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Challenges of Transitioning Away from Fossil Fuels in Developing Countries

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Third World Network

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Executive Summary

THIS paper addresses a key question being discussed in international climate change negotiations: the need for transitioning energy systems away from fossil fuels. It delves into the challenges of energy transitions in developing countries and attempts to respond to what a 'just, orderly and equitable' transition could mean from a climate justice perspective.

Following the introductory section, Section 2 discusses what 'just, orderly and equitable' implies in the context of a fair sharing of the global carbon budget. Developed countries are historically responsible for the climate crisis and have used much more than their fair share of the global carbon budget. They have largely failed in meeting their legal obligations to reduce their emissions as well as to provide means of implementation (MOI) to developing countries under the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Paris Agreement. Given this context, the phrase 'just, orderly and equitable' would have two key elements:

(1) developed countries picking up the pace and leading the transition away from fossil fuels and reflecting their intention to do so in their forthcoming nationally determined contributions (NDCs); and

(2) developing countries being supported to implement their transitions away from fossil fuels as per their national contexts through the provision of MOI by developed countries.

This section emphasizes that for energy transitions in developing countries to be just, there must be a discussion on solutions to energy access for their people, reducing energy poverty and ensuring sustainable development.

Section 3 shows how it is taking developed countries a huge amount of time and investments to transition away from fossil fuels. It spotlights the hypocrisy of the developed countries by elaborating on their massive fossil fuel expansion plans that go up to as far as 2050.

Section 4 details the challenges of developing countries in transitioning away from fossil fuels. The fossil fuel and allied sectors form an important backbone of the economy in many developing countries, besides being a key source of employment in both the formal and informal sectors. This section presents case studies of three countries in the Asian region – China, India and Malaysia – and shows the extent of their dependence on fossil fuels, their plans to expand the non-fossil-fuel share in energy and difficulties in implementing the transition. It shows the huge amount of financing required in each of these countries for implementing any kind of transition in their energy systems.

The concluding section highlights the fact that developing countries are already doing much more than their fair share of climate change mitigation, using their own resources, even as they face 'dis-enablers' like unilateral climate-related trade measures imposed by developed countries. In contrast, developed countries are not only failing to do their fair shares on emission reductions, they are actually moving in the opposite direction with their fossil fuel expansion plans and backsliding on their climate commitments. The paper stresses the need for developed countries to repay the carbon debt they owe to developing countries, put forward ambitious NDCs for the forthcoming timeframe of 2031–2035, lay out their plans to transition away from fossil fuels immediately and reduce their emissions without resorting to loopholes like the use of carbon offsets.

1 Introduction

IN 2023, Parties to the Paris Agreement (PA) adopted a decision on 'transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner' at the 28th session of the Conference of the Parties (COP28) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Dubai, United Arab Emirates. It was seen as a historic decision because it was the first time such a call against the use of fossil fuels was made under the UNFCCC and the PA. It was hailed by many quarters, especially developed countries, as a key political success.

Since the adoption of the decision, which was part of the outcome of the first Global Stocktake (GST),[1] climate policy forums have been abuzz about its implementation. Negotiations on the implementation have dominated climate policy talks. This issue is highly contentious, with several developed countries and some developing countries pushing for further outcomes under the Paris Agreement on operationalizing transitions, even though the former continue to have plans for fossil fuel expansion up to 2050 and beyond.

Some developing countries, such as the small island developing states and the least developed countries, want to pursue the transitions discussion urgently and say that with the continued use of fossil fuels, their very survival is at stake. For other developing countries, the discussion on transitions is deeply linked to the challenges they face in their efforts on poverty eradication, sustainable development, diversifying their economies and providing energy security to their people. They all also stress the crucial need for delivery of means of implementation (MOI) from developed to developing countries.

2 'Just, Orderly and Equitable' Transitions in the Context of a Fair Sharing of the Global Carbon Budget

THE decision on transitioning energy systems away from fossil fuels is contained in paragraph 28(d) of the first GST outcome. Paragraph 28 reads:

'Further recognizes the need for deep, rapid and sustained reductions in greenhouse gas emissions in line with 1.5°C pathways and calls on Parties to contribute to the following global efforts, in a nationally determined manner, taking into account the Paris Agreement and their different national circumstances, pathways and approaches:

(a) Tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030;
(b) Accelerating efforts towards the phase-down of unabated coal power;
(c) Accelerating efforts globally towards net zero emission energy systems, utilizing zero- and low-carbon fuels, well before or by around mid-century;
(d) Transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science;
(e) Accelerating zero- and low-emission technologies, including, inter alia, renewables, nuclear, abatement and removal technologies such as carbon capture and utilization and storage, particularly in hard-to-abate sectors, and low-carbon hydrogen production;
(f) Accelerating the substantial reduction of non-carbon-dioxide emissions globally, in particular methane emissions by 2030;
(g) Accelerating the reduction of emissions from road transport on a range of pathways, including through development of infrastructure and rapid deployment of zero- and low-emission vehicles;
(h) Phasing out inefficient fossil fuel subsidies that do not address energy poverty or just transitions, as soon as possible'.

The phrase in the chapeau of paragraph 28, ‘taking into account the Paris Agreement’, implies that, inter alia, principles of equity and common but differentiated responsibilities and respective capabilities (CBDR-RC) have to be kept in mind while interpreting paragraph 28, given that Article 2.2 of the PA states that the Agreement ‘will be implemented to reflect equity and the principle of CBDR-RC, in the light of different national circumstances’.

Equity and CBDR-RC are the core principles of the Convention and the Paris Agreement. These principles stem from the historical responsibilities of developed countries in contributing to the climate crisis and from the different starting points of countries based on their stage of development. Through various provisions in the Convention and the Paris Agreement, these principles provide that developed countries must take the lead in climate action and deliver MOI in the form of finance, technology and capacity building to developing countries to help support their climate action. The Convention in its Article 4.7 states explicitly that the extent of developing countries’ efforts in dealing with climate change would depend on the ‘effective implementation’ of commitments made by developed countries for providing MOI to developing countries. This same relationship between action by developing countries and support from developed countries is implicitly carried over into the PA in various ways (such as under Articles 4 and 9 of the PA).

In light of the above context, the phrase ‘just, orderly and equitable’ in paragraph 28(d) would have two key elements:

(1) Developed countries picking up the pace and leading the transition away from fossil fuels and reflecting their intention to do so in their forthcoming nationally determined contributions (NDCs) for the 2031–2035 timeframe; and

(2) Developing countries being supported to implement their transitions away from fossil fuels as per their national contexts through the provision of MOI by developed countries.

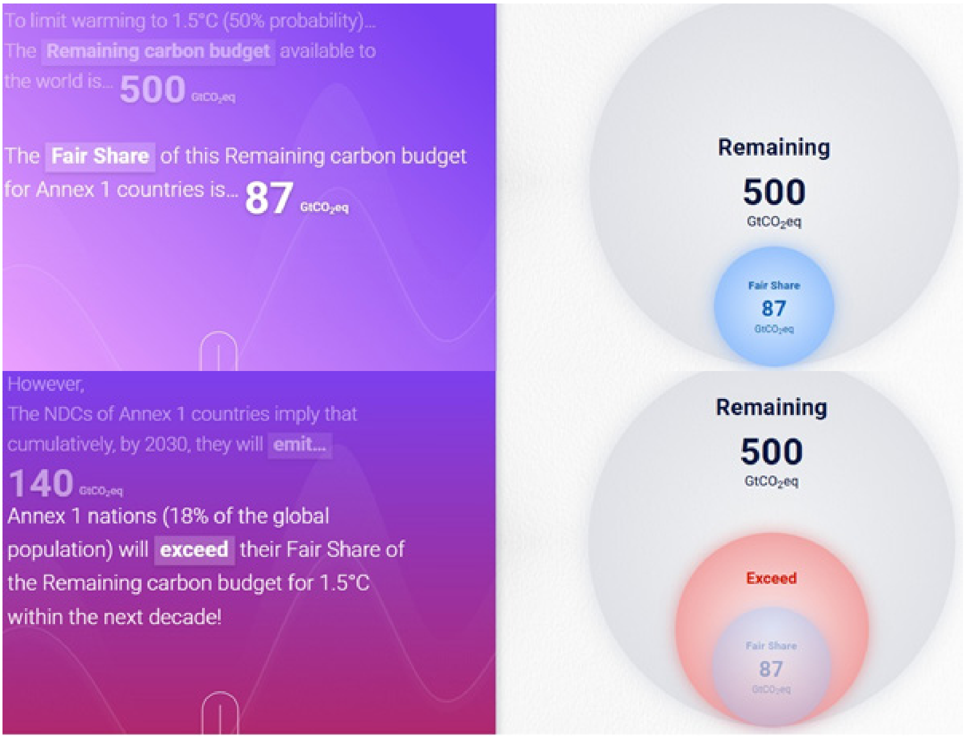
Fair sharing of the global carbon budget

The global carbon budget refers to the total amount of cumulative emissions that are allowed from 1850 till the year of net zero in order to keep temperature increase below a specified limit.[2] A fair sharing of this global carbon budget implies that it is to be shared equitably by all countries – developed and developing.

According to the Intergovernmental Panel on Climate Change (IPCC), four-fifths of the global carbon budget for limiting temperature rise to 1.5°C (>50% probability) and two-thirds of the global carbon budget for limiting temperature rise to 2°C (>67% probability) have already been used up.[3] The amount of carbon budget remaining for limiting temperature rise to 1.5°C (>50% probability) is 500 gigatonnes (Gt).[4]

Further, it is scientifically established that the historical cumulative emissions of developed countries have contributed to the current climate crisis that the world is facing. Developed countries are responsible for 68% of the historical cumulative carbon dioxide (CO_2) emissions (non–land use, land-use change and forestry, LULUCF) from 1850–2019 although they represented only 19% of the world's population in 2019. Developing countries' historical cumulative CO_2 emissions on the other hand totalled 32% for the same period, while they represented 81% of the global population in 2019.[5]

An assessment by Climate Equity Monitor (CEM)[6] shows that, for limiting temperature rise to 1.5°C (>50% probability), the fair share of the remaining carbon budget for Annex I countries[7] is 87 Gt carbon dioxide equivalent (CO_2 eq), if past emissions are not considered. If the total carbon budget is considered, then developed countries have to undertake negative emissions immediately (i.e., start absorbing more greenhouse gas emissions than they emit). However, CEM's analysis of Annex I countries' NDCs shows that cumulatively, by 2030, they will emit 140 Gt CO_2 eq, exceeding their fair share of even the remaining carbon budget by 53 Gt CO_2 eq. CEM's analysis reveals that developed countries' current climate mitigation efforts are insufficient for limiting the temperature rise to 1.5°C, and that they overconsume the remaining carbon budget. This is made worse when the exit in 2025 of the US from the Paris Agreement is factored in.



Source: Climate Equity Monitor, at https://climateequitymonitor.in

Given that they have used much more than their fair share of the global carbon budget, developed countries owe a carbon debt to developing countries. This carbon debt can be repaid only when developed countries take ambitious and urgent action to reduce their emissions immediately,[8] go into negative emissions at the earliest, and provide MOI to developing countries.

Most developing countries, on the other hand, must address key priorities of achieving poverty eradication and sustainable development, besides dealing with the impacts of climate change. Many developing countries will need to attain a specific threshold of energy use to achieve sustainable development.[9] For instance, poverty eradication measures would include the construction of social and economic infrastructure like schools, hospitals, transportation and communication networks, all of which would require energy consumption.[10] Therefore, the remaining global carbon budget, which is already very limited, is required by developing countries to ensure sufficient levels of human development for their people.[11]

According to a 2020 study, an equitable sharing of the global carbon budget requires wealthier countries with diversified economies like the United States, the United Kingdom, Canada, Germany and Norway to implement the transition away from fossil fuels the fastest.[12] This study shows that the difficulties these countries would face in phasing out fossil fuels are much lower compared with those faced by developing countries. Its authors write: 'For example, consider coal mining in Germany compared to China. Any equitable solution to ending German coal extraction must take into account the workers and communities in mining regions. But Germany's 15,000 coal miners account for 0.03% of the national workforce, whereas China's 5.2 million account for 0.6% of its workforce. Assuming each country can reasonably transition the same proportion of its workforce and economy per year, China would then need twenty times as long as Germany to make the transition. Moreover, Germany's $900 million coal mining wage bill amounts to 0.03% of gross domestic product (GDP); China's $50 billion to 0.5%. Assuming the costs of just transition (such as retraining and social protection) are proportional to the wage bill, this suggests that Germany has sixteen times greater resources relative to what is needed than China, as well as a broader base of employment elsewhere to absorb the displaced workforce, labour policies and welfare budgets to support it.'

According to a 2023 study that adopts the lens of climate and energy justice, for energy transitions to be 'just', 'aspects of global inequity, energy access, energy security and labour' must be addressed.[13] This would involve a focus on 'examining where the injustice emerged, the parties that are affected and ignored, as well as mechanisms that are in place to reduce and reveal the injustice'.[14] The three main elements that need to be addressed in this context are: '(i) energy access for meeting objectives of modernization and industrial development (ii) energy security for ensuring reliability and uninterrupted energy supply (iii) the issue of labour in energy transitions'. This study points out that along with a focus on accelerating decarbonization globally, there should be recognition of the need for delivering on climate and energy justice. This in turn relates to the core principles of equity and CBDR-RC under the UNFCCC and the Paris Agreement.

Thus, keeping a fair sharing of the global carbon budget and climate justice in mind, a 'just, orderly and equitable' transition away from fossil fuels implies that developed countries must show leadership and pave the way for energy transitions, reduce their fossil fuel consumption, and provide support to developing countries for their transitions. It also implies that there can be no one-size-fits-all approach to implementing energy transitions as there will be multiple pathways depending on the different national circumstances of countries.

Unfortunately, developed countries have not reduced their aggregate emissions by much compared with 1990 levels and continue to plan for more fossil fuel expansion, nor has the financial support to developing countries been forthcoming. Meanwhile, the financial needs of developing countries for addressing climate change continue to increase. According to a 2024 UNFCCC report, developing countries need around US$5.1–6.8 trillion up to 2030 to deal with climate change.[15] Another report estimates that developing countries require US$215–387 billion annually up to 2030 to meet their adaptation needs.[16] An analysis of countries' technology needs assessment reports developed under the UNFCCC shows that a major share of the needs expressed by developing countries relate to mitigation technologies.[17] For implementing their technology action plans too, developing countries require considerable finance. According to estimates by the UNFCCC, 'for the implementation of the technology action plans, a cumulative estimated budget of $20.1 billion for mitigation and $4.4 billion for adaptation is needed. For the implementation of technology project ideas, $22.0 billion for mitigation and $14.0 billion for adaptation would be needed'.[18]

Even as developing countries face such huge financing needs for addressing climate change, the support they receive from developed countries remains highly inadequate. COP29 held in Baku, Azerbaijan, in 2024 adopted a decision on the 'big finance goal', the new collective quantified goal on climate finance (NCQG), under which countries are to deliver a meagre US$300 billion per year by 2035. This new climate finance goal was touted as being triple the previous goal of US$100 billion per year agreed in Cancun, Mexico, in 2010. However, in reality it amounts to a much lower sum when inflation is factored in.[19] According to one estimate, with a 5% inflation rate, 'the net present value of $300 billion mobilized in 2035 would be worth approximately $175 billion in 2024 dollars'.[20]

Besides having to address their crucial needs of poverty eradication and sustainable development, developing countries are also experiencing immense stress due to impacts of climate change. A 2023 analysis by the World Meteorological Organization shows that between 1970–2021 the total number of reported disasters due to weather, climate and water extremes was 11,778. Seventy-one percent of the disasters were reported from developing economies, 24% from developed economies and 5% from economies in transition. The analysis puts the total number of deaths caused by these disasters at 2,087,229, of which 91% were reported from developing economies, 6% from developed economies and 3% from economies in transition.[21]

3 Developed Countries’ Slow Pace of Energy Transition and Fossil Fuel Expansion Plans

EXPERIENCE from some developed countries shows that implementing policies to shift away from coal requires a lot of time and investment. Even then, virtually none of the developed countries has completed such a transition, and they continue to display a heavy reliance on fossil fuels for meeting their primary energy consumption needs and extremely high levels of per capita primary energy consumption (see Table 1 in Annex I).

The US took 100 years to reduce the number of people employed in its coal sector from 1 million in 1920 to 42,000 in 2020.[22] Yet around 26 counties in the US spread across 10 states remain economically dependent on the sector to this day. In 2025, the country had 460 operational coal mines and 391 coal-fired power plants.[23] To make matters worse, the Trump administration has embarked on a policy of ‘drill, baby, drill’, while exiting the Paris Agreement.

Australia, the world’s second largest exporter of coal, continues to rely heavily on the mineral for both revenues and more than 50% of its domestic power generation.[24] In 2025, the country had 101 operational coal mines and 52 coal-fired power plants.[25] In 2017, it initiated the closure of its oldest coal power plant, the Hazelwood plant near Melbourne. The decommissioning plan involved an investment of A$700 million and a 30-year timeframe for the rehabilitation of the site.[26] There are however currently no plans to completely wean the country off coal.

Germany began implementing its phasing down of coal in the 1960s as a result of cheaper overseas oil and gas. In the 1930s and ’40s, its coal sector employed 600,000 people. This number declined to under 100,000 by the 1990s and fell further to 3,000 in 2018. However, the country restarted its coal and lignite power stations when it faced an energy crisis due to the conflict in Ukraine.[27]

In the UK, the number of jobs in the coal economy fell from 200,000 in 1985 to 7,000 in 2005. To support its transition away from coal, the country set up a Coalfield Regeneration Trust for monitoring the decommissioning of its coal plants. The Trust received GBP300 million over 20 years, which became the country's longest-running and largest financial intervention.[28] Despite the considerable reduction in its reliance on coal, in 2024, the UK still depended on fossil fuels to meet 73.54% of its primary energy consumption needs and 34% of its electricity production.

These examples show that any kind of energy transition is a long-drawn, difficult process, and requires substantial amounts of financial resources. Major developed countries took many years to reduce their dependency on the coal sector despite having a higher economic capacity to bear the costs of the transition. One should also not forget that their 'transitions away from coal' are not transitions to renewable energy (RE) but transitions to natural gas. And they continue to display substantial dependence on fossil fuels for meeting their primary energy consumption needs.

'Drill, baby, drill': Fossil fuel expansion plans of some developed countries

Instead of ramping up their use of renewable energy at a rapid pace, several developed countries have fossil fuel expansion plans, not just in this critical decade but up until 2050.[29] The US, Canada, Australia, Norway and the UK account for a majority (51%) of planned expansion of new oil and gas fields through 2050. These five countries are also responsible for more than two-thirds (67%) of all new oil and gas licences awarded since 2020.[30] Except for Norway, the other four countries are among the top 10 historical contributors to the climate crisis through their cumulative domestic emissions.

The US alone accounts for more than one-third of the planned global oil and gas expansion, followed by Canada and Russia.[31] In 2024, then President Joe Biden approved the Sea Port Oil Terminal, the US' largest offshore oil export terminal, which is expected to produce emissions equivalent to 90 coal plants.[32] In 2023, the US issued 758 new licences for extraction projects. The total number of projected licences by the US for 2024 alone is estimated to cause 397 million tonnes of emissions.[33] The cumulative CO2 emissions threatened by the US' new extraction plans total 72.5 Gt, which is equivalent to the lifetime emissions of 454 new coal plants, or 13 years of US domestic emissions at current levels.[34]

In 2023, Canada provided at least C$18.553 billion in financial support to fossil fuel and petrochemical companies.[35] Between 2019–2023, Canada's federal government provided financial support of C$65 billion to the oil and gas industry.[36] The country's gas extraction has increased by three times in the last three decades from 6 to 18 billion cubic metres (bcm).[37] Canada is expected to be the world's second largest developer of new oil and gas extraction from 2023 to 2050.[38]

Australia ranks as the world's third largest exporter of fossil fuels. According to a 2025 report,[39] its fossil fuel exports have doubled twice in the last three decades, from 1990 to 2005 and from 2005 to 2025. Export of its liquefied natural gas (LNG) has increased by seven times since 2005, and Australia now produces 20% of all internationally traded LNG.[40] It recently approved an extension of almost 50 years for Woodside Energy's North West Shelf gas processing facility, allowing it to operate till 2070. As per the company's own estimate, this project will cause around 4 billion tonnes of CO2 eq emissions. In 2021–2022, Australia provided A$1.1 billion in domestic fossil fuel subsidies.[41] Since 2021, the country has approved 30 new coal and gas projects. One conservative estimate of greenhouse gas emissions from Australia's planned fossil fuel projects puts the figure at 18.6 billion tonnes, which amounts to 6.2% of the world's remaining 1.5°C carbon budget, when Australia's population represents just one-third of one percent of the global population.[42]

In 2022, the UK allowed over 100 new licences for oil and gas projects. The UK government has given significant domestic tax breaks to the oil and gas industry. The windfall tax introduced by the government in 2022 has a loophole that would allow companies to claim tax relief on oil and gas investments for up to GBP11 billion.[43] It had been forecast that the UK would hand out 72 oil and gas licences in 2024 which would result in an estimated 101 million tonnes of emissions.[44] The cumulative CO2 emissions threatened by new extraction plans of the UK amount to 1.8 Gt, which is equivalent to lifetime emissions of 12 new coal plants, or four years of UK domestic emissions at current levels.[45] In 2024, the UK's incoming government announced policy support of US$28 billion for carbon capture and storage, which is expected to slow the speed of fossil fuel phase-out in the country.[46]

Norway, in 2023, awarded 47 new licences to 25 different oil and gas companies on the Norwegian shelf.[47] It was projected to give 80 oil and gas licences in 2024 which would result in an estimated 771 million tonnes of emissions, equivalent to 183 million new gasoline-powered cars on the road.[48]

Developing countries, on the other hand, despite their high dependency on coal and other fossil fuels, have put in place ambitious plans of setting up alternative sources of energy and are invested in a cleaner, greener future. In 2024, China invested more than double the global average on its energy transition.[49] In its updated NDC, China has stated it 'aims to have CO2 emissions peak before 2030 and achieve carbon neutrality before 2060 … [it] will lower its CO2 emissions per unit of gross domestic product (GDP) by over 65% from the 2005 level … increase the share of non-fossil fuels in primary energy consumption to around 25% ... and … bring its total installed capacity of wind and solar power to over 1.2 billion kilowatts by 2030'.[50] India's updated NDC states it aims 'to reduce emissions intensity of its GDP by 45 percent by 2030, from 2005 level'.[51] It also states the country plans 'to achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF)'.[52]

4 Challenges of Developing Countries in Transitioning Away from Fossil Fuels

EVEN as they try to implement ambitious plans of energy transition, developing countries face several challenges along this path away from fossil fuels. Their dependence on fossil fuels is tied to their goals of energy access, energy security and ending energy poverty. All of these are in turn closely linked to addressing the sustainable development needs of their people. Additionally, fossil fuel and allied sectors in these countries are a major source of formal and informal employment. These sectors contribute to the GDP of these countries to different degrees.

For most developing countries, their per capita primary energy consumption is substantially lower compared with that of developed countries. For instance, in 2024 India's per capita energy consumption was a mere 7,813 kilowatt hours (KWh) – almost 10 times lower than that of the US at 76,800 KWh.[53] A developing country like India would have to raise its per capita primary energy consumption in order to deliver sustainable development.[54] However, doing this only on the basis of renewable energy would be a very tall order as that would involve a complete shift away from fossil fuels, which in turn would require a massive scale of financial and technological investment. Implementing any kind of energy transition thus poses a complex set of challenges for developing countries. This section presents case studies of such challenges faced by three developing countries in the Asian region: China, India and Malaysia. (See Annex II for a summary of these case studies.)

China

Dependence on the fossil fuel sector

China is the largest country in Asia and the second most populous country in the world, with a population of 1.41 billion in 2024.[55] It is the world's largest producer and consumer of coal.[56] In 2024, it relied on coal for meeting 52.81% of its energy consumption needs and 58.18% of its electricity needs.[57] It relied on fossil fuels to meet 61.9% of its electricity needs in 2024. Around 80% of its primary energy consumption needs were met through fossil fuels, while 17.47% came from renewable energy sources in 2024.[58]

In 2017, the revenue from the fossil fuel sector contributed to 4.2% of the GDP.[59] China has an export-oriented economy and holds 'the largest national production capacity for several key energy-intensive commodities, such as steel, aluminium, cement, plastics, methanol and ammonia; for many of these commodities, China accounts for more than half of total global production. The energy consumption of these industries accounts for around 60% of the country's gross final energy use. Coal has been widely used in the industrial sector, and its consumption has been rising in recent years. This is particularly the case for China's rapidly developing chemical and petrochemical industry: in 2019, coal consumption in China's metallurgical sector grew 7% and in the chemicals sector grew 11%'.[60]

In 2025, it had 1,900 operational coal mines and 3,269 coal-fired power plants.[61] The coal industry in China employed around 3.473 million people in 2018,[62] which accounts for 58.27% of the workforce employed by the coal industry globally.[63] In 2018, coal production in the country was concentrated in its western region, accounting for 59.38% of the national output, and the central region, which accounted for 33.63%, while the eastern region accounted for 6.99%.[64] Some of the largest coal-producing provinces of China are Shanxi, Shaanxi and Inner Mongolia.[65]

Challenges of transitioning away from fossil fuels

Some of the challenges that China faces in transitioning away from fossil fuels, especially coal, include the need for securing energy access, regional variations in terms of extent of dependency on coal, loss of jobs based on the coal sector and the need for generating alternative jobs, and the impact on other aspects of the economy that are crucial for China's growth.

According to an article published in the *Chinese Journal of Population, Resources and Environment* in 2020, costs of investment for implementing an energy transition (including power generation, electricity transmission, distribution and storage, extraction and conversion of fuels) in China from 2020 to 2050 would range from US$7.65 trillion to US$24.7 trillion depending on different scenarios.[66]

Securing access to energy is an important priority for the country. In 2023, around 88.7% of its population had access to clean cooking fuels.[67] In the recent past when the country suffered droughts, the output from its hydropower plants was affected drastically,[68] resulting in an increased production of coal to meet the shortfall in energy generation. The country also suffered major power blackouts in 2021, which made it evident that despite immense growth in installed capacity of renewables, China cannot stop using coal overnight.[69]

According to a 2023 report, China would be the most affected by the job losses that the coal-mining industry potentially faces globally, with more than half a million miners facing the risk of job loss.[70] Shanxi province, for instance, is projected to lose nearly 241,900 jobs by 2050 due to mine closures, making it the most impacted province in China.[71]

Compounding the problem of job loss is the fact that most of the workforce in the sector are low-skilled workers, which would make it harder for them to find alternative jobs.[72] Further, provinces that are more reliant on coal production for their local economy lack economic diversification, adding to the difficulties of the workforce in seeking alternative jobs.[73] Large seasonal differences in regional climate are another factor that adds to the challenges of electrification in China.[74]

China's industrial sector accounts for 60% of gross energy use, with two-thirds of the industry demand being met by coal and a quarter by electricity.[75] Key energy-intensive industries include iron and steel, aluminium, chemicals and petrochemicals, and cement and lime. These industries are not expected to decline during 2020–2050.[76] In 2019, China accounted for half of the world's cement production, more than half of the global output of crude steel and 56% of the global output of electrolytic aluminium.[77] China's manufacturing sector with its high energy and material consumption, and low added-value rate, is still in the middle and low ends of the international industrial value chain, which poses huge challenges of economic structural adjustment and industrial upgrading.[78]

China's cities and their surrounding areas constitute around 85% of its energy demand.[79] In 2020, 60% of China's population were concentrated in its urban areas, and as per the country's 14th Five Year Plan, this number is expected to grow to 65% in 2025,[80] resulting in a further increase in energy demand. Industries accounted for 70% of the urban final energy consumption in 2016, while buildings accounted for 19% and transport for 11%, as per the State Grid City and Energy Research Institute.[81] China accounted for around half of global passenger electric car sales and nearly 100% of global electric bus sales.[82] Despite making these strides, China faces the challenge of building deeper understanding of 'the extent to which the electric grid can support the substantial increase in electricity demand for vehicle charging; how to couple charging with variable renewable energy production; and the measures needed to manage the charging processes, including smarter charging infrastructure that can provide charging services for several cars synchronously'.[83] An additional challenge that will also need to be addressed is the 'need to avoid un-coordinated electrification, which could threaten to increase system peaks and cause issues for transmission and distribution networks'.[84]

In 2023, rural areas accounted for 34% of China's total population.[85] Its rural areas have experienced a steady improvement in living standards due to modernization, accompanied by an increase in energy demand.[86] In 2019, rural areas constituted 35.18% of the country's electricity consumption.[87] Energy consumption in rural areas mostly relies on coal, followed by diesel and electricity. Rural areas in China's central and eastern regions have witnessed the development of renewable energy sources as well. However, challenges persist in large-scale development and utilization of RE in rural areas. These include scattered distribution, high cost of RE technology development, and insufficient understanding of the technology.[88] There also exists an imbalance between supply and demand of energy. Energy demand will further increase with the acceleration of urbanization and industrialization.[89] This is likely to result in a situation where traditional energy sources are also needed to meet the needs of rural areas.[90] Given the weak infrastructure of rural areas along with insufficient technology development institutions, the general energy service ability is also inadequate. Follow-up technical services could not keep up with the RE infrastructure projects that were constructed in rural areas.[91] Further, rural RE construction investment has a long recovery cycle and high uncertainty. Therefore investment in the energy industry in these areas is driven largely by state capital resources. All these factors cause a huge capital gap, adding to the challenges of energy transition in rural areas.[92]

State of renewables

Despite the many challenges it faces in implementing its energy transition, China is a global leader in the growth of renewables. In 2024, it generated 34% of its electricity from renewable energy sources.[93] By 2023, China had already invested US$676 billion towards its energy transition, which makes it the world's largest investor in this field.[94] Its renewable energy sources include solar, wind, hydropower, geothermal, bioenergy, wave and tidal. According to data released by China on the progress it made in the past decade towards energy transition,[95] in 2023, the country's total installed capacity for power generation amounted to 2,920 gigawatts (GW), of which clean energy contributed 1,700 GW, which amounted to 58.2%. By the end of 2023, China's cumulative installed capacities for wind and solar photovoltaic (PV) energy were 441 GW and 609 GW respectively. Its installed capacity of distributed PV power exceeded 250 GW, accounting for more than 40% of the total installed capacity of PV power. The regular installed hydropower capacity of the country stood at 370 GW by the end of 2023;[96] that of biomass was 44.14 GW.[97] The total installed capacity of nuclear power plants under construction and in operation was 100.33 GW by the end of 2023.[98] In terms of electricity generation, in 2024, hydropower constituted the largest share at 13.45%, followed by wind at 9.84% and solar at 8.28%.[99]

Though China accounts for the largest share of growth in renewable energy capacity,[100] 61.9% of its electricity production in 2024 was still dependent on fossil fuel sources.[101] Challenges in shifting towards renewables as the primary source of energy include problems of intermittency, limited integration with the national and state grids,[102] and insufficient energy storage capacity.[103] These challenges exist particularly for solar and wind power generation where volatility and uncertainty during electricity generation can have a negative impact on the power grids and lead to a high rate of abandoned solar and wind energy.[104] Dealing with this would require increasing flexibility in the country's power systems to allow for the integration of high shares of variable RE electricity.[105] In terms of energy storage, China's cumulative installed capacity of electrochemical energy storage exceeded 2 GW in 2020. China plans to grow this capacity to 20 GW as provided for in its 14th Five Year Plan.[106] Advanced electrochemical energy storage includes lithium ion and sodium ion batteries.[107] China imports more than 70% of its lithium supply, which makes it a bottleneck for scaling up lithium-based energy storage at an accelerated pace since it has to rely on others for raw materials.[108] The country is therefore focusing on increasing the use of sodium ion batteries.

Sixty-nine percent of China's solar PV power plants are centralized, with the remaining being decentralized or distributed.[109] To scale up reliance on RE from solar, China may need to move from a centralized to a decentralized power system.[110] This would involve a re-optimization of the power system from the current traditional centralized system to a hybrid configuration that is a combination of centralized and distributed power generation systems.[111] Strengthening research and development capacities, standard setting, proficiency testing and verification have also been identified as requirements for scaling up solar.[112] Improving utilization of solar PV power generation would be crucial to scaling up solar energy consumption; this in turn would require the above issues to be addressed.

Regional imbalance also manifests in the RE sector. Different sources of renewable energy are concentrated in different parts of the country: 70% of hydropower generation is located in the southwest, 80% of wind power generation is in the north, 60% of solar generation is in the west, while most power consumption is in the eastern and central regions (70%).[113] To overcome these imbalances, China would need to enhance its inter-regional trade in power so that it is able to maintain a balance between supply and demand.[114]

India

Dependence on fossil fuels

India, with 1.42 billion people, is the most populous country in the world.[115] It is the world's second largest producer and consumer of coal.[116] The country relies on coal for meeting 55% of its primary commercial energy needs and 70% of its electricity needs.[117] The contribution of the mining sector (of which coal mining is a part) to the country's GDP is 2%, with the share of coal and lignite being 0.7%.[118] Although in absolute terms the share of coal in the country's GDP appears low, the taxes and levies from the sector constitute an important source of revenue for both the federal and state governments.[119] In large coal-producing states like Jharkhand and Chhattisgarh, coal provides an estimated 10% and 9% of the state revenues.[120] Coal contributed 49% to Indian Railways' freight revenue in 2022–2023.[121] Indian Railways in turn constitutes an important source of revenue for the federal government.

In 2025, 49.3% of India's installed power capacity is based on fossil fuels, while the rest is based on other sources like solar, hydro, wind, small hydro, nuclear and biopower.[122] In 2023, 76.7% of its population had access to clean cooking fuels.[123] India's efforts to transition away from fossil fuels would, like China's, also need to focus largely on phasing down unabated coal-based sources of energy even as it deals with the need to achieve sustainable development and poverty eradication, and secure energy access for its people.

Challenges of transitioning away from fossil fuels

Phasing down of unabated coal in India would have an impact not just on the coal sector, but on multiple sectors reliant on coal-based energy for their functioning. Some of the sectors which are likely to face a greater impact include mining, power and manufacturing. Each of these sectors provides employment and adds value to the country's economy. Any phasing down of unabated coal would have an implication for these sectors' energy security and access.

There are 417 operational coal and lignite mines in India.[124] Coal production in the country is spread out over 51 districts and 13 states.[125] Most of the states which have a higher concentration of coal are in central and eastern parts of the country. India has 634 operational coal-based/thermal power plants (TPPs) located in 17 states.[126] India's TPP fleet is relatively young, with three-fourths of the existing capacity being under 20 years of age.[127]

Figures on the number of people employed formally by the coal sector range from 0.44 million[128] to 0.74 million.[129] The sector also employs people in the informal sector, estimated at between 1.7–2.4 times the formal workforce.[130] It is also a substantial source of indirect employment. For instance, transportation of coal is estimated to create an additional 0.5 million jobs in mining areas.[131] According to other estimates, India's coal sector is believed to employ 15 million people.[132]

The extent of vulnerability of people employed by the coal sector depends on the type of worker, with informal workers being more vulnerable than those in the formal sector.[133] Workers in the informal sector are unlikely to receive adequate reskilling/training for employment in other sectors.

Shutting down coal mines and TPPs will not only have an immediate impact on those who are employed by them, but also affect the local economies and communities of the districts in which they are located.[134] Coal companies, especially the ones which are run by the public sector, provide social infrastructure like schools and hospitals for local communities.[135] Closure of their operations will have an impact on the provisioning of those basic welfare facilities too.[136]

Emerging research has shown that people who lose jobs due to the closure of coal mines and thermal power plants could potentially be hired in the renewable energy sector,[137] which is likely to witness continuous growth due to rising needs of finding alternative sources of energy in the country. However, this would depend on the availability of adequate training programmes and the level of skills the workers already possess. There is no guarantee that a person who is employed indirectly by the coal sector as a coal gatherer or coal seller would find a job in the renewable energy sector.[138] A person who is employed for operations and maintenance in a TPP would have skills specific to that power plant which may not necessarily be relevant for the renewable energy sector.[139]

Another challenge emanates from the labour intensity of alternative sectors that would seek to replace employment provided by the coal industry. If the new sectors are not as labour-intensive as the older ones, the number of jobs generated would be lower. For instance, according to survey-based estimates of Indian renewable energy power plants, the operation and maintenance aspects of the plants have been found to be not labour-intensive, because of which the extent of jobs produced by them is limited, especially when compared with thermal power plants.[140] Likewise, the electric vehicle sector in India is less labour-intensive than the traditional automotive sector.[141]

Apart from power generation, which is responsible for the bulk of coal consumption in India, there are other key industrial sectors that also consume coal. These include steel and washery, cement, paper, textile, sponge iron, fertilizers and chemicals, and bricks. From 2009–2010 to 2018–2019, the top three consumers of coal were the electricity (66%), steel and washery (7.2%), and cement (0.9%) sectors.[142] Growth in the cement industry is driven by India's needs for infrastructure development and urbanization, both of which are important activities for the country's development.[143] The iron and steel sector contributes around 47% of all inputs in the building and construction sector and is also a crucial source of inputs for the production of machinery and goods.[144] Other highly energy-intensive manufacturing sectors in India include non-metallic mineral products (including glass and cement), basic metals, paper and paper products.[145]

Another area of the Indian economy that will face serious challenges in phasing down unabated coal is the micro, small and medium enterprise (MSME) sector. It contributed 35.4% of the manufacturing output in 2022, while the share of MSME-specified products in the country's exports was 45.7% in 2023–2024.[146] Lack of access to the latest technologies makes MSMEs vulnerable in terms of energy security in the context of a transition away from fossil fuels.[147] One of the main obstacles preventing MSMEs from adopting technologies that would help improve their energy conservation and efficiency measures is the lack of finance.[148] Another key barrier MSMEs face stems from the scale of their operations. For small-scale MSMEs, the limited space makes it difficult for them to electrify their production processes.[149]

A phase-down of unabated coal would require heavy financial investments. A recent study estimates the cost of phasing down operations of existing coal mines and TPPs by 2050 to be more than a trillion US dollars.[150] These investments cover the cost of closing coal mines, rehabilitation and repurposing of coal mining land, green repowering of land available at TPP sites, and transition support for about 5.9 million workers whose income is dependent on or induced by these industries.[151]

State of renewables

As of June 2025, India has 233.99 GW of RE installed capacity, with the share of solar and wind being 119.02 GW[152] and 52.14 GW respectively.[153] Other RE sources include small hydro power and biomass. Eighty percent of India's RE capacity is concentrated in seven states located in western and southern parts of the country.[154] India had set itself a target of installing 500 GW of RE capacity by 2030 and meeting 50% of its energy requirements from RE.[155] It achieved the latter target five years ahead of schedule in 2025, when renewables constitute 50.07% of India's total installed power capacity.[156]

Despite witnessing a steady growth in RE capacity, the country continues to face several challenges in scaling up utilization of RE. A substantial part of India's current power generation infrastructure was designed keeping in mind fossil-fuel-based (mainly coal) power supply sources.[157] Therefore, despite having built some RE capacity, issues of intermittency (energy generation from renewable sources depends on weather conditions which may not always be suitable, e.g., the sun shines for a limited period only) and discontinuous supply, which in turn impact grid stability, continue to constitute important barriers[158] and reduce the reliability of RE in delivering energy access and security. These issues can be overcome only through a significant revamp of the existing grid infrastructure.[159] Insufficient battery storage capacity is another factor that makes large-scale use of RE currently unfeasible in India.[160] The initial capital cost for setting up RE installations remains high compared with other sources of energy, even though the costs of operation and maintenance may be lower.[161] Further, even though there has been a decline in the levelized cost of electricity (LCOE, a metric that is used for determining the average minimum price at which electricity generated from a power plant can be sold to recover the total cost of production in the plant's lifetime and make a profit[162]) for renewables in India, the costs related to intermittency and dispatchability are not accounted for in the LCOE;[163] when taken into consideration, they increase the costs of RE. The latter are costs related to the lack of continuous supply of RE-based power for electricity and the ability of the grid to use power from a source as per demand. Given that RE installed capacity is concentrated only in a few states, there exist regions of high and low RE capacity, translating into a need for heavy investments in transmission infrastructure for connecting RE surplus and deficient states.[164]

Lack of availability of the latest RE technologies is yet another challenge the country faces. For instance, the state of solar photovoltaic technology has been found to be insufficient despite various technological advances made in the area.[165] India also lacks crucial raw materials like critical minerals required for manufacturing RE products, which makes the country's transition vulnerable to imports and price fluctuations.[166]

A huge amount of land will be required to set up solar parks to meet India's ambitious targets of solar energy development. However, the per capita availability of land in the country is a meagre 0.002 square kilometre[167] and per capita arable land available was 0.11 hectare in 2021.[168] The limited availability of land is compounded by the fact that agriculture happens to be a crucial sector for the country. It employs more than 45% of the total workforce[169] and supports livelihoods of 42.3% of the population.[170] This gives rise to important tradeoffs that the country would have to deal with in the context of land use. Acquisition of land at scale would have serious implications for socio-economic justice[171] leading to conflicts around land which will need to be addressed for India's RE growth to be sustainable. Further, installation of large solar projects and the need for a huge amount of land have had negative environmental impacts due to the habitat loss suffered by protected species.[172]

Malaysia

Dependence on fossil fuels

Malaysia is Southeast Asia's sixth largest country in terms of population (approx. 35 million)[173] but has the third highest GDP per capita in the region.[174] Like China and India, Malaysia too relies heavily on fossil fuels to meet its energy needs. As a net exporter of oil, fossil fuels also constitute an important source of revenue for the country.

The energy sector contributed around 28% of the GDP and employed 25% of the total workforce in Malaysia,[175] which numbered around 16 million people in 2022.[176] Petroleum-related products contribute 31% of the fiscal income, and energy exports account for 13% of the total export value.[177] The country has four main sources of energy: natural gas, crude oil and petroleum, and coal. In 2020, natural gas accounted for the largest share at 42.4%, crude oil and petroleum products 27.3% and coal 26.4%.[178]

Malaysia relies primarily on fossil fuels for meeting its electricity needs. In 2024, 80.3% of its electricity needs were met by fossil fuels and 20% by renewables.[179] Coal was the primary source of electricity generation, with its share being 43.05%, followed by gas (36.68%) and oil (0.60%).[180] Among non-fossil-fuel sources, hydropower was the largest contributor at 16.86%, while solar energy accounted for only 2.08% of the total electricity generation.

Industry is the main user of natural gas and oil.[181] However, the industrial sector's energy demand has been slowing since 2007, while that of the transport sector began increasing. In 2017, the energy demand of the transport sector was 1.4 times more than that of the industrial sector.[182]

Within the industrial sector, eight sub-sectors are key consumers of energy: cement (47.6%), steel and iron (19.2%), pulp and paper (13.9%), food (10.6%), glass (2.9%), wood (1.4%), rubber (1.1%) and ceramic (0.91%).[183] The share of buildings in total energy demand is around 12%. A key source of demand is for cooling, with 70% of households owning air conditioners.[184]

In 2019, oil products constituted the largest share of Malaysia's final energy consumption. Three-fourths of all oil were used in transport, the rest was used in industry. The next most consumed energy by fuel type was natural gas, with a share of 29%. In terms of final energy consumption by sectors like industry, transport, residential and commercial, and agriculture and fishery in 2021, the share of coal was highest at 46.1%, followed by gas (32.7%) and hydropower (18.2%).[185]

Challenges of transitioning away from fossil fuels

The Malaysian government laid out its National Energy Transition Roadmap (NETR) in 2023. Some of the key targets in the NETR are to achieve a 70% share of installed capacity for renewables by 2050, to not open any new coal plants, and to increase the penetration of electric vehicles (four- and two-wheelers) to 80% each of the total vehicle fleet. In terms of primary energy sources, the plan envisages natural gas to be the main source at 56%, followed by renewables (including solar, hydropower and bioenergy) which would collectively contribute 23% of the total primary energy source, compared with their contribution of 4% in 2023.[186] According to the NETR's projections, implementing the transition process in Malaysia would require investments in the range of US$287 billion–311 billion[187] till 2050. Implementing changes in the power system alone is expected to require a cumulative investment of US$100 billion[188] up to 2050.

In its updated NDC, Malaysia has plans to reduce carbon intensity against GDP by 45% by 2030 compared with 2005 levels.[189]

With its high reliance on fossil fuels for meeting its energy and revenue needs, Malaysia faces a steep challenge in making the shift away from fossil fuels. Consider, for instance, the role of Petroliam Nasional Berhad (Petronas), the country's top conglomerate in the resources and energy sector. In 2019, Petronas paid a dividend of US$12.59 billion[190] and employed 47,669 people, and in 2018 the Malaysian government relied on its petroleum sector for 23% of its revenue.[191] Given the government's dependency on its fossil fuel sector, not just as a source of revenue but also for the social services it provides, making any kind of transition in its energy systems will be marked by the twin challenges of finding alternative sources of energy and alternative sources of revenue.

The steel industry constitutes an important part of Malaysia's economy. In 2021, it contributed to 2.5% of the GDP.[192] As mentioned earlier, Malaysia's industrial sector, including the steel industry, relies heavily on coal-based power plants for meeting its energy needs. It will need to find reliable alternative sources of energy like renewables to reduce its dependency on fossil fuels. The utilization of renewables-based power, however, is currently very low in Malaysia. Additionally, the technological processes (for instance, the use of blast furnaces) employed for steel production emit high amounts of carbon dioxide, but currently the steel industry finds them to be the most economically feasible technology.[193] Three-fourths of the country's industrial output come from small and medium enterprises, which also include a share of steel units. These enterprises would need strong support from the government for adopting improved technologies in their processes.[194] The industrial sector therefore faces the double challenge of not only moving towards using alternative sources of energy but also upgrading its technologies to reduce its carbon dioxide emissions. The challenge would therefore be to reform both structural and regulatory aspects of industry to adopt a coherent strategy at the federal and state levels.[195]

State of renewables

Currently, renewables consisting of hydropower, solar and bioenergy provide only 3.9% of Malaysia's primary energy needs.[196] Located near the equator, Malaysia receives a high amount of sunlight nearly the whole year, making solar the most suitable form of renewable energy that the country can adopt.[197] The potential for wind energy in the country has been found to be very low,[198] while social acceptance of nuclear energy is also low.[199] Along with an already high use of hydropower,[200] solar energy has the highest potential for expansion in the country.

The challenges that Malaysia faces in ramping up its use of solar energy include high financing costs, technological and infrastructural limitations along with issues of intermittency, inadequate trained workforce required for the maintenance of RE infrastructure, and limited availability of land. The initial up-front investment required for large solar projects is still very high, acting as a deterrent in their development.[201] Adding to these financial costs is the need for upgrading technologies and infrastructure associated with large-scale use of solar power plants. Malaysia's existing infrastructure has been designed for centralized power generation using fossil fuels. This would have to be adjusted considerably to integrate variable and decentralized RE sources.[202]

Given the intermittent nature of solar energy, scaling its use would have to be accompanied by a substantial increase in the deployment of battery energy storage systems (BESS) so that excess energy can be stored when available and released back to the grid when required.[203] Though there has not yet been any deployment of utility-scale BESS which are connected to the transmission level, the Energy Commission of Malaysia plans to install 500 MW of BESS by 2030–2034 in various parts of the country.[204] To deliver on this plan, BESS systems would need to be made compatible with the existing grid infrastructure. Since BESS is a new technology that is yet to be implemented in Malaysia at scale, it would also require high financial support from the government.[205] A regulatory framework will also be needed to address the environmental concerns associated with the manufacturing process of BESS, including raw materials extraction and battery disposal.[206] More people will also have to be trained in these new technologies for their installation and maintenance. Efforts will also be needed in building adequate transmission networks to connect regions of high and low solar potential/availability.[207]

5 Conclusion

THE decision to transition away from fossil fuels in energy systems was taken in the context of the need to carry out the transition in a 'just, orderly and equitable' manner and taking into account the Paris Agreement and different national circumstances and approaches. This paper shows clearly through the case studies of three important Asian countries that developing countries will have multiple pathways towards transitioning away from fossil fuels.[208] Further, a fair sharing of the global carbon budget requires that developed countries reduce their emissions immediately and, ideally, achieve negative emissions as early as 2030. This means that they must take the lead in transitioning away from fossil fuels. Developing countries need to use the remaining global carbon budget to meet their sustainable development goals and eradicate poverty. Given their historical responsibilities in causing the problem of climate change, and in light of principles of equity and CBDR-RC, developed countries must also provide means of implementation (finance, technology, capacity building) to developing countries.

However, developed countries are moving in the opposite direction of what is actually required for keeping alive the goal that countries agreed to in the Paris Agreement of limiting global warming to 1.5°C.[209] Instead of taking urgent action to reduce their emissions, they are planning a huge fossil fuel expansion.

President Donald Trump started his second term in the US government by withdrawing his country from the Paris Agreement, dismantling climate regulations in the US[210] and calling for a massive expansion of fossil fuels. He is aggressively promoting the sale of US oil and gas to trading partners by leveraging trade tariffs imposed by the US on these countries.[211] The European Union in its recently concluded trade deal with the US agreed to buy from it US$750 billion worth of oil and liquefied natural gas.[212]

We are witnessing a similar backsliding of climate action in the European region. In its recently published climate law, the EU has provided greater flexibility to its member states for implementing their greenhouse gas emission reduction targets by using international carbon credits. Up to 3% of the emissions, amounting to about the size of the emissions of Austria and Greece, can be offset through mitigation action carried out in countries outside of the EU.[213] This flexibility in the EU's climate law allows member states to get away with lower emission reduction ambition than is required of them as per their fair shares. In fact, the EU is currently facing a lawsuit before the Court of Justice of the European Union (CJEU) for not contributing its fair share as per global standards in its emission reduction targets.[214] Non–EU member Switzerland's 2035 climate target, announced in 2025, also relies considerably on the use of international carbon offsets and falls short of its fair share.[215] At the same time, countries like Germany, France and the UK have cut their international aid budgets and instead increased their military budgets.

Developed countries also score poorly in transitioning to cleaner sources of energy and they continue to prioritize defence spending over saving the planet in this critical decade. According to a 2025 publication by the International Renewable Energy Agency (IRENA), Asia recorded the largest share of renewable energy capacity addition in 2024 at 72%, the majority of which occurred in China. The corresponding figures for Europe and North America were 9% and 8% respectively.[216] China also led on investment in energy transition. It spent 4.2% of its GDP on energy transition, far higher than developed countries such as the US which spent 1.2% of its GDP, the EU (1.9%), the UK (1.8%), Germany (2.3%), France (1.6%), Australia (1.3%) and Japan (0.7%).

Developed countries instead prioritized defence spending in 2024, with the US spending the highest amount as a percentage share of GDP (3.3%), followed by the UK (2.3%), South Korea (2.3%), France (2%), Australia (2%), the EU (1.9%) and Germany (1.8%). China spent 1.3% of its GDP on defence.[217]

Developed countries are also imposing unilateral climate-change-related trade measures which are acting as 'dis-enablers' of climate action in developing countries by reducing the latter's fiscal space.[218] The EU's carbon border adjustment mechanism (CBAM) serves as an example.

The CBAM imposes a carbon levy on imports from non-EU regions and is purported to be a measure to reduce carbon emissions. But studies have found the emission reduction potential of the CBAM to be minuscule. It is projected to reduce CO2 emissions by an amount equivalent to 0.1% of global emissions or 0.9% of the EU's emissions.[219] In fact, emission reductions through the introduction of carbon pricing policies around the world would be far more substantial than the emission reduction potential of the CBAM.[220] Implementation of the CBAM is also expected to have adverse distributional impacts that would increase regional inequality. It would in particular impact exports from energy-intensive sectors of developing countries by reducing their competitiveness and limit their opportunities for generating revenue through pursuing an export-led development pathway.[221]

Benefits of the CBAM in real income terms would accrue to developed countries, with their income expected to rise by US$2.5 billion, while incomes of developing countries are expected to decline by US$5.9 billion.[222] The GDP of developed countries is expected to rise by 0.1%, with the EU receiving the maximum benefits, and that of developing countries would fall. For instance, the CBAM is projected to impose a tax burden of 25% on average on India, which amounts to 0.05% of the country's GDP.[224] It would thus widen the income gap between developed and developing countries.[225]

A phase-out of fossil fuels is needed urgently for dealing with climate change, but it should not occur through a transfer of the burden from developed to developing countries. It is quite clear that developing countries are doing more than their fair share of climate action by reducing emissions, adapting to climate change and addressing loss and damage from climate change, alongside pursuing sustainable development and making efforts to eradicate poverty. Most of this is being done using their own resources and in the face of climate 'dis-enablers' being imposed by developed countries. What is needed urgently is for developed countries to reflect their intention to transition away from fossil fuels and reduce their emissions immediately in their forthcoming NDCs for the 2031–2035 timeframe without resorting to the use of any loopholes like international offsets.

Annex I

Table 1: Extent of dependency on fossil fuels of some developed countries in 2024

Country	Primary energy consumption dependent on fossil fuels	Electricity needs dependent on fossil fuels	Per capita primary energy consumption (in kilowatt hours)
Australia	85.27%	64.5%	62,595
Canada	67.39%	20.7%	97,785
Germany	76.03%	42.6%	37,793
United Kingdom	73.54%	34%	28,016
United States	80.3%	58%	76,800

Source: Our World in Data

Table 2: Extent of dependency on fossil fuels of some developing countries in 2024

Country	Primary energy consumption dependent on fossil fuels	Electricity needs dependent on fossil fuels	Per capita primary energy consumption (in kilowatt hours)
China	80.26%	61.9%	35,514
India	89.67%	77.5%	7,813
Malaysia	91.72%	80.3%	38,866

Source: Our World in Data

Table 3: Solar installed photovoltaic (PV) power and concentrated solar power (CSP) (in megawatts)

Country	2023	Share in world
Australia	33,683	2.40%
Canada	5,757	0.40%
China	609,921	43%
France	20,551	1.40%
Germany	81,739	5.80%
India	73,109	5.20%
Japan	87,068	6.10%
Malaysia	1,933	0.10%
UK	15,657	1.10%
US	139,205	9.80%
Total world	1,418,969	

Source: *Statistical Review of World Energy 2024*, p. 60

Table 4: Installed wind turbine capacity (in megawatts)

Country	2023	Share in world
Australia	11,327	1.10%
Canada	16,989	1.70%
China	441,895	43.40%
France	22,196	2.20%
Germany	69,459	6.80%
India	44,736	4.40%
Japan	5,232	0.50%
Norway	5,065	0.50%
UK	30,215	3%
US	148,020	14.60%
Total world	1,017,199	

Source: *Statistical Review of World Energy 2024*, p. 61

Annex II
Summary of Case Studies Presented in the Paper

Dependency on fossil fuels

	China	**India**	**Malaysia**
Extent of reliance on coal	It is the world's largest producer and consumer of coal.[226] In 2024, it relied on coal for meeting 52.81% of its energy consumption needs and 58.18% of its electricity needs.[227]	It is the world's second largest producer and consumer of coal.[228] The country relies on coal for meeting 55% of its primary commercial energy needs and 70% of its electricity needs.[229]	It relies primarily on fossil fuels for meeting its electricity needs. In 2024, 80.3% of its electricity needs came from fossil fuels and 20% from renewables.[230] In 2020, natural gas constituted its largest source of energy at 42.4%, crude oil and petroleum products accounted for 27.3%, and coal for 26.4%.[231]
Share of fossil fuel in electricity	It relied on fossil fuels to meet 61.9% of its electricity needs in 2024.	Some 49.3% of India's installed power capacity is based on fossil fuels, while the rest is based on other sources like solar, hydro, wind, small hydro, nuclear and biopower.[232]	In 2024, coal was the primary source of electricity generation at 43.05%, followed by gas (36.68%) and oil (0.60%).[233] Among non-fossil-fuel sources, hydropower was the largest contributor at 16.86%, while solar energy constituted only 2.08% of the total electricity generation. There was no contribution at all from wind and nuclear energy.

Contribution of fossil fuels to GDP	In 2017, the revenue from the fossil fuel sector contributed to 4.2% of the GDP.[234]	The contribution of the mining sector (of which coal mining is a part) to the country's GDP is 2%, with the share of coal and lignite being 0.7%.[235] Coal contributed 49% to Indian Railways' freight revenue in 2022–2023.[236] Indian Railways in turn constitutes an important source of revenue for the federal government.	The energy sector contributed around 28% of the GDP. Petroleum-related products contribute 31% of the fiscal income, and energy exports account for 13% of the total export value.[237]
Number of coal mines and associated employment	In 2025, it had 1,900 operational coal mines and 3,269 coal-fired power plants.[238] The coal industry in China employed around 3.473 million people in 2018,[239] which accounts for 58.27% of the workforce employed by the coal industry globally.[240]	It has 417[241] operational coal and lignite mines, spread over 51 districts and 13 states.[242] It also has 634 operational coal-based/thermal power plants (TPPs) in 17 states.[243] Its coal sector formally employs between 0.44 million[244] and 0.74 million[245] people. The sector also employs people in the informal sector, whose estimated number is 1.7–2.4 times the formal workforce.[246]	It has one operating coal mine and 25 operational coal power plants.[247] Its energy sector employed 25% of the workforce.[248]
Extent of reliance of industries on fossil fuels	China's industrial sector accounts for 60% of gross energy use (for both energy and non-energy uses), with two-thirds of the industry demand	Key industrial sectors that consume coal include steel and washery, cement, paper, textile, sponge iron, fertilizers	The steel industry constitutes an important part of Malaysia's economy. In 2021, it contributed to 2.5% of the GDP.[256] Malaysia's

	being met by coal and a quarter by electricity.[249] Key energy-intensive industries include iron and steel, aluminium, chemicals and petrochemicals, and cement and lime. These industries are not expected to decline during 2020–2050.[250] In 2019, China accounted for half of the world's cement production, more than half the global output of crude steel and 56% of the global output of electrolytic aluminium.[251]	and chemicals, and bricks. From 2009–2010 to 2018–2019, the top three consumers of coal were the electricity (66%), steel and washery (7.2%), and cement (0.9%) sectors.[252] Growth in the cement industry is driven by India's needs for infrastructure development and urbanization, both of which are important activities for the country's development.[253] The iron and steel sector contributed around 47% of all inputs in the building and construction sector and is also a crucial source of inputs for the production of machinery and goods.[254] Other highly energy-intensive manufacturing sectors in India include non-metallic mineral products (including glass and cement), basic metals, paper and paper products.[255]	industrial sector, including the steel industry, relies heavily on coal-based power plants for meeting its energy needs.

Challenges of transitioning away from fossil fuels

	China	India	Malaysia
Scale of investment required	The cost of investment for implementing an energy transition in China from 2020 to 2050 would range from US$7.65 trillion to US$24.7 trillion depending on different scenarios.[257] These costs cover power generation, electricity transmission, distribution and storage, extraction and conversion of fuels. By 2023, China had already invested US$676 billion towards its energy transition, which makes it the world's largest investor in this field.[258]	The cost of phasing down operations of existing coal mines and TPPs by 2050 in India is estimated to be more than a trillion US dollars.[259] These investments cover the cost of closing coal mines, rehabilitation and repurposing of coal mining land, green repowering of land available at TPP sites, and transition support for about 5.9 million workers whose income is dependent on or induced by these industries.[260]	According to projections under its National Energy Transition Roadmap (NETR), Malaysia would require investments of US$287 billion – 311 billion[261] till 2050 for its transition process. Implementing changes in the power system alone is expected to require a cumulative investment of US$100 billion[262] up to 2050.
Impact of shifting away from coal plants/fossil fuels on those employed by the sector	China would be the most affected by the job losses that the coal-mining industry potentially faces globally, with more than half a million miners facing the risk of job loss.[263] Shanxi province, for instance, is projected to lose nearly 241,900 jobs by 2050 due to mine closures, making it the most impacted province in China.[264]	Shutting down coal mines and TPPs will not only have an immediate impact on those who are employed by them, but also affect the local economies and communities of the districts in which they are located.[267] Coal companies, especially the ones which are run by the public sector, provide social infrastructure like schools and hospitals for local	In 2019, Petroliam Nasional Berhad (Petronas), the country's top conglomerate in the resources and energy sector, paid a dividend of US$12.59 billion[272] and employed 47,669 people, and the Malaysian government relied on its petroleum sector for 23% of its revenue.[273]

	Compounding the problem of job loss is the fact that most of the workforce in the sector are low-skilled workers, which would make it harder for them to find alternative jobs.[265] Further, provinces that are more reliant on coal production for their local economy lack economic diversification, adding to the difficulties of the workforce in seeking alternative jobs.[266]	communities.[268] Closure of their operations will have an impact on the provisioning of those basic welfare facilities too.[269] Shifting the workforce from the coal sector to cleaner energy sectors, though possible, would depend on the availability of adequate training programmes and the level of skills the workers already possess. There is no guarantee that a person who is employed indirectly by the coal sector as a coal gatherer or coal seller would find a job in the renewable energy sector.[270] A person who is employed for operations and maintenance in a TPP would have skills specific to that power plant which may not necessarily be relevant for the renewable energy sector. [271]	
Challenges industries would face in transitioning away from fossil fuels	Decarbonization of the industrial sector would require the development of advanced technologies like zero-carbon iron-making technology using hydrogen as a reducing	Micro, small and medium enterprises (MSMEs) contributed 35.4% of the manufacturing output in 2022, while the share of MSME-specified products in the country's exports	The utilization of renewables-based power is currently very low in Malaysia. Technological processes (for instance, the use of blast furnaces) employed for steel

	agent.[274] China's manufacturing sector with its high energy and material consumption, and low added-value rate, is still in the middle and low ends of the international industrial value chain, which poses huge challenges of economic structural adjustment and industrial upgrading.[275]	was 45.7% in 2023–2024.[276] Lack of access to the latest technologies makes MSMEs vulnerable in terms of energy security in the context of a transition away from fossil fuels.[277] Lack of finance is the main obstacle which prevents MSMEs from adopting technologies that would help improve their energy conservation and efficiency measures.[278]	production emit high amounts of carbon dioxide. But currently the steel industry finds them to be the most economically feasible technology.[279] Three-fourths of the country's industrial output come from small and medium enterprises, which also include a share of steel units. These enterprises would need strong support from the government for adopting improved technologies in their processes.[280]

State of renewables

	China	**India**	**Malaysia**
Installed renewable capacity	China is a global leader in the growth of renewables. In 2024, it generated 34% of its electricity from renewable energy sources.[281] According to government data,[282] in 2023, its total installed capacity for power generation amounted to 2,920 GW, of which clean energy contributed 1,700 GW, which amounted to 58.2%. By the end of 2023,	In 2025, India has 233.99 GW of RE installed capacity, with the share of solar and wind being 119.02 GW and 52.14 GW respectively.[283]	Renewables consisting of hydropower, solar and bioenergy constituted only 3.9% of the primary energy source.[284]

	China's cumulative installed capacities for wind and solar energy were 441 GW and 609 GW respectively. Its installed capacity of distributed photovoltaic (PV) power exceeded 250 GW, accounting for more than 40% of the total installed capacity of PV power. The regular installed hydropower capacity of the country stood at 370 GW by the end of 2023; that of biomass was 44.14 GW. The total installed capacity of nuclear power plants under construction and in operation was 100.33 GW by the end of 2023.		
Future plans for renewables growth	In its updated NDC,[285] China has stated it 'aims to have CO2 emissions peak before 2030 and achieve carbon neutrality before 2060 … to increase the share of non-fossil fuels in primary energy consumption to around 25% ... and to bring its total installed capacity of wind and solar power to over 1.2	India had set itself a target of installing 500 GW of RE capacity by 2030 and meeting 50% of its energy requirements from RE,[286] achieving the latter target five years early in 2025. According to a study conducted in 2020, India would need to scale up its solar capacity to about 1,000 GW for transitioning about	The Malaysian government laid out its plan for energy transition in its NETR in 2023. Some of the key targets include achieving 70% of installed capacity share of renewables by 2050, not opening any new coal plants, and increasing the penetration of electric vehicles

	billion kilowatts by 2030'.	half a million people directly employed in coal mines.[287]	(four- and two-wheelers) to 80% each of the total vehicle fleet. In terms of primary energy sources, the plan envisages natural gas to be the main source at 56%, followed by renewables including solar, hydropower and bioenergy which would collectively contribute 23% of the total primary energy source, compared with their contribution of 4% in 2023.[288]
Challenges in scaling up renewable energy	Challenges in shifting towards renewables as the primary source of energy include problems of intermittency, limited integration with the national and state grids,[289] and insufficient energy storage capacity.[290] These challenges exist particularly for solar and wind power generation where problems of volatility and uncertainty during electricity generation can have a negative impact on the power grids and lead to a high rate of abandoned wind and solar energy.[291]	Despite having built some RE capacity, issues of intermittency (problems due to the fact that energy generation from renewable sources depends on weather conditions which may not always be suitable, e.g., the sun shines for a limited period only) and discontinuous supply, which in turn impact grid stability, continue to constitute important barriers[292] and make RE unreliable. These issues can be overcome only through a significant revamp of the existing grid infrastructure. [293]	The challenges that Malaysia faces in ramping up its use of solar energy include high financing costs, technological and infrastructural limitations, issues of intermittency, inadequate trained workforce required for the maintenance of RE infrastructure, and limited availability of land. The initial up-front investment required for large solar projects is still very high, acting as a deterrent in their development.[297] Adding to these financial costs is the need

	China imports more than 70% of its lithium supply, which makes it a bottleneck for scaling up lithium-based energy storage at an accelerated pace since it has to rely on others for raw materials. The country is therefore focusing on increasing the use of sodium ion batteries.	Insufficient battery storage capacity is another factor that makes the use of RE at a large scale currently unfeasible in India.[294] The initial capital cost for setting up RE installations remains high, compared with other sources of energy, even though the costs of operation and maintenance may be lower.[295] Further, even though there has been a decline in the levelized cost of electricity (LCOE)[296] of RE in India, the costs related to intermittency and dispatchability are not accounted for in the LCOE; when taken into consideration, they increase the costs of RE.	for upgrading technologies and infrastructure associated with large-scale use of solar power plants. Dealing with the problem of intermittency would require the country to increase substantially the deployment of battery energy storage systems (BESS) so that excess energy can be stored when available and released back to the grid when required.[298] This is something that the country has not deployed yet, though it plans to install 500 MW of BESS by 2030 in various parts of the country.[299] To deliver on this plan, BESS systems would need to be made compatible with the existing grid infrastructure. Since BESS is a new technology that is yet to be implemented in Malaysia at scale, it would also require high financial and technological support from the government.[300]

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CHALLENGES OF TRANSITIONING AWAY FROM FOSSIL FUELS IN DEVELOPING COUNTRIES

In 2023, Parties to the Paris Agreement on climate change adopted a decision on 'transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner'. Implementation of this landmark decision will hinge to a large extent on what is deemed 'just, orderly and equitable'.

According to this paper, the Paris Agreement's core principles of equity and 'common but differentiated responsibilities and respective capabilities' of countries require that developed countries take the lead in the transition while also supporting developing countries' own transition efforts.

However, developed countries continue to exceed their fair share of the global carbon budget and are in many cases even planning to expand fossil fuel extraction. Developing countries, on the other hand, face huge challenges in shifting away from the fossil fuel sector, currently a key source not only of energy but also of revenue and employment. They are in fact doing much more than their fair share of climate action despite the many challenges they have to deal with. In light of this, only a transition that advances energy access and promotes sustainable development can deliver climate justice.

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TWN CLIMATE CHANGE SERIES

is a series of papers published by Third World Network on the climate change crisis which, if not dealt with rapidly and adequately, will overwhelm the world's environment and economy. At the same time, the solutions and actions have to be based on equity, so that those responsible for emissions and those that are able to contribute most will take their rightful share of the burden of adjustment, while all countries move to the path of sustainable development. The series aims at contributing to highlighting the issues and the solutions.

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