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The economic case for climate finance at scale

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Executive summary

IT WILL BE impossible to contain the global temperature rise to 1.5 to 2 degrees Celsius above pre-industrial levels unless emerging market and developing economies (EMDEs) decarbonise much more rapidly. This policy brief examines the economic case for advanced-country financial support for replacement of coal with renewable energy sources in EMDEs. Such conditional financial support is *necessary* in the sense that an exit from coal consistent with keeping the global temperature rise to between 1.5°C and 2°C will not happen without it, *desirable* from the perspective of the financier countries, and financially *feasible*.

ALTHOUGH THE GLOBAL economic benefits of phasing out coal are very large, the costs of exiting coal generally exceed the benefits to EMDEs. However, the collective economic benefits to advanced countries greatly exceed those costs. These net benefits are positive even for small coalitions of advanced countries (G7 or G7 plus EU). The fiscal costs of financing the coal exit in EMDEs (without China) are modest as a share of G7+EU GDP at about 0.3 percent of GDP per year, assuming public-sector participation in renewable energy investment costs through blended finance of around 25 percent.

ALTHOUGH PROVIDING CLIMATE finance to EMDEs is economically desirable and feasible from the G7 perspective, it is not happening at the necessary scale, partly because of incentives and political-economy challenges. Advanced countries are more likely to be willing to commit financing to climate action outside their borders if they have more control over how this money is spent. Developing countries are reluctant to phase out coal unless sufficiently large financial support is forthcoming for renewable investments that are consistent with their development goals.

THESE PROBLEMS COULD be overcome by tying renewable finance to a coal phase-out. Already-existing Just Energy Transition Partnerships with South Africa, Indonesia and Vietnam are prototypes of this approach. They should be scaled up, with sufficient grants to pay for coal closures and the social transition in coal communities, by explicitly conditioning funding on a coal phase-out and through a stronger governance structure to implement these deals.

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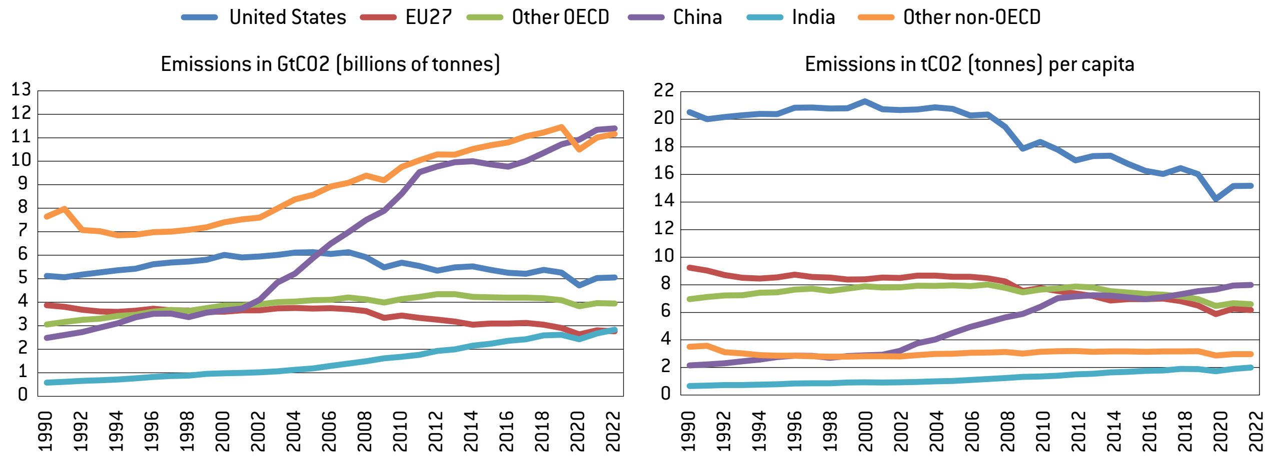
1 Introduction

Global carbon emissions are at a historic high. Emissions in 2023 consumed 10.67 percent of the remaining carbon budget consistent with limiting global warming to 1.5 degrees Celsius compared to pre-industrial levels (Liu *et al*, 2024). On current trends, the remaining budget will be gone in fewer than six years[1]. While commitments made under the 2015 Paris Agreement (referred to as nationally determined contributions, or NDCs) imply a drop in emissions by 2030, this decrease would not be sufficient to limit the temperature increase to 2°C, let alone 1.5°C (UNFCCC 2023).

Although *per-capita* emissions in most emerging market and developing economies remain much lower than those of advanced countries (Figure 1, left panel), EMDEs now produce almost 70 percent of global CO2 emissions (Figure 1, right panel). Reflecting their higher populations and GDP growth rates, this share is projected to grow. Putting decarbonisation on track to stay well below 2°C warming will hence require a large step-up in efforts to cut emissions, particularly in EMDEs. Unless advanced countries offer much more conditional financial support for EMDE decarbonisation than currently, this is unlikely to happen within the framework of the Paris Agreement (which relies on voluntary commitments), given the size of the required investment in renewables.

This policy brief explores both the desirability and the feasibility of such expanded support from the perspective of the financier countries, focusing on a particular strategy for accelerating emissions reduction: phasing out the use of coal.

Figure 1: Global CO2 emissions from fossil fuels since 1990



Source: Global Carbon Project, https://www.globalcarbonproject.org. Note: EU27 refers to the 27 current EU members. 'Other OECD' refers to countries that are members of the Organisation for Economic Co-operation and Development excluding the United States and EU members. 'Other non-OECD' refers to countries that are not members of the OECD and are not China, India or members of the EU.

Our analysis does not imply that conditional financial support provided by advanced countries should be the only instrument to accelerate EMDE decarbonisation. Carbon border adjustment mechanisms (CBAMs) or other schemes that tax imported goods based on their carbon content can offer additional incentives to adopt meaningful carbon pricing in exporting jurisdictions. International emissions trading – as envisaged in Article 6 of the Paris Agreement – can support mitigation projects in EMDEs and help exploit efficiency gains associated

1 See Liu *et al* (2024). An ongoing estimate of the time remaining until the carbon budget is depleted is provided by the Mercator Research Institute Carbon Clock (https://www.mcc-berlin.net/en/research/co2-budget.html).

with lower abatement costs (Glennerster and Jayachandran, 2023; Piris-Cabezas *et al*, 2023)[2].

However, these instruments are unlikely to be sufficient. CBAMs do not offer incentives for decarbonisation of non-traded goods and services. Carbon tariffs levied on countries with lower mitigation standards could capture such activities (Nordhaus 2015, 2020), but would violate World Trade Organisation rules and are likely make EMDEs worse off (Bekkers and Cariola, 2022). Voluntary carbon markets require governance structures that verify that mitigation projects are being implemented, while cross-border mandatory carbon markets (ie linking emissions trading systems) require compatibility.

For these reasons, it is hard to imagine that the required acceleration in EMDE emissions reduction will happen without advanced country financial support being stepped up. Any such support would need to encourage both emission reduction policies and private investment in renewable energy sources (One Planet Lab, 2021; Bhattacharya *et al*, 2022, 2023; IEA and IFC, 2023).

The remainder of this brief is structured as follows.

Section 2 makes the case for the desirability of climate finance at scale, both from a global perspective and from the perspective of advanced countries, in three steps: (i) the global economic benefits of decarbonisation exceed their costs, even over relatively short (2024-30 or 2026-35) investment horizons; (ii) the individual economic benefits of country-level decarbonisation are unlikely to exceed their costs, except for the US and China, underscoring the need for international coordination; (iii) the collective economic benefits to advanced countries from EMDE decarbonisation exceed their costs to advanced countries, even if one were to make the extreme assumption that advanced countries bear the entire cost of EMDE decarbonisation. This analysis implies that a cornerstone of the Paris Agreement – the principle of common but differentiated responsibilities, with advanced countries contributing more – is justified not only on fairness grounds, but is also supported by hard economic calculations, which reflect the expectation that physical damages from climate change will be greater in richer countries.

Climate finance at scale may be unaffordable even for advanced countries, if it exceeds normal public borrowing limits

Section 3 examines the feasibility of north-south climate finance at scale. Although this is in the collective interests of advanced countries, it may not be feasible for three reasons. First, there could be a free-rider problem across donor countries. Second, climate finance at scale may be unaffordable even for advanced countries, in the sense that it exceeds normal public borrowing limits. Third, the conditionality that would be required to reassure advanced countries that climate finance at scale achieves its intended decarbonisation purposes may not be feasible.

We argue that the first problem can be addressed through coalitions of advanced countries that are small enough – the G7, or the G7 plus the EU – to prevent free riding, while still being large enough to reap a large part of the benefits of EMDE carbonisation. On the second problem, we show that climate finance at scale would raise the fiscal burden of the G7+EU countries by about 0.3 percent to 0.6 percent of GDP per year. Upfront funding of the carbon phase-out required during 2024-30 would raise the debt of G7+EU countries by 2-4 percent of GDP, well within their borrowing capacity. For the third problem, we examine briefly an emerging governance structure for climate finance at scale: Just Energy Transition Partnerships (JETPs). We conclude that these have the necessary ingredients to address monitoring and verification problems, but only if advanced countries contribute more (grant) funding and technical assistance. This will likely require a more explicit link between policy actions and climate finance than is evident from the present JETP implementation plans.

2 Article 6 of the Paris Agreement allows advanced countries to pay for emission reductions in EMDEs and count those reductions towards their NDCs, thus benefitting from lower abatement costs in EMDEs. To avoid double counting however, the recipient EMDE cannot count these emission reductions toward its own NDC.

2 The desirability of climate finance at scale

We use a dataset (Adrian *et al*, 2022, 2024) of estimates of the costs and benefits of phasing out coal use – the largest single source of carbon emissions – and replacing the phased-out coal energy with renewable energy[3]. To our knowledge, this is the only analysis that links the plant/mine-level costs of replacing fossil fuels to their emissions benefits. Costs include investment outlays in renewable energy development, the costs of expanding battery and grid capacity, and the opportunity costs of shutting down coal operations (including the cost of re-training coal workers and compensating coal communities). In the early years or decade, the phase-out concerns mostly coal-fired power plants; industrial coal-based operations that are harder to decarbonise are assumed to be phased out later, if at all. Benefits are computed by multiplying the emission reductions resulting from the coal phase-out with a conservatively estimated average social cost of carbon (SCC). The average SCC mainly reflects the additional expected output loss from climate damages that can be avoided by reducing carbon emissions. We use two SCC estimates: $80/tonne of CO2, which represents the lower-bound estimates of a large pool of climate experts and economists surveyed by Pindyck (2019), and a more recent estimate of $190/tonne of CO2 based on Rennert *et al* (2022)[4]. Even the latter likely underestimates the overall benefit of phasing out coal, both because SCC estimates have been shown to increase over time (Tol, 2023) and because the SCC does not include the health benefits from reduced air pollution, which can be substantial (Ebenstein *et al*, 2017).

2.1 The global net benefits to decarbonisation are very large

The economic benefits of a coal phase-out far exceed the costs of replacing coal with renewables, even in the short term

Table 1 sets out the global costs and benefits from a gradual coal phase-out, consistent with achieving net-zero emissions by 2050. Over the full 2024-2100 horizon, the economic benefits of a coal phase-out far exceed the costs of replacing coal with renewables, even in the short term, and even for the low-end SCC estimate of $80/tCO2. The global net benefit rises over time, reflecting investment cost declines resulting from learning (Adrian *et al*, 2022). The net benefit of phasing out coal is $78 trillion in present value terms over the entire 2024-2100 horizon when evaluated at the $80/tCO2 SCC, more than three times its cost (217 percent), while it is $235 trillion, over 650 percent of cost, when evaluated at an SCC of $190/tCO2. If the benefits of avoided air pollution are included, the total net benefit would increase by a further $52 trillion (Adrian *et al*, 2024).

Table 2 compares our cost estimates for EMDEs with those of the IEA and IFC (2023), which estimated average annual investments required to replace all fossil fuel-based energy production with clean-energy sources, consistent with reaching global net-zero emissions by 2050, for two time periods: 2026-30 and 2031-35. Consistent with the broader scope of energy transition considered, the IEA and IFC (2023) cost estimates for EMDEs are about $2.2 trillion per year (about $1.4 trillion if China is excluded), about twice as high as the average annual estimates for 2026-2030 in Adrian *et al* (2022). For the 2031-35 period, the IEA and IFC (2023) estimate is about $2.8 trillion, three times more than Adrian *et al* (2022). Since the share of coal in the fossil-fuel energy mix varies significantly across regions, there are significant regional variations in cost estimates. Estimates by Bhattacharya *et al* (2022, 2023) put the annual investment cost of the energy transition by 2030 for EMDEs excluding China at about $1.5 trillion, roughly in line with IEA and IFC (2023).

3 The estimates in the dataset of the coal phase-out costs and benefits are in line with the GCAM 5.3 Net Zero 2050 scenario of NGFS (2023). This projects annual coal production from 2020-2100 consistent with a 50 percent probability of limiting global warming to below 1.5°C. Avoided emissions are computed as the difference with the GCAM 5.3 current-policies scenario. Most of these estimates are downloadable from https://greatcarbonarbitrage.com.

4 The US administration has adopted an SCC estimate of $190/tCO2 in recent environmental regulation; see Coral Davenport, 'Biden Administration Unleashes Powerful Regulatory Tool Aimed at Climate,' *The New York Times*, 2 December 2023, https://www.nytimes.com/2023/12/02/climate/biden-social-cost-carbon-climate-change.html.

Table 1: The global costs and benefits of Paris Agreement-consistent coal phase-out

	2024-2030	2024-2050	2024-2100
Costs of coal phase-out and replacement (in $ trillions)	12.2	23.5	36.0
of which: Advanced countries	3.8	6.9	10.5
Emerging market and developing countries	8.5	16.6	25.4
China	3.0	5.9	9.1
Emerging market countries without China	5.0	9.9	15.3
Developing countries	0.5	0.7	1.0
Avoided emissions (Gt CO2)	174.4	459.2	1424.1
(assuming global social cost of carbon of $80/tCO2eq)			
Benefits of coal phase-out and replacement (in $ trillions)	14.0	36.7	113.9
Net benefit (in $ trillions)	1.7	13.3	78.0
Net benefit per avoided ton of CO2 ($)	10.0	28.9	54.7
Net benefits in percent of cost	14.2	56.5	216.8
(assuming global social cost of carbon of $190/tCO2eq)			
Benefits of coal phase-out and replacement (in $ trillions)	33.1	87.2	270.6
Net benefit (in $ trillions)	20.9	63.8	234.6
Net benefit per avoided ton of CO2 ($)	120.0	138.9	164.7
Net benefits in percent of cost	171.3	271.8	652.3

Source: Bruegel based on Adrian *et al* (2022).

Overall, these comparisons offer some reassurance that the cost numbers reported in Table 1 are in a reasonable range. Unfortunately, IEA and IFC (2023) did not report the avoided emissions attributable to these investments, making it impossible to conduct a cost-benefit comparison as in Table 1[5].

Table 2: Comparison of coal phase-out cost estimates (annual averages, $ billions)

	IEA-IFC (2023) estimates		Adrian *et al* (2022) estimates			
	Investment needs		Investment needs		Opportunity costs	
	2026-31	2031-35	2026-31	2031-35	2026-31	2031-35
Total EMDEs	2222	2805	998	892	0.4	0.8
China	853	947	340	318	0.1	0.2
EMDEs excluding China	1369	1858	658	573	0.3	0.5
India	263	355	206	200	0.1	0.1
Southeast Asia	185	244	99	78	0.1	0.1
Other Asia	85	112	38	26	0.0	0.0
Africa	203	265	79	72	0.0	0.1
Latin America	243	332	25	20	0.0	0.0
Europe and Eurasia	188	232	209	174	0.1	0.2
Middle East	202	318	2	2	0.0	0.0

Source: Bruegel based on IEA and IFC (2023), Adrian *et al* (2022). Notes: IEA-IFS (2023) estimates refer to 'upper estimates' (aligned with the IEA Net Zero Emissions scenario) from IEA and IFS (2023), Table 1, p.12. Costs include costs of energy storage and grids in addition to investment in emission-free energy sources.

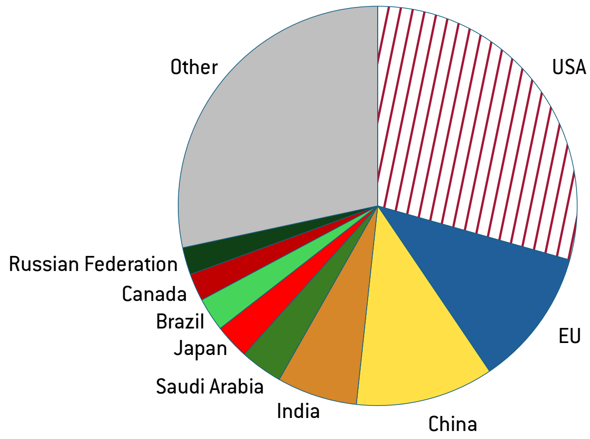
5 That said, the conclusions of IEA and IFC (2023) are in line with those of Table 1 (energy transition offers global economic benefits) and those of section 2.3 (it is in the interest of advanced countries to step up support for EMDE decarbonisation). See IEA and IFC (2023), p. 75.

2.2 Country-level net decarbonisation benefits are generally negative

If the global benefits of phasing out coal are so large, why is the coal phase out not happening more quickly? Part of the answer is that countries that pay the cost of the coal phase out only capture a small share of the global economic gains from reducing emissions (their shares of the world SCC plus reduced air-pollution benefits).

Figure 2 shows the highly unequal distribution of the country-level SCC, based on country-by-country estimates of the potential economic damage from climate change (Ricke *et al*, 2018). Larger and richer countries stand to gain the most from avoiding climate change[6]. According to baseline estimates in Ricke *et al* (2018), the US would suffer close to 30 percent of global economic damage from climate change, the EU and China each about 11.2 percent, India 6.5 percent, Saudi Arabia 3.4 percent, Japan 2.8 percent and Brazil 2.7 percent. This means that when Brazil, for example, undertakes a costly emissions reduction effort, less than 3 percent of this effort benefits Brazil directly, while 97 percent goes to the rest of the world. This is an important reason why appeals to developing countries to voluntarily reduce emissions, even when backed by peer pressure through the UNFCCC process, is likely to have limited impact unless accompanied by financing from advanced countries.

Figure 2: Distribution of the world SCC



Source: Ricke *et al* (2018).

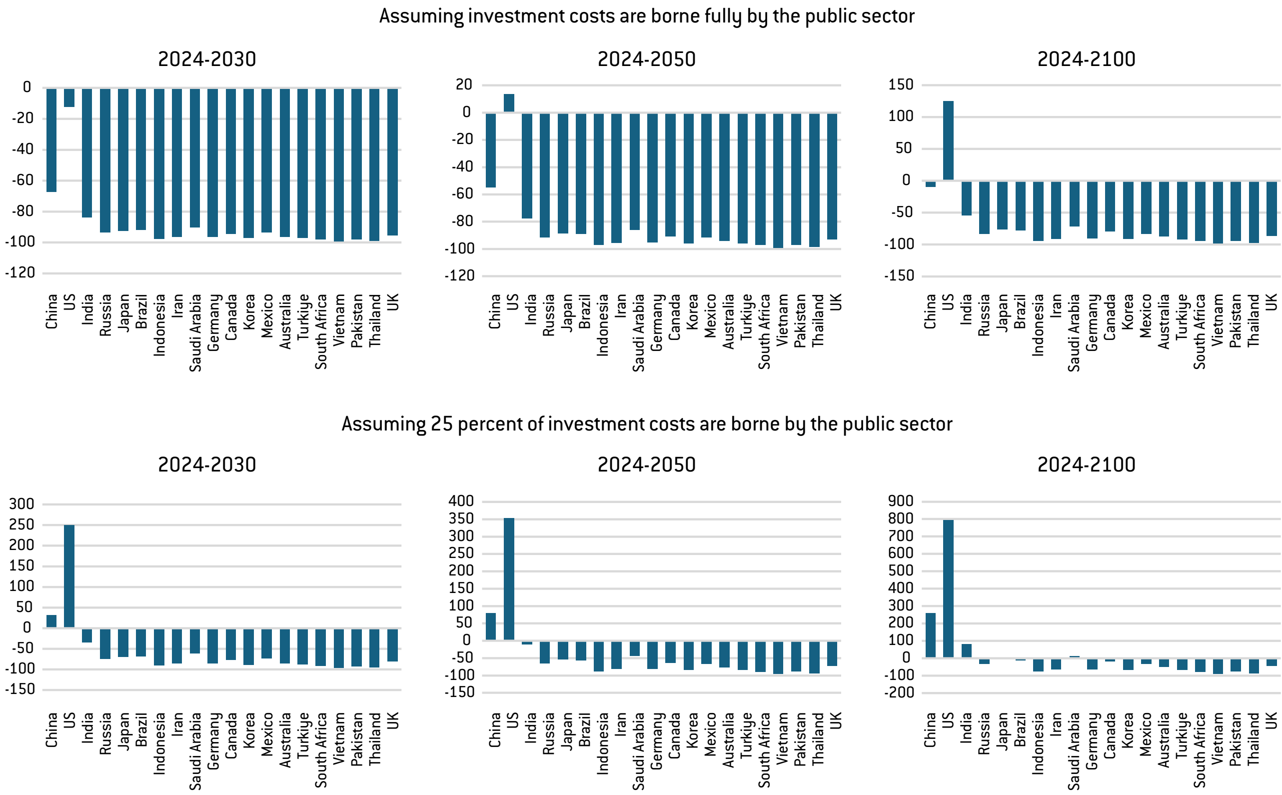
Figure 3 illustrates this point over three horizons by showing the country-level net-benefit breakdown (in percent of the total cost of a coal phase out) for the 20 largest CO2 emitters, based on an assumed SCC of \$190/tCO2. The higher of the two SCC estimates is a conservative estimate in this case: if the coal phase out is not worth it from an individual country perspective at the higher SCC, then for sure it is not worth it at the lower SCC. The top row shows the results assuming that the entire investment need is a 'cost' to the public purse. The only country for which there is a positive net benefit (over the 2050 and 2100 horizons) is the United States. However, this result is likely too pessimistic, as IEA and IFC (2023) estimated that with some public 'de-risking' (on average, about \$1 in donor finance for \$10 in private finance), 60-80 percent of the investment need could be privately funded. Box 1 describes how such 'blended' finance for country-wide decarbonisation could be operationalised.

We hence assume that the cost to the public sector of a coal phase out are 25-50 percent of

6 The intuition is that richer countries have more output to lose from natural catastrophes and lower growth due to climate change, even though the physical risks and risks to human life induced by climate change are greater in developing countries, particularly countries close to the equator and small-island economies (Bolton *et al*, 2022, chapter 2). The rational response of most developing countries to these risks is to invest in climate adaptation that increases resilience, not mitigation.

total of investment and opportunity costs[7]. To see how much of a difference this might make, the bottom row of Figure 3 undertakes a robustness check in which it is assumed that just 25 percent of the investment is a cost to the public purse. Even with this assumption, only the US and China would find it in their self-interest to undertake the required investment over the 2030 and 2050 horizons. Over the 2100 horizon there is a marginally positive benefit for two more countries, India and Saudi Arabia.

Figure 3: Country-level net benefits of phasing out coal (% of present value of costs, based on an SCC of $190/tCO2)



Sources: Bruegel based Adrian *et al* (2024). Notes: Investment costs are calculated based on the location of coal consumption, while opportunity costs are based on the location of coal mines. The second row of the table assumes that 75 percent of investment costs can be financed by (international) investors or multilateral development banks. Air pollution benefits are not taken into account.

7 The 25 percent minimum corresponds to IEA and IFC's lower bound of about 20 percent of public financing, plus a low subsidy of about 6 percent for the remaining 80 percent, corresponding to a high leverage ratio of $17 (100/6) in private financing per $1 donor funding). The 50 percent maximum corresponds to IEA and IFC's lower bound of about 40 percent of public financing plus a high subsidy of 17 percent for the remaining 60 percent (corresponding to a low leverage ratio of about $6 (100/17) in private financing to $1 in donor funding). IEA and IFC's (2023) assumed average leverage ratio of $10 in private financing to $1 in donor funding (p. 127) lies between these two extremes.

Box 1: System-wide blended finance

Blended finance refers to the combination of private finance and a public subsidy given to the private financiers. Providing such a subsidy makes economic sense when it is both essential to attract private sector investment, and the risk-adjusted return of the project to the public sector exceeds the cost of the subsidy.

Benefits notwithstanding, this type of structure creates a conflict of interest between public and private investors. The higher the public subsidy, the higher the risk-adjusted return to private investors. To protect its interests, the public sector must screen projects (directly, or through a delegate such as a bank) and set the subsidy to reduce the risk to the private sector to the point that makes it attractive, but not beyond.

System-wide blended finance involves a framework that seeks to coordinate projects and domestic government measures. This can significantly increase the benefits (and/or lower the cost of blended finance). For example, linking the phase-in of green energy to the phase-out of brown energy can accelerate emissions reductions while ensuring energy security (Darmouni, 2024). Macroeconomic and/or regulatory reforms can reduce the cost of capital. Pooling multiple investments in a green fund diversifies idiosyncratic project risk. These elements – coordination, integration with policy actions and pooling – lower the required public sector subsidy and increase the scale and hence impact of climate finance.

The degree of required public funding will be different for the phase out (of coal, say) and the phase in of renewables, which together constitute the energy transition.

- The cost of the coal phase-out is the opportunity cost of closing each coal operation along the phase-out pipeline. This includes the stranded asset value of coal and compensation for lost wages and retraining of workers. Since phasing out coal does not generate a revenue stream (and it is unsure if the sale of coal carbon credits will deliver global net emission reductions), subsidies must cover early coal closure. There is an economic case to do so, as this brief shows.
- The phase-in of renewables requires an upfront investment needed to build each renewable asset (including supporting technologies). But since renewables generate a revenue stream from sold electricity, this investment can be largely financed through capital markets. In section 2.3 we estimate that no more than 25 percent (possibly 50 percent in extreme cases) of the investment costs require public funds to de-risk these investments. The remainder can come from tapping capital markets (see also Flammer *et al*, 2024).

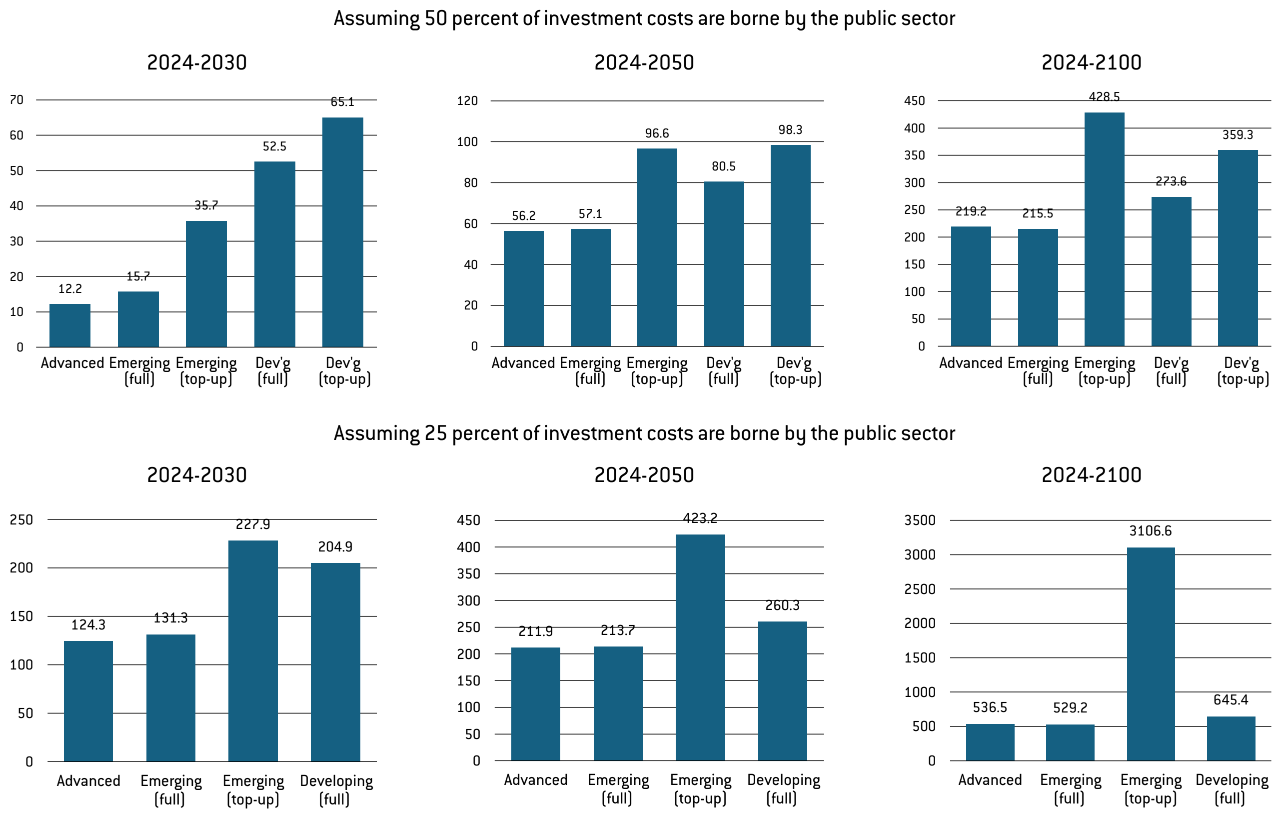
Public funds can be provided in the form of a first-loss tranche in a green fund, with the senior tranche being issued to global (institutional) investors (Arezki *et al*, 2017). They can also take the form of guarantees, against, for instance, political risks, exchange-rate risk (Persaud, 2023) and project-delay risk, or long-term electricity price commitments (eg purchase power agreements) to secure a reliable revenue stream for renewables.

In sum, a system-wide blended-finance approach, rather than the current project-based approach, is the best way forward. It is critical to enable a net-zero transition to take place, which requires an integrated and well-timed, at-scale approach involving different phase-in technologies and phase-out projects. It also reduces risk by allowing investments in a fund holding multiple projects with lower permitting and other ad-hoc risks, since the projects are part of an integrated plan with country-level buy-in.

2.3 Funding the coal phase-out in EMDEs is in the collective self-interest of advanced countries

The last step in the argument in this section involves computing the collective net benefits to advanced countries of funding: (1) their own phase-outs; (2) phase-out in emerging market countries, and (3) phase-out in developing countries not classified as emerging markets[8]. Figure 4 reports the net benefits to the group of advanced countries, assuming public-sector shares to cover the renewable investment costs of 50 percent and 25 percent, in two funding scenarios: first, in which the advanced countries pay the public sector share in full, and second, in which they merely provide a 'top up' equal to the portion of the costs that exceeds the benefits of phasing out coal to the developing country being funded[9]. Figure 4 also assumes a 100 percent public sector share (ie a subsidy) to cover the opportunity cost of early coal closure. The lower bound \$80/tCO2 SCC is used, since the point is to examine whether avoided-emissions benefits are large enough.

Figure 4: Net benefit to advanced countries of funding coal phase-out (% of present value of costs, based on \$80/tCO2 SCC)



Sources: Bruegel based on Adrian *et al* (2024). Notes: Each chart shows the return to the advanced countries from funding their own phase-outs ('Advanced') and from funding the phase-outs in emerging markets ('Emerging') and developing countries ('Developing'). Columns labelled 'full' assume that the full public sector portion of investments is shouldered by the advanced countries. Columns labelled 'top-up' assume that the countries for which investments are funded contribute their level of private benefits, while advanced countries pay for the rest.

8 We use the group classifications from Adrian *et al* (2022), who in turn relied on the classifications in the IMF World Economic Outlook. Their dataset contains 27 countries classified as advanced economies, 52 countries classified as emerging markets and 26 countries classified as developing economies.

9 For example, for Brazil, the total cost of phasing out coal is \$176.6 billion by 2050 in present value terms. Assuming a 50 percent public share of investment costs, the cost to the public sector is \$88.4 billion, while the individual benefit to Brazil (avoided emissions multiplied by Brazil's share of the SCC of \$80) is \$8.1 billion. 'Top up' means that advanced countries would cover \$88.4 – \$8.1 = \$80.3 billion of the public cost of phasing out coal in Brazil by 2050.

The results confirm that the collective economic benefits to advanced countries from funding EMDE decarbonisation are positive and generally very large[10]. For example, for a 25 percent public investment share, the net benefit to advanced countries of fully funding an emerging market coal phase-out would be 131 percent (benefits are more than twice the costs), while the net benefit of fully funding developing country decarbonisation would be 205 percent (benefits are more than three times cost). A few further points are noteworthy:

- The benefits to advanced countries from funding EMDE investments are generally greater than the benefits of collectively funding their own investment (the left column tends to be the smallest).
- The benefits of fully funding developing countries (fourth column) are always greater than the benefits of fully funding emerging markets (second column).
- From the perspective of advanced countries, cost sharing makes a huge difference over longer horizons, particularly for emerging markets (third column). Because the recipients are assumed to contribute their private share to the investment cost, this contribution becomes very large as the horizon lengthens for China and a few other emerging markets with large SCC shares. Consequently, the subsidy required from advanced countries declines sharply.

The first two points confirm the view that emissions abatement costs – the mitigation 'bang for the buck' – are higher in EMDEs (and particularly in developing countries) than in advanced countries (see Glennerster and Jayachandran, 2023; IEA and IFC, 2023).

3 The feasibility of climate finance at scale

The fact that advanced-country funding of EMDE decarbonisation is in the advanced countries' own collective economic interest is, however, not a guarantee that it will happen – and it is not happening fast enough. Box 2 shows that, up to 2022, north-south climate funding fell short of even the $100 billion per year goal set at COP15 in 2009, even including mobilised private financing. In 2022, it finally surpassed the $100 billion goal (OECD, 2024), but continues to fall far short of the much larger volumes that are required to finance the energy transition in EMDEs (Table 2).

Setting aside the possibility that advanced-country governments may not understand fully that funding a coal exit in EMDEs is in their own economic interests, there could be three reasons why climate finance at scale is not yet happening:

1. There is a free-rider problem within the group of advanced countries. The calculations in section 2.3 ignored this problem, by focusing on the collective benefits to advanced countries.
2. The scale of financing required to fund the EMDE's exit from coal may just be too high, in the sense that the public share of the required investment might exceed the borrowing capacity even of advanced countries, or would require borrowing at very high interest rates. This could undermine the argument that advanced countries are necessarily better off by funding EMDE decarbonisation (the calculations in section 2.3 did not take into account the costs of debt write-offs or very expensive borrowing).

10 For the 2050 and 2100 horizons, the results are robust for much higher assumed public sector shares. For example, if a public sector share of 75 percent is assumed, the net benefits from funding coal phase-out accruing to advanced countries would still be positive for the 2050 and 2100 horizons. For the 2024-2030 horizon they would be negative with respect to funding emerging markets, but still positive when funding developing countries.

3. Advanced countries may not be willing to fund an EMDE coal exit (at least not at levels that exceed normal development aid) because they are not convinced that the recipient countries would take the required policy actions. That is, they fear that their money would be wasted.

The remainder of this paper investigates these three obstacles, assuming that advanced-country support for EMDEs would happen on a recipient-country-by-recipient-country basis. This assumption is important particularly for the discussion of the implementation problem (problem 3). Unless this can be solved at the recipient-country level – by providing technical support and writing an enforceable contract with that country – it is hard to see how it could be solved at the level of a large group of EMDEs.

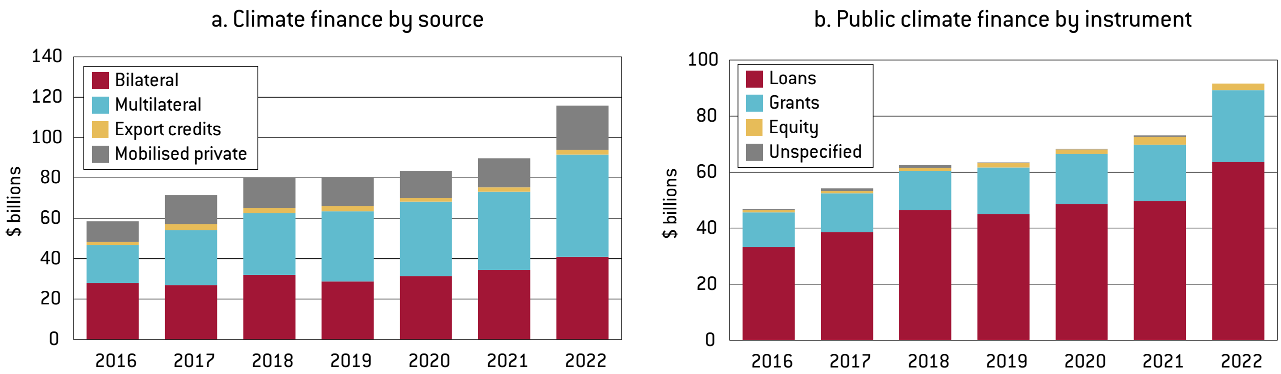
Box 2: Taking stock of north-south climate finance

In 2009, the fifteenth Conference of the Parties to the UNFCCC in Copenhagen (COP15) agreed on non-binding targets for both short- and long-term finance. Articles 8-10 of the Copenhagen Accord outlined a pledge of $30 billion for the period 2010-2012, increasing to $100 billion annually by 2020, including funds from private, bilateral official and multilateral sources (UNFCCC, 2009). Article 114 of the 2015 Paris Agreement reaffirmed this commitment, urging "*developed country Parties to scale up their level of financial support … while significantly increasing adaptation finance from current levels*" and establishing a Green Climate Fund to channel this money to projects in developing countries (UNFCCC, 2015). It also called for a new quantified goal for climate finance, exceeding $100 billion/year, to be agreed prior to 2025.

The $100 billion goal was finally reached in 2022, when total climate finance provided and mobilised by developed countries for developing nations amounted to about $116 billion, with about 60 percent directed at mitigation projects, 28 percent to adaptation and the rest to cross-cutting projects (OECD, 2024).

Public climate finance, comprising bilateral and multilateral contributions, amounted to $91.6 billion (Figure 5, left panel), consisting mainly of loans ($63.6 billion, 70 percent). Grants made up $25.6 billion (22 percent), while equity investments represented only a marginal share (Figure 5, right panel). Furthermore, the lending component was predominantly non-concessional. According to OECD Development Assistance Committee (DAC)[11] estimates, ODA for climate change (grants and concessional loans) amounted to $50 billion on average in 2021-22, 33 percent of the DAC members' total bilateral allocable ODA.

Figure 5: North-south climate finance, 2016-2022 ($ billions)



Source: OECD (2024).

11 See https://www.oecd.org/dac/development-assistance-committee/.

Importantly, climate finance reporting is fraught with uncertainty. Development flows that do not directly support an adaptation or mitigation project can be assigned a 'climate component', subject to an OECD DAC methodology. However, this leaves substantial room for interpretations of a flow's climate relevance, and donors may have an incentive to overstate it (Zagema *et al*, 2023). Furthermore, grant-equivalent reporting is not compulsory for climate finance, implying that grants, loans and other non-grant instruments can be reported at face value, notwithstanding their vastly different fiscal implications.

3.1 Free riding

Advanced countries are members of the OECD, whose mission includes the promotion of collective action. But OECD members might be considered too large and heterogenous a group to address free-riding concerns in advanced countries in the context of climate finance at scale.

But there are subsets of advanced countries held together by strong political or institutional ties that could overcome free riding among themselves. The prime candidate is the G7, expanded by the EU and some allied economies. Economic, historical and military ties across this group have enabled common funding efforts on several occasions, ranging from the Highly Indebted Poor Countries (HIPC) initiative and Multilateral Debt Relief Initiatives (that provided over $100 billion in debt relief to low-income countries in the 1990s and 2000s), to support for Ukraine in the face of Russian aggression (about €157 billion allocated as of end-February 2024) (Bomprezzi *et al*, 2024)[12].

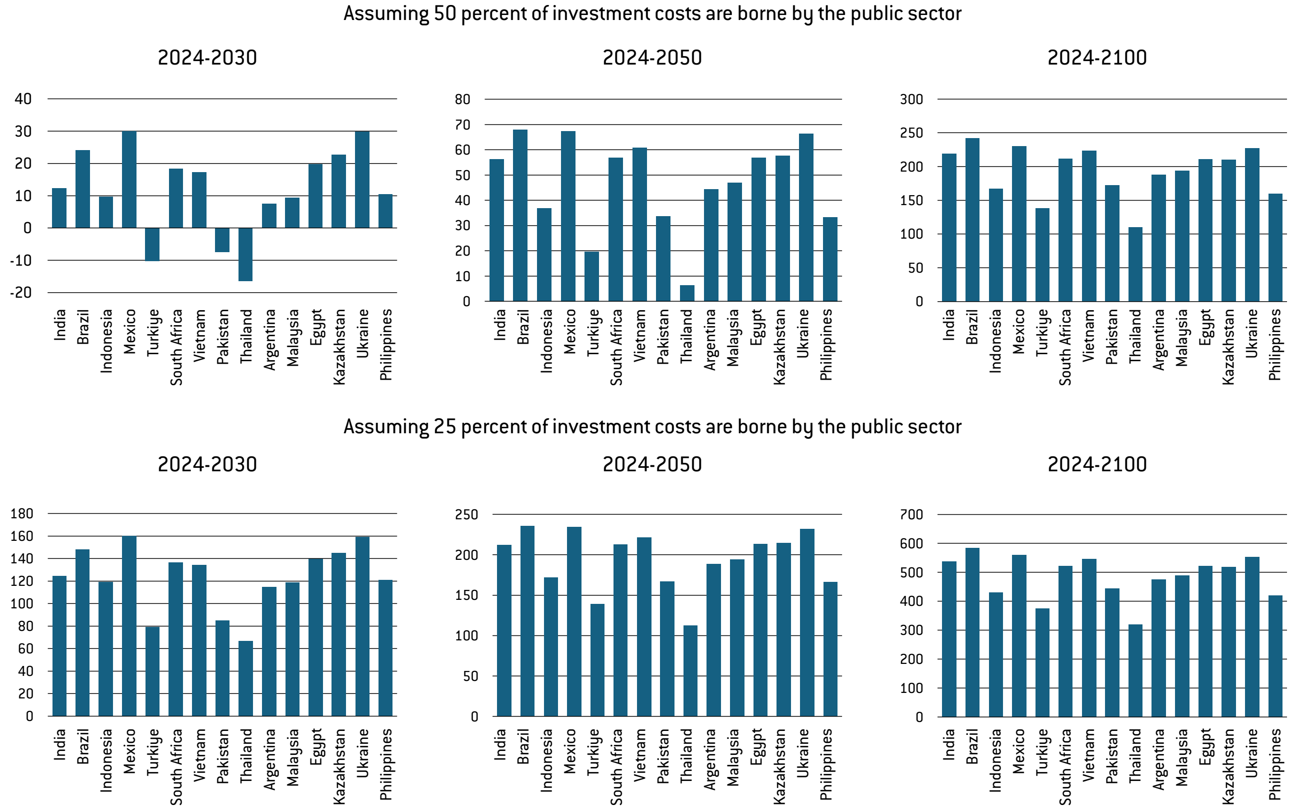
Together, the G7+EU bear almost half (48 percent) of the global SCC (Ricke *et al*, 2018). When countries such as Australia, New Zealand, Norway and Switzerland are included, the share of the global SCC of this group exceeds 50 percent. The question is whether this share is large enough to sufficiently internalise the global benefits of funding a coal phase out to cover the costs. Figure 6 answers this question for the net benefit to the G7+EU of funding the decarbonisation of the largest developing country emitters except China[13].

With few exceptions, the net benefits to the G7+EU of fully funding the coal exit of the largest emerging-market emitters would be positive even over the short (2030) horizon, and even assuming a high 50 percent public sector share in investment. The net benefit can be very large – about 200 percent of cost up to 2050 for India, Brazil, Indonesia and South Africa, in the case of a 25 percent investment share. If the costs are shared by recipient countries contributing their private benefits, the returns to the G7+EU would be even higher (see Annex 1).

12 There are also counterexamples, such as the lack of cooperation among the G7 countries during the pandemic. But the latter embodied an element of immediacy which is absent from the climate crisis, where building up the response can be more gradual and a country-by-country approach may be feasible.

13 China is excluded both because G7 funding of its coal exit is implausible for political reasons and because its share of the SCC is likely high enough, particularly when combined with the air pollution benefits of phasing out coal, to make it worth funding the coal phase out itself (see Ebenstein *et al*, 2017, on the benefits of reducing air pollution from coal). Chinese emissions reductions efforts so far seem to be consistent with this view, with the IEA (IEA 2023, p. 238) predicting that China's coal use will peak in 2025 and decline at a rate of 3-6 percent thereafter.

Figure 6: Net benefits to G7+EU of funding coal phase-out in selected countries (% of present value of costs, based on $80/tCO2 SCC)



Sources: Bruegel based on Adrian *et al* (2024). Notes: The figure shows the net benefits to a funding coalition consisting of the EU, the US, Japan, and Canada from funding a portion the investment cost of phasing out coal in the 16 largest EMDE emitters (in 2020, based on World Bank data), excluding oil producers (which do not use coal in significant amounts). The EU+G7 funding coalition is assumed to shoulder the full public sector portion of investments.

3.2 Fiscal cost

Funding the coal-phase out in EMDEs may be in the interests of the G7+EU, but is it affordable? Table 3 gives the answer. It shows the costs, expressed in three ways, for 2024-2030 and 2024-2050, of compensating the coal industry and funding renewables investment, assuming a public-sector share of either 50 or 25 percent. The estimates in percent of G7+EU GDP should be interpreted as the average fiscal cost the G7+EU would need to shoulder each year of the 2024-30 or 2023-50 investment horizon, while the numbers in percent of 2024 G7+EU GDP denote the increase in public-sector debt if the G7+EU were to borrow upfront to finance the entire coal phase-out programme for the following six years (left columns) or 26 years (right columns).

Table 3: Fiscal cost to the G7+EU of funding the coal exit

	Public sector share = 50 percent		Public sector share = 25 percent	
	2024-2030	2024-2050	2024-2030	2024-2050
	in $ billions			
India	1017.6	1923.59	509.0	963.11
Brazil	47.3	88.37	23.6	44.23
Indonesia	132.7	283.72	66.4	142.69
Mexico	16.1	34.44	8.0	17.24
Turkiye	85.6	179.36	42.8	89.81
South Africa	283.1	577.99	141.6	289.67
Vietnam	77.9	150.91	39.0	75.53
Pakistan	22.9	39.43	11.5	19.73
All EM ex China	2507.5	4963.6	1254.4	2486.9
All developing	162.1	291.2	81.1	145.8
	in percent of G7+EU GDP			
India	0.24	0.10	0.12	0.05
Brazil	0.01	0.00	0.01	0.00
Indonesia	0.03	0.01	0.02	0.01
Mexico	0.00	0.00	0.00	0.00
Turkiye	0.02	0.01	0.01	0.00
South Africa	0.07	0.03	0.03	0.01
Vietnam	0.02	0.01	0.01	0.00
Pakistan	0.01	0.00	0.00	0.00
All EM ex China	0.59	0.25	0.30	0.13
All developing	0.04	0.01	0.02	0.01
	in percent of 2024 G7+EU GDP			
India	1.77	3.35	0.89	1.68
Brazil	0.08	0.15	0.04	0.08
Indonesia	0.23	0.49	0.12	0.25
Mexico	0.03	0.06	0.01	0.03
Turkiye	0.15	0.31	0.07	0.16
South Africa	0.49	1.01	0.25	0.50
Vietnam	0.14	0.26	0.07	0.13
Pakistan	0.04	0.07	0.02	0.03
All EM ex China	4.4	8.6	2.2	4.3
All developing	0.3	0.5	0.1	0.3

Sources: Bruegel based on Adrian *et al* (2024) and IMF World Economic Outlook (October 2023). Note: Figures assume that the full public sector portion of investments is shouldered by EU+G7. See Annex 1 for results that assume that countries whose investments are being funded contribute to the cost in the amount of their level of private benefits and the funding coalition pays for the rest.

Table 3 confirms, first, that the fiscal cost of funding the coal exit is high in absolute terms: for example, $500 billion to $1 trillion for India alone, and $1.3 trillion to $2.5 trillion for all EMDEs excluding China over 2024-2030, depending on the assumed public-investment share. However, the cost is small as a share of G7 plus EU GDP over the same period (0.3-0.6 percent to fund the coal phase out for all EMDEs excluding China). For 2024-2050, the funding requirements are larger in absolute terms ($2.5 trillion to $5 trillion for all EMDEs excluding China), but smaller as a share of G7 plus EU GDP (just 0.13-0.25 percent). Even prefunding the entire 2024-30 investment programme in one year would raise 2024 debt in the G7+EU by just 2.2-4.4 percent of GDP. This is clearly within the fiscal capacity of the rich countries.

The reader may wonder why these numbers appear small relative to estimates of the required renewable investments in advanced countries (for example, about 5 percent of GDP per year in the EU, according to Calipel *et al*, 2024). There are several explanations. First, Table 3 focuses only on the fiscal cost of a coal exit, assumed to be 25-50 percent of the renewable energy investment cost. Second, the numbers refer only to the replacement of coal, which based on Table 2 is in the order of half of the total cost of the energy transition estimated by IEA and IFC (2023). Finally, Table 3 refers to decarbonisation in EMDEs, where abatement costs are likely to be lower than in advanced economies.

In sum, phasing out coal in EMDEs is fiscally affordable, generates a large social benefit and preserves the carbon budget.

3.3 Linking financing to policy action

Phasing out coal effectively and efficiently – as well as any other successful emissions reduction scheme – requires supportive policy, for two main reasons.

First, it hinges not just on investments in emission-free energy sources but also on reducing (or shutting down) production of polluting plants. The closure of coal operations comes with social and economic sacrifices for the communities and investors involved. These sacrifices can only be addressed by compensating coal communities and offering them alternative opportunities. As Coase (1960) argued – paying polluters to stop polluting (and workers for their loss of income) – is sound economic logic, making everyone economically better off, as we show in Figures 6 and 7.

Second, the cost of renewable investment depends on the cost of capital – the interest rate or expected equity return charged by capital markets – which in turn depends on both country-level and sector-level risks (IEA, 2024). These are influenced by policy: at country level, because macroeconomic policies influence exchange rate risk as well as broader country risk; and at sector level through the quality of regulation and infrastructure (grids), which influence 'off-take risk' (the risk that a zero-emissions energy source may not be able to sell its energy at the expected price).

From the perspective of a donor that seeks to support exit from coal and encourage private investment in renewables, both classes of policies are fraught with incentive problems. Policy actions required to lower the cost of capital – including macroeconomic stabilisation or better regulation – may be difficult both technically and politically. Keeping these costs down drives up the costs to the funders, and vice versa. As a result, donors may not be willing to provide funding unless they can be sure that supportive policies are implemented and the technical and institutional capacity to sustain such policies is created[14]. This may be one reason, if not the main reason, why advanced countries have so far financed emissions reductions almost exclusively within their borders, notwithstanding emission-reduction opportunities in EMDEs that could in principle offer a higher emissions bang for the buck (section 2.3).

The solution to these incentive problems, in principle, is to negotiate a package of technical support and conditional funding which is disbursed as agreed policy actions are implemented. Technical assistance and conditionality could be offered through, and monitored with, the help of multilateral development banks (and for countries with macro issues, the International Monetary Fund), which could also provide additional financial support. Advanced-country donors could coordinate with these institutions on a recipient country-by-county basis, to design and negotiate country-specific phase-out plans in partnership with the recipient. Collaborations of this form have for decades been the basis for most development finance and multilateral debt

14 This is true even if high EMDE country risk premia reflect market failures as well as policy failures. If the cost of hedging foreign exchange rate risk is higher than can be justified by fundamentals, as argued by Persaud (2023), it would make sense for an official entity supported by advanced countries to reduce country risk by offering foreign exchange hedges at lower cost than the market. However as long as country risk is also influenced by macroeconomic policies that come at a cost to domestic policymakers, donors will not want to offer this support unconditionally.

relief. The challenge is to adapt them to the much larger financial flows (and possibly deeper accompanying policy actions) that are required for emissions mitigation, and to bring in private sector financing, in the form of 'blended finance' (Box 1, One Planet Lab, 2021; IEA and IFC, 2023; Bhattacharya *et al* 2022, 2023).

As it turns out, this approach already exists to some degree, in the form of Just Energy Transition Partnerships (JETPs), inaugurated at the 2021 Glasgow UN climate summit (COP26). Four JETPs have been announced so far, to accelerate the energy transitions in South Africa, Indonesia, Vietnam and Senegal (Table 4). In each case JETPs consist of 'country platforms' – a coordination forum involving a secretariat, country authorities and a funding consortium ('International Partners Group') including G7 members, the EU, other advanced countries such as Norway and multilateral development banks. In all but the most recent case, these platforms have worked out detailed investment plans focusing mostly on replacing local mined coal with renewables (Republic of South Africa, 2022; JETP Indonesia, 2023; Socialist Republic of Vietnam, 2023, referred to collectively as JETP implementation plans below). The exception is Senegal, which mines and uses little coal, and where the objective is to reduce dependence on imported fossil fuels.

Table 4: Just Energy Transition Plans (JETPs) announced by March 2024

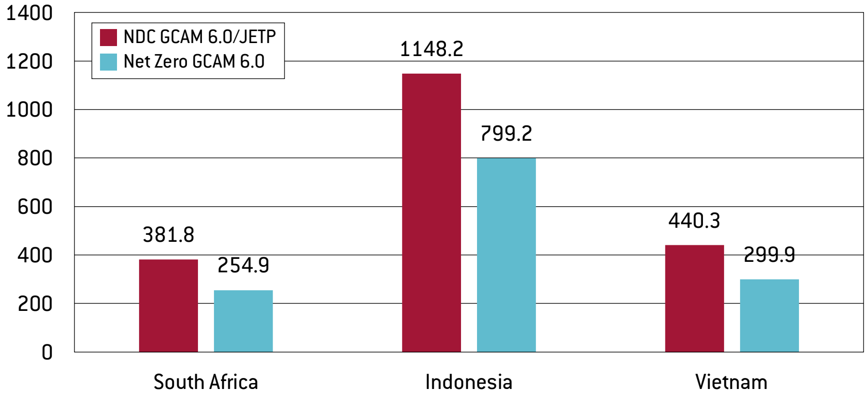
Country	Date announced	Funding consortium	Implementation plan?	Pledge ($ bn)	Needs estimates by 2030 ($ bn)	
					JETP	Adrian *et al* (2022)
South Africa	Nov-21	US, EU, UK, France, Germany, Denmark, Netherlands, Spain, World Bank	Yes	11.9	68.7 1/	566
Indonesia	Nov-22	G7+EU, Norway, Denmark, World Nank, ADB, GFANZ	Yes	20.0	97	265
Vietnam	Dec-22	G7+EU, Denmark, Norway, ADB, FMO, GFANZ	Yes	15.5	134.7	156
Senegal	Jun-23	France, Germany, EU, UK, Canada	No	2.7	n/a	1

Source: Bruegel based on Simpson *et al* (2023), JETP implementation plans and Adrian *et al* (2022). Note: Needs estimates refer to investments in the energy sector, including grids and storage. South Africa's estimate of $68.7 billion refers to the electricity sector, 2023-27 (including spending to support and retrain coal communities). South Africa's JETP also plans to expand new energy vehicles ($8.5 bn) and the green hydrogen sector ($21.2 bn). ADB = Asian Development Bank; FMO = Dutch Entrepreneurial Development Bank; GFANZ = Glasgow Alliance for Net Zero, a group of over 500 financial institutions.

Notwithstanding the similarities, there are at least four main differences between the current JETPs and the archetypical conditional climate finance pacts we have sketched above.

First, while JETP implementation would speed up the coal phase-out significantly relative to business-as-usual, the initiatives are substantially less ambitious than the coal phase-outs envisaged by Adrian *et al* (2022), for two reasons. First, the Adrian *et al* (2022) pathways would eventually phase out coal for all purposes, including industry, while Indonesia's and Vietnam's JETPs focus only on replacing coal in electricity production. Second, all JETPs are designed to deliver emissions reductions in line with – or in the case of Indonesia, below but very close to – the most recent (2022) updated nationally determined contributions announced by these countries[15]. However, according to standard estimates, these fall significantly short of the emissions reductions needed to stay within the Paris temperature objectives (Figure 7). As a result, it is not surprising that the estimated financing requirements of JETP plans are much less than the financing requirements estimated by Adrian *et al* (2022), particularly for South Africa and Indonesia (last two columns of Table 3). The 2030 renewables electricity generation capacity targeted in South Africa's and Indonesia's JETPs remains significantly below, and 2030 estimated electricity generation based on coal is significantly above, the level corresponding to a Paris-consistent net-zero scenario (see Annex 3 for more details). The discrepancy is particularly large for Indonesia.

Figure 7: NDC/JETP based emissions targets for 2030 compared to Paris-aligned emissions (megatonnes of CO2)



Source: NGFS Phase 4 scenario builder, https://data.ece.iiasa.ac.at/ngfs/, and JETP implementation plans. Note: The figure compares 2030 projected CO2 emissions implied by the latest (2022) nationally determined contributions for South Africa and Vietnam with the emissions level of the most recent Paris-consistent net zero scenario of NGFS (2023). In the case of Indonesia, NGFS (2023) reports a 2030 level of emissions of 1234.2 MtCO2 for the NDC GCAM 6.0 scenario. The number shown in the figure, 1148.2 reflects the additional avoided emissions that the JETP aims to achieve for the on-grid power sector, namely 86 (=334-250) MtCO2. See JETP Indonesia, pp. 43-44.

Second, the financing pledges offered by the funding consortia so far – which include private sector pledges coordinated by the Glasgow Financial Alliance for Net Zero, and loans in addition to grants and guarantees – are an order of magnitude smaller than the financing requirements estimated in the JETP implementation plans[16]. As a result, most of the cost associated with JETPs is currently unfunded. The proposal that the difference could be raised through domestic revenue or sovereign borrowing seems illusory, given the orders of magnitude involved, except possibly in Indonesia. Based on IMF GDP projections for 2024, the unfunded gap is about 22 percent of GDP for South Africa, 5 percent for Indonesia, and 25 percent for Vietnam.

Third, financing pledges support JETP emission-reduction objectives and their broad strategy (replacing coal-based electricity with renewable energy sources) without linking the funding to specific policy actions and technical assistance. This may reflect the timing of the financing pledges, which mostly accompanied the original political declarations announcing the JETPs, before implementation plans were developed. That said, the financing pledges could have been upgraded and linked to specific investments and policies as part of the implementation plans. This has not yet happened. Hence, JETPs currently remain incomplete conditional

15 South Africa's and Vietnam's JETPs are designed to support the most recently announced nationally determined contributions, while Indonesia's JETP aims to reduce on-grid power emissions below the levels envisaged in its 2023 National Electricity Master Plan, which followed its 2022 enhanced NDC, from 336 MtCO2 to 250 MtCO2 in 2030 (JETP Indonesia 2023, Table 5.2-3, p. 44). However, this reduction is modest as a share of Indonesia's projected 2030 emissions (Figure 2). See also Annex 3.

16 Private sector pledges constitute half of the total promised to Indonesia and Vietnam.

finance pacts, which do not explicitly tie large volumes of funding promises to difficult policy measures on the ground.

Fourth, the JETP financing packages have primarily been offered in the form of concessional loans and guarantees to support investments in renewables and supporting technologies to replace coal, while not enough subsidies have been offered to pay for the stranded-asset value of coal, or compensation for coal communities and retraining costs. For instance, the Indonesian JETP only has a 3 percent grant component, much of which is allotted to technical assistance. Consequently, hardly any money is set aside to pay for early coal closures. As Indonesia already has an oversupply of electricity, the renewable supply will not be developed without closures of coal-fired power plants. Similarly, the South Africa JETP deal does not offer sufficient grants to pay for coal closures and the social transition of coal communities.

There are four interpretations for these gaps in the JETPs as they currently exist and JETPs as they would be ideally financed and structured.

1. Advanced-country policymakers may not understand that large-scale conditional funding for a coal phase-out is in the best economic interests of their own countries. Instead, funding is framed as a form of development aid. Given the low level of funding, recipient countries have no interest in accepting meaningful conditionality.
2. Pledged financing volumes may be small because of the (initial) lack of an explicit link to policy actions, but creating that link is in principle technically and politically feasible. In that case, it is possible that, if the link is established gradually during the implementation phase with support of national agencies and MDBs, financing would be upgraded significantly.
3. While advanced-country policymakers may understand that much higher funding levels would be in their economic interests if linked to appropriate conditionality, they face political-economy constraints to scaling up funding. Domestic constituencies may not accept that spending large amounts of taxpayer money on compensating coal communities in foreign countries or de-risking private investment is in their interests, even if the costs are comparatively small as a share of GDP.
4. While much higher funding levels could be made available if linked to appropriate conditionality, the requisite level of conditionality is politically unfeasible in the recipient countries.

Future work to improve and scale the JETP approach should focus on identifying and loosening these constraints. If point 1 above is true, then evidence of the type presented in this paper should help increase the willingness of advanced countries to invest in EMDE decarbonisation. If point 2 is true, acceleration of EMDE emissions reductions should focus on establishing effective governance structures that link climate finance to climate mitigation policies and monitor their implementation. If points 3 or 4 are true, then the focus should be on overcoming the political-economy constraints in both financier and recipient countries. Of course, it is also possible that several of these constraints matter and must be addressed simultaneously.

4 Conclusion

Our results imply that there is a strong economic case for wealthy countries to provide climate finance at scale, beyond their moral obligations under the Paris Agreement's principle of common but differentiated responsibilities.

A template for conditional funding of coal phase-out exists already: the JETPs agreed with South Africa, Indonesia and Vietnam. But the funding levels committed to these JETPs are tiny compared to what is needed. Furthermore, unlike other forms of conditional assistance (for example, EU grants and loans supporting the recovery and resilience programmes of EU countries), the link between funding and specific climate mitigation policy actions does not appear to have been fully worked out.

Financial commitments provided by advanced countries under the existing JETPs must be multiplied by a factor of at least ten, and JETPs should be expanded to other large EMDE emitting countries, including Colombia, Kazakhstan, Nigeria, Mexico, Thailand and India[17]. A necessary condition for scaled-up funding is more detail in the conditions that would trigger the release of such funding, and a governance structure to monitor that the conditions are met. But even that may not be sufficient. Future work on JETPs must focus on identifying and loosening the political and technical constraints that are holding up what could otherwise be a promising route to faster emissions reductions in EMDEs.

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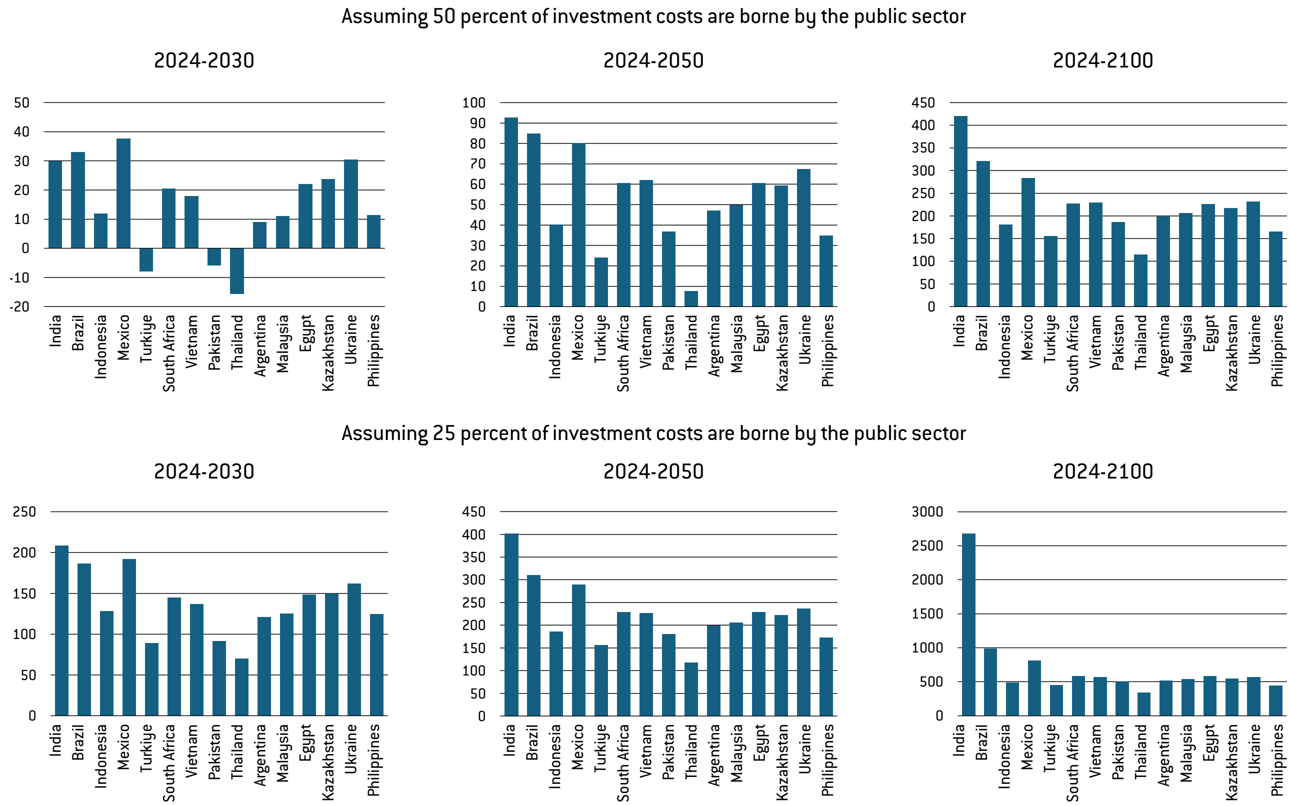
Annex 1: Net benefits to G7+EU of 'topping up' coal phase-out costs (% of present value of costs based on a world SCC of $80/tCO2)



Sources: Bruegel based on Adrian *et al* (2024). Note: The figure shows the net benefits accruing to a funding coalition consisting of the EU, the US, Japan and Canada, from funding a portion the investment cost of phasing out coal in the countries shown in the charts. The top row assumes that the public sector bears 50 percent of the investment cost, while the bottom rows assume that it bears 25 percent. Figure assumes that recipient countries would pay for the public sector portion of investments up to the level of their private benefits (avoided emissions times their share in the assumed global cost of carbon of $80/tonne of CO2) while the rest would be shouldered by an EU+G7 funding coalition.

Annex 2: The fiscal cost of funding the coal exit for the G7+EU if EMDEs share the cost up to the level of their private benefits from decarbonisation

	Public sector share = 50 percent		Public sector share = 25 percent	
	2024-2030	2024-2050	2024-2030	2024-2050
	in US$ billions			
India	879.16	1559.53	180.20	98.48
Brazil	44.07	80.32	16.08	25.10
Indonesia	130.06	276.76	60.24	126.17
Mexico	15.17	32.00	5.93	11.45
Turkiye	83.43	173.18	37.59	75.14
South Africa	278.10	564.52	129.80	257.68
Vietnam	77.48	149.70	37.89	72.65
Pakistan	22.53	38.50	10.56	17.52
All EM ex China	2330.5	4494.5	600.0	193.4
All developing	149.7	264.9	51.8	83.5
	in percent of G7+EU GDP			
India	0.21	0.08	0.04	0.00
Brazil	0.01	0.00	0.00	0.00
Indonesia	0.03	0.01	0.01	0.01
Mexico	0.00	0.00	0.00	0.00
Turkiye	0.02	0.01	0.01	0.00
South Africa	0.07	0.03	0.03	0.01
Vietnam	0.02	0.01	0.01	0.00
Pakistan	0.01	0.00	0.00	0.00
All EM ex China	0.55	0.23	0.14	0.01
All developing	0.04	0.01	0.01	0.00
	in percent of 2024 G7+EU GDP			
India	1.53	2.72	0.31	0.17
Brazil	0.08	0.14	0.03	0.04
Indonesia	0.23	0.48	0.10	0.22
Mexico	0.03	0.06	0.01	0.02
Turkiye	0.15	0.30	0.07	0.13
South Africa	0.48	0.98	0.23	0.45
Vietnam	0.13	0.26	0.07	0.13
Pakistan	0.04	0.07	0.02	0.03
All EM ex China	4.1	7.8	1.0	0.3
All developing	0.3	0.5	0.1	0.1

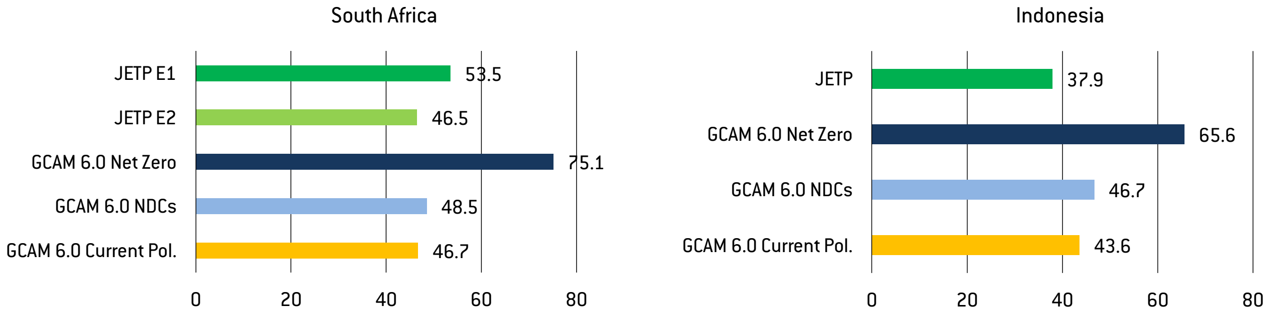
Sources: Bruegel based on Adrian *et al* (2024) and IMF World Economic Outlook (October 2023). Note. Table shows the fiscal cost to the G7+EU of financing coal phase out in the countries indicated in the left column, in $ (top panel), percent of GDP over the investment horizon (middle panel), and percent of 2024 GDP (bottom panel), for an assumed public sector share of 50 percent (left side) or 25 percent (right side). Figures assume that the public sector portion of investments is shared between the G7+EU and the EMDE recipient, with the latter paying up to the level of its private benefit (avoided emissions times share of the assumed world SCC of $80), and the G7+EU funding the rest.

Annex 3: How ambitious are South Africa's and Indonesia's JETPs?

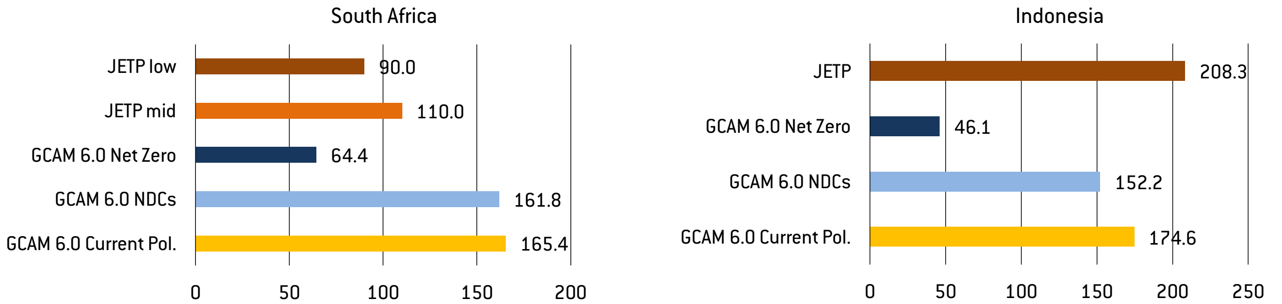
Comparing the ambitiousness of the coal phase-out envisaged in Adrian *et al* (2022) and the JETPs is complicated by the fact that Adrian *et al* (2022) consider a phase-out of all coal production and consumption, whereas the JETPs focus only on the replacement of coal in electricity production (the power sector). It is therefore unclear whether the much larger financing requirements in Adrian *et al* (2022) reflect mainly the broader scope of phase-out considered by Adrian *et al* (2022), or also the fact that the JETPs are not as ambitious as they might need to be to achieve a Paris-consistent coal phase-out in the power sector.

To address this question, we use the fact that the latest NGFS Global Change Assessment Model (GCAM 6.0, see https://data.ece.iiasa.ac.at/ngfs/#/docs) provides updated scenario-based estimates of both wind and solar electricity generation capacity, and electricity production using coal for 32 countries/regions, including Indonesia and South Africa. These can be compared with the actual wind and solar capacity targets as well as coal electricity production targets for 2030 stated in the JETP implementation plans. The figure below shows the results. For South Africa, we show two sets of JETP targets: one associated with an ambitious implementation and the other with less ambitious implementation.

2030 solar and wind electricity generation capacity target (in GW)



2030 Coal-based electricity production target (in TWh)



Source: Bruegel based on NGFS Phase 4 scenario builder, GCAM 6.0 model, and JETP implementation document. Note: in the top row, larger bars mean more ambitious emissions reduction, while in bottom row, shorter bars mean more ambitious emissions reductions. For South Africa, JETP E1 and JETP E2 solar and wind capacity targets correspond to scenario E1, 'large-scale renewable energy investment' and scenario E2, 'moderate renewable energy investment' shown in Table 35, p. 165 and Figure 2, pp. 176-177, of Republic of South Africa (2022). JETP low and JETP moderate coal electricity generation targets correspond to lower NDC range and mid NDC range estimates shown in Figure 19, p. 175 of Republic of South Africa (2022). For Indonesia, JETP solar and wind capacity targets are taken from Table 5.2-5 and the coal-based electricity production target from Table 5.2-4 of JETP Indonesia (2023), p. 45.

The main result is that in both the South African and Indonesian JETPs, 2030 renewables capacity and coal electricity generation phase-out targets fall well short compared to the latest NGFS net zero scenario, in the sense that planned renewables capacity would be smaller, and coal based electricity production larger, than consistent with the NGFS net-zero emissions path. The shortfall is much larger for Indonesia than for South Africa. While South Africa's 2030 JETP solar and wind target is 61-71 percent of the net-zero requirement according to CGAM 6.0, Indonesia's target is 58 percent; and while South Africa's 2030 JETP coal electricity production target exceeds the net-zero-consistent target by 40-70 percent, Indonesia's exceeds its by 350 percent.

The results for Indonesia are surprising in the sense that the JETP coal-production target is higher than what the NGFS GCAM model considers consistent with Indonesia's NDCs. However, the gap with the net zero-consistent estimate (just 46.1 TWh) would remain very large even if one were to substitute the NDC estimate (152.2 TWh) for the JETP target (208.3 TWh).