economic cooperation. It performed very well at the time of the global financial crisis in 2008. However, since then, it failed to come up to expectations on saving the Doha Round and it has also failed in generating cooperation in ensuring equitable access to COVID-19 vaccines during the pandemic. It could perhaps take on the challenge of restoring its reputation on the issue of multilateral finance for sustainable development in a world of climate change.

The agenda of the G20 thus far has been set largely by developed countries. However, the next three G20 Summit meetings offer a unique opportunity for developing countries to set the agenda: Indonesia has the G20 presidency in 2022, followed by India in 2023 and Brazil in 2024. These three developing countries should not only collaborate closely in the upcoming COPs, but also work together within the G20 to (a) get a broad acknowledgement of the substantial steps that developing countries are proposing to take to help limit global warming, (b) ensure that there will be a sufficient scale of public funding, both bilateral and multilateral, available to support this effort, and (c) structure the increased flow of public finance to ensure a much larger flow of private finance to meet the climate related goals.

The G20 works on two tracks—the Finance Ministers Track and the Summit Track. The troika, which will comprise only developing countries in 2023, should cooperate to get the Finance Ministers Track to work on these ideas expeditiously so they can be considered later at the Summit.

Appendix: Figure 9.5: Committed versus required trajectories (Gt-CO_2/year)



Note: Green curves represent the trajectories as per the latest commitments of the countries. Purple curves represent population-weighted trajectories.
Source: Authors' calculations, WRI Climate Watch 2021, Global Carbon Project 2021, UN Population Division 2019, IPCC 2018, IPCC 2021