Climate Compatible Growth

CLIMATE FINANCE FOR **GRID INVESTMENTS** IN **EMERGING** AND **DEVELOPING ECONOMIES**

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IN PARTNERSHIP WITH ITALY

CONTENTS

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- Agence Française de Développement (AFD)
- Asian Development Bank
- Climate Bonds Initiative (CBI)
- European Bank for Reconstruction and Development (EBRD)
- European Investment Bank (EIB)
- Green Climate Fund (GCF)
- International Energy Agency (IEA)
- International Renewable Energy Agency (IRENA)
- Renewable Energy and Energy Efficiency Partnership (REEEP)
- World Bank

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FOREWORD

This report is a collaboration between the Climate Compatible Growth (CCG) programme and a working group of the COP26 Energy Transition Council set up to address financing issues related to investment in green grids under the Green Grid Initiative (GGI).

GCF IS DELIGHTED to support this initiative. As the major global climate fund, we are all too aware of the urgent need for greater investment in climate technologies and infrastructure around the world to increase resilience to climate change and to reduce greenhouse gas emissions. This report argues that access to secure, reliable and affordable low-carbon power is key to both these goals, and shows that grid infrastructure plays an essential role in achieving them.

According to needs, GCF uses a flexible range of financing instruments including concessional financing to increase the flows of climate finance to developing countries from both the public and private sectors. The report shines a light on three key questions facing countries seeking climate finance, and which we as GCF (along with other international finance institutions) have to address when looking to support enabling investments in green grids:

- How do current MDB common principles and private financiers' eligibility criteria for climate finance apply to grids in different parts of the world?
- If there are the gaps, how might climate funds accelerate investment through blending in concessional finance to developing countries?
- How can countries and partners estimate and monitor climate impact from grid investments in order to justify concessional climate funding?

Huge technological advances over recent years mean that renewable electricity from solar and wind is now the cheapest source of power on the planet. At the same time, major sectors of the economy such as transport, industry and households are increasingly turning to electrification as a route to decarbonisation. These trends have greatly improved both the probability of achieving climate goals of net zero emissions, as well as the economics of the low-carbon energy transition, allowing renewable power to be a viable alternative to fossil fuel generation.

As the share of renewables increases in response to these climate and economic imperatives, the next major challenge will be to integrate large volumes of low carbon sources of supply and demand into a reliable and secure electricity system. The intermittent nature of renewables requires future electricity systems to be far more flexible. This means more storage, more responsive demand, and crucially, expanding and strengthening electricity grids at local, national and international scales.

The scale of the challenge (and the opportunity) is illustrated in the International Energy Agency's recent analysis on Clean Energy Transition in Emerging Markets and Developing Economies, which calls for an increase in investment in grid expansion and modernisation from $75bn to $325bn annually by 2030, approximately 34% of the total investment needed for the EMDE's reaching Net Zero in the power sector as a whole. Realising this investment will need accelerated action to match the pace and scale of the energy transition. Whilst grids do not emit

much themselves, they are legitimate targets for climate finance due to their role in facilitating the growth of clean power.

This report takes an important step forward by exploring the contribution of climate finance to grid investments, and suggesting how to fill potential gaps. In countries and regions where power systems are already strongly heading towards renewables, financial institutions have already agreed to count investment in grids towards climate finance targets, enabling an important source of financial flows. However, further derisking and concessionality may be required in order to unlock capital. Also, in large parts of the world, power generation is not yet clean enough for grids to qualify for climate finance under current private sector and MDB rules, risking the creation of a chicken-and-egg problem of lack of investment due to the high carbon nature of the current generation fleet. This report suggests 60-90% of total future investment needs to 2030 may fall into this category.

The report goes on to suggest a way forward to transparently and proactively derisk grid investments. When combined with robust political engagement on energy transition planning, such derisking by climate funds can help identify promising enabling investments in grids and other electricity system infrastructure that will help countries accelerate the pace of their transition.

Monica Gullberg
Green Climate Fund

SUMMARY

Grid investments enable decarbonisation by supporting increased shares of renewables and other forms of low carbon generation in power systems. Significant investments are required at an unprecedented scale and speed to meet the challenge of decarbonising the global power system.

THESE INVESTMENTS are especially crucial in Emerging and Developing Economies (EMDEs) where power systems are being rapidly expanded to meet growing electricity demand, in order to support economic growth and a low carbon transition in other sectors like transport as they electrify. The IEA puts the necessary investment in grid infrastructure in EMDEs at $300 billion per year by 2030, up from around $70 billion today. The bulk of the transition from fossil fuels to renewable power generation in these countries will occur after 2030, but the next decade is essential to set up power systems so they can reliably absorb the large volumes of renewable power needed.

Whilst commercially-financed renewable generation projects have become common (often via power purchase agreements, or PPAs), much of the grid investments in EMDEs tends to be publicly financed due to its ownership structure. International climate finance is an important source of investment to accelerate the low carbon transition, as part of the UNFCCC goal of £100bn per year to support mitigation and adaptation to climate change, including both private and public finance.

To maintain the credibility of these goals, rules for attributing investments to climate finance need to be carefully determined and scrupulously applied. International finance organisations - including multilateral banks and bilateral institutions – have therefore developed well-defined eligibility criteria to assess whether grid projects are climate finance attributable and can therefore be taken forward as actions that support emission mitigation efforts. These include the 'Common Principles' approach developed by development finance institutions (MDBs / IDFC, 2021), and the 'EU Taxonomy' developed by the European Commission (EU Technical Expert Group on Sustainable Finance, 2020a).

The analysis presented in this paper suggests that less than 40% of the grid investment needed in 2030 in EMDEs would be climate finance attributable under current eligibility criteria used by financing organisations.

However, there is a concern that these criteria may be too restrictive to mobilise investment in EMDE grids at the pace and scale required. This is either because they are based on the current grid carbon intensity of countries (which can often be too high for consideration in EMDEs), or because they determine climate finance attribution based on prospective shares of low carbon

SUMMARY

generation in 2030, which can be quite low for countries ramping up renewable investments from a low base. The analysis presented in this paper suggests that less than 40% of the grid investment needed in 2030 in EMDEs would be climate finance attributable under current eligibility criteria used by financing organisations. These criteria are relatively new, and need to be monitored over the next year or so to assess coverage. Some suggestions are made in the paper about how these criteria might be adjusted in the future to increase coverage.

Directly tying the climate finance eligibility of grid investments to the emissions profile of the power generation fleet, whilst fairly simple and transparent, is not necessarily the most accurate way to reflect grids' systemic role in the low carbon transition. The paper suggests alternative forward-looking model-based approaches to estimate emission reduction potential of grid investments. These approaches may be particularly applicable for climate funds such as GCF who can provide important concessional financing to kick start grid investment in countries that might be overlooked due to the challenging investment environment or high system carbon intensity today. These funds typically refer to a wider range of investment criteria, including system-level emission reductions and paradigm shifting potential, that could be assessed using the suggested approaches.

1. Introduction

GRID INFRASTRUCTURE is vital for enabling the generation and supply of electricity, required to improve energy access in Emerging Markets and Developing Economies (EMDE), and meet growing demand. From a climate perspective, it is vital that grid capacity is invested in to both improve and expand grid capacity to enable the supply of low carbon electricity. Flexible and well-interconnected grids are fundamental to this, and will require substantial investment in the coming decade. Not only is this needed to enable deep decarbonisation of the power system but also to provide clean electricity to the wider economy, further displacing fossil fuels.

As this paper outlines, the grid investment needs are massive for meeting global climate goals. International finance will therefore be critical for mobilising the financial resources needed to realise the necessary investments. Bilateral and multilateral finance institutions, and other private sector organisations have recognised the need for increasing investment in grid projects that enable low carbon generation. To that end, they have been developing approaches to ensure that investments made in grids will lead to decarbonisation of the power system, and can therefore be defined as climate finance. These include the 'Common Principles' approach developed by development finance institutions, and the 'EU Taxonomy' developed by the European Commission.

However, there are concerns that such approaches may be too restrictive for the EMDE context. This is because they focus too much on the current carbon intensity of the grid system, which is high in many EMDEs. Or they consider the projected share of low carbon generation, which may be low over the next decade due to ramping up from a low base. With many EMDEs at a nascent stage of their transition to a low carbon grid system, the risk is that grid projects are overlooked, as they fail to meet eligibility criteria that qualifies investments as climate finance attributable.

For other multilateral funds, such as the GCF, whose purpose is the allocation of funds for climate-related projects, the challenge is not about climate finance attribution but about justification of concessional financing for projects. Such organisations need a different type of

Bilateral and multilateral finance institutions, and other private sector organisations have recognised the need for increasing investment in grid projects that enable low carbon generation.

approach to determining grid projects to finance, based on a broader set of criteria that helps assess effectiveness of any financing, and prioritisation of projects.

In this paper, we first set out the investment needed in grid infrastructure to enable the clean expansion of power systems, and contribute to broader decarbonisation goals. In section 3, we then review existing approaches developed by financial institutions, and used to assess whether investments in grid infrastructure can be considered as climate finance, with a focus on the EU Taxonomy and Common Principles approach.

We then, in section 4, assess the extent to which these approaches are likely to mobilise financing for grid projects across EMDEs, based on their climate finance eligibility rules. This is done by identifying carbon intensity of different national grids, recent capacity additions, and projected low carbon generation shares across different regions of the world, and assessing likely climate finance attribution. Finally in section 5, having established what the current guidance is and the possible 'gaps' in enabling climate financing for projects, we propose possible options for increasing climate finance attribution in existing approaches. We also propose an alternative forward-looking model-based approach for those institutions providing concessional financing, who need to justify projects based on criteria such as country need, emission reduction potential, and other development goals.

2. Grid investment needs

THE CURRENT INVESTMENT level in grid infrastructure is dominated by three regions – USA, Europe and China (Figure 1). In aggregate, this is around $300 billion per year, with about two-thirds on distribution systems and the remainder on transmission. This dipped in 2019-2020 due to the COVID-19 pandemic but is expected to almost recover to pre-2019 levels in 2021. In the context of global efforts needed to meet climate targets, these investment levels will need to rapidly scale. Under the IEA's Net-Zero climate policy scenario (NZE), the projected investment needs increase by 167%, to just under 800 billion in the period 2026-30 (IEA, 2021a), and remain at this higher level out to 2050 (IEA, 2021c). This increase in the level of investment reflects the scaling of power systems to supply low carbon electricity.

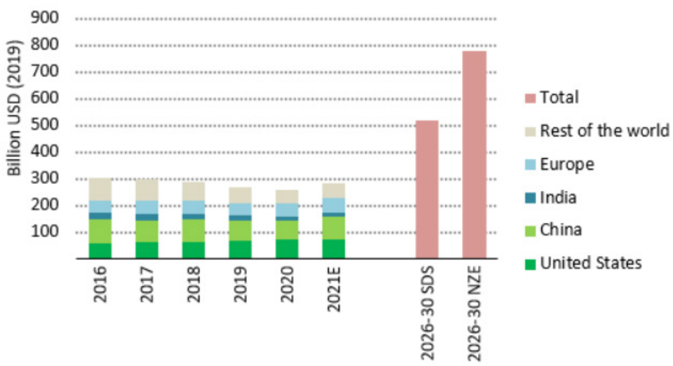


Figure 1. Investment in grids by geography and segment, 2016-21E, and projected needs, 2026-30. *Note that 2021 is an estimated value. Source: IEA (2021a); based on Figs. 1.7 & 1.9*

Of the current investment in grid infrastructure (2016-20 average), 25% (or $72 billion) is in EMDEs (Figure 2, right hand panel). The investment needs under the NZE scenario increase by 317%, to an average of $300 billion for the period 2026-30, with 28% on transmission and the remainder on distribution. This level of scaling is much higher compared to the overall global increase, and as a result, the share of investment to EMDE increases to just under 40%, up from 25% today.

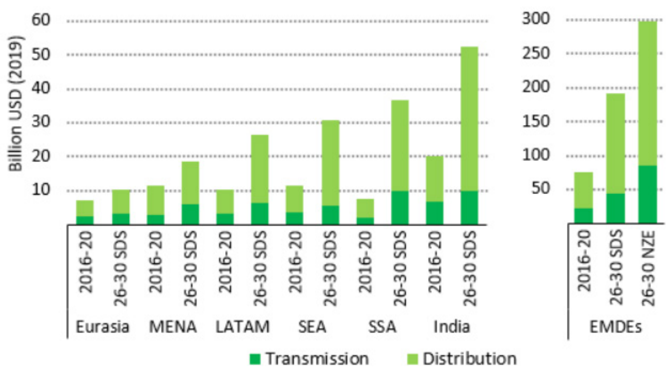


Figure 2. Annual average EMDE investment in power grids in IEA climate-driven scenarios. *Note that 2021 is an estimated value. Source: IEA (2021b); based on Fig. 3.12. Eurasia includes Caspian region countries and Russia; MENA is Middle East and North Africa; LATAM is Latin America; SEA is South East Asia; and SSA is Sub-Saharan Africa.*

In terms of who will provide the necessary investment under the IEA scenarios, it is evident that the majority will continue to be public funding, but with an increasing role for private finance institutions, particularly for electricity distribution projects (Figure 3, left hand panel). The high share of public funding for such investments reflects predominantly public ownership via state owned enterprises (SOEs). However, it is estimated that private funding institutions will play a stronger role, through loans to SOEs but in direct investment to help drive more private capital across different investments (IEA, 2021b). Country examples of involving private sector investment can be found in IEA, 2021b (from p126). It is also important to note that public funding from multilateral funding institutions, such as GCF, through concessional finance can help drive increased private sector investment.

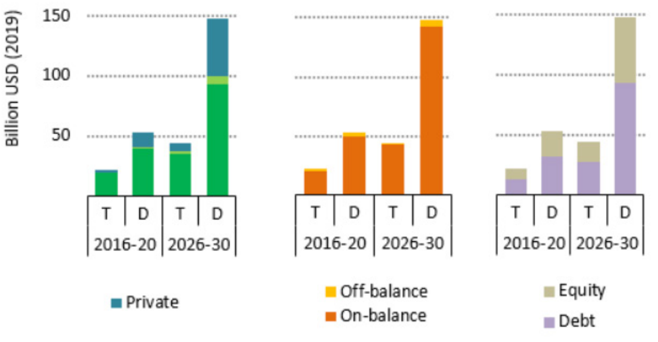


Figure 3. Sources of finance for EMDE investment in power grids in the SDS scenario. *Source: IEA, 2021b*

The level of investment under the IEA climate scenarios puts into context the $100 billion per year pledge by developed countries for provision of climate financing. This has currently reached $80 billion as of 2018, with 34% going into the energy sector, or $27 billion (OECD 2020). 58% of this went on generation projects, predominantly renewables, with the remainder across a range of other energy-related investments. In terms of total climate finance across all countries, Climate Policy Initiative (CPI) estimates this at over $600 billion in 2018. Of this, around $3 billion went towards transmission and distribution (CPI, 2020).

Climate finance for grid investments is predominantly provided either as a debt instrument (such as project debt) or as a grant (see Figure 4 below). Between 2015 and 2019, debt instruments represent an average of 88% of climate finance for grid investments, with grants making up the rest. The largest bilateral providers of climate finance (with annual flows in brackets) include countries such as Germany ($680 million), Japan ($554 million) and France ($245 million). For Multilateral Development Banks (MDBs), the largest institutional contributions came from the World Bank ($577 million), Asian Development Bank ($442 million) and the European Bank of Reconstruction and Development ($290 million). Asia (including Far East Asia) and Africa (including both North and South of Sahara) are the largest recipient regions with annual averages of $1105 million and $987 million, respectively.

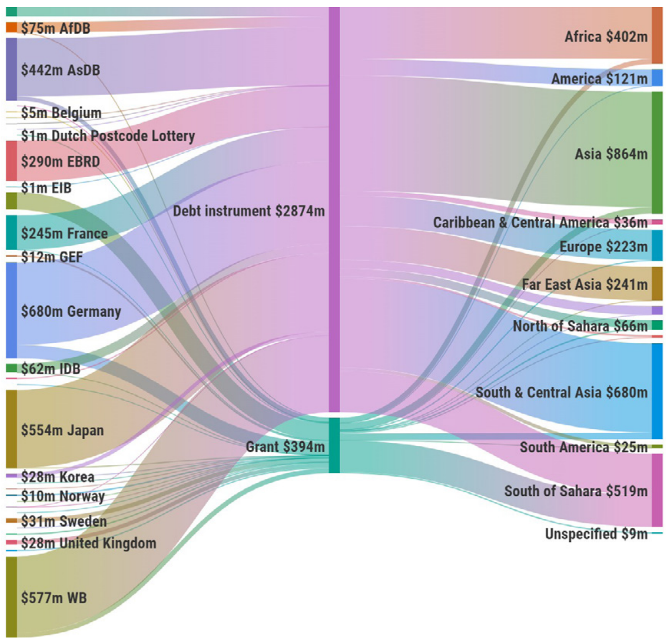
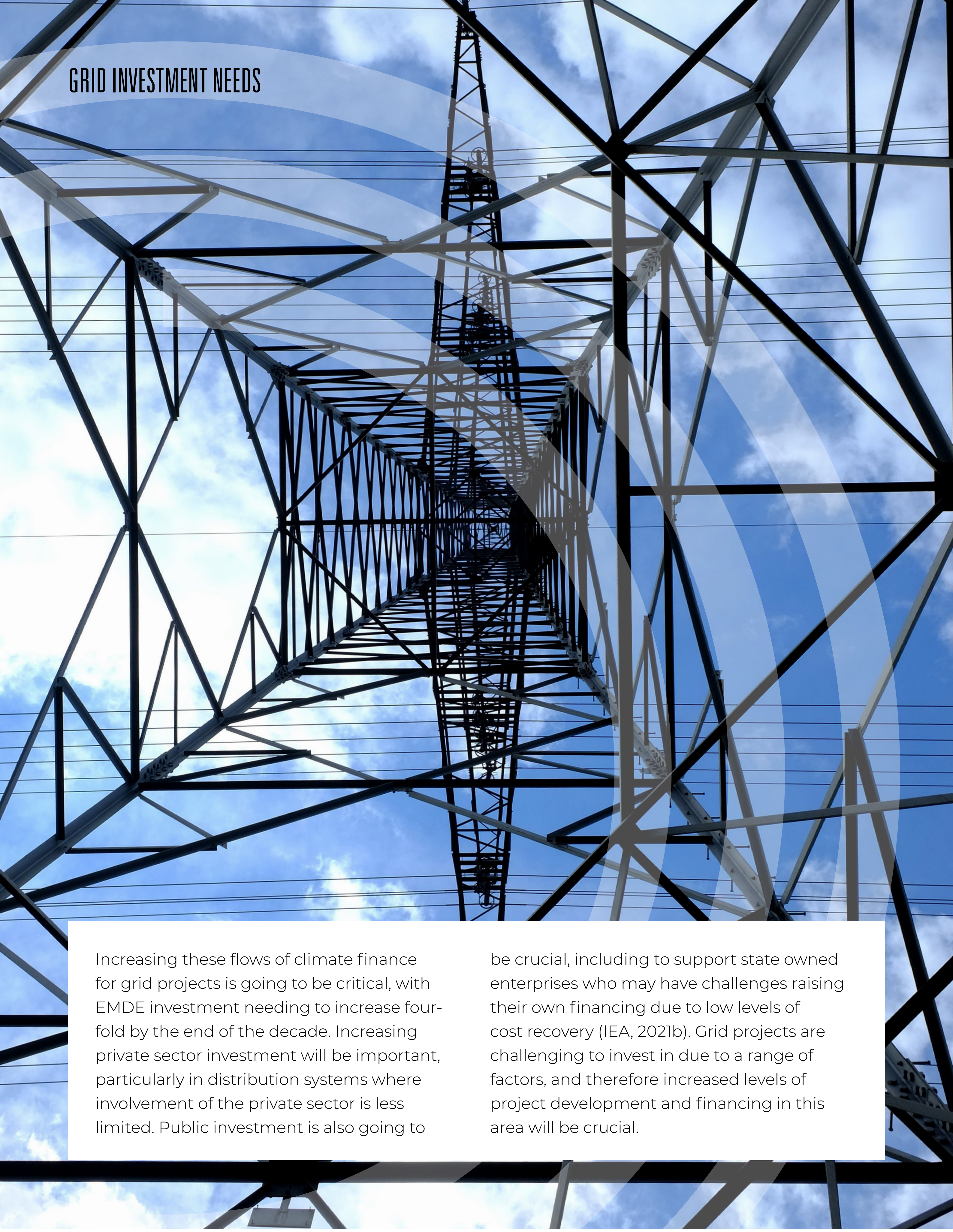


Figure 4. Annual average climate finance flows for grid investments (2015-2019) by donor, financial instrument, and recipient region. *(Based on data from Climate Change: OECD DAC External Development Finance Statistics)*



GRID INVESTMENT NEEDS

Increasing these flows of climate finance for grid projects is going to be critical, with EMDE investment needing to increase four-fold by the end of the decade. Increasing private sector investment will be important, particularly in distribution systems where involvement of the private sector is less limited. Public investment is also going to be crucial, including to support state owned enterprises who may have challenges raising their own financing due to low levels of cost recovery (IEA, 2021b). Grid projects are challenging to invest in due to a range of factors, and therefore increased levels of project development and financing in this area will be crucial.

3.

Current guidance on climate finance attribution for grid projects

OVER THE LAST few years, there has been some serious consideration of how funding of grid projects can be counted as climate finance. Two main approaches have emerged, the first being the EU Taxonomy, developed by the European Commission, and the second developed by a grouping of MDBs, and now adopted by the International Development Finance Club (IDFC), known as the Common Principles.

EU TAXONOMY

The EU Taxonomy is a framework developed to help project developers and investors 'navigate the transition to a low-carbon, resilient and resource-efficient economy' (EU Technical Expert Group on Sustainable Finance, 2020a). It sets thresholds known as technical screening criteria that help guide what investments constitute green finance. While the taxonomy has wide application across most sectors, there is specific guidance for grid investments. The principles for the technical screening criteria for electricity transmission and distribution (EU Technical Expert Group on Sustainable Finance, 2020b) include to -

- Support the integration of renewable energy into the power grid
- Support the transition from carbon-intensive energy supply, via electrification and parallel development of low carbon power generation capacity
- Support grid management technology used for integrating low carbon emission generation and demand side energy savings
- Decrease direct emissions from transmission and distribution (T&D) infrastructure

The criteria state that 'all electricity transmission and distribution infrastructure or equipment in Systems which are on a trajectory to full decarbonisation are eligible except infrastructure that is dedicated to creating a direct connection, or expanding an existing direct connection, between a power production plant that is more CO_2 intensive than 100 gCO_2e/kWh, measured on a LCE (Life cycle engineering) basis, and a substation or network.'

The term 'full decarbonisation' is defined as either a system where more than 67% of newly connected generation capacity is below the generation threshold value of 100 gCO_2e/kWh measured on a PCF (Product Carbon Footprint) basis, over a rolling five-year period or where the average grid emissions factor is below the threshold value of 100 gCO_2e/kWh measured on a PCF basis, over a rolling five-year average period.

The Taxonomy also lists a range of grid-related activities that are eligible irrespective of 'full decarbonisation' (see Box 1 on the following page).

BOX 1. T&D activities eligible irrespective of 'full decarbonisation' requirements under the EU Taxonomy

- Direct connection, or expansion of existing direct connection, of low carbon electricity generation below the threshold of 100 gCO_2e/kWh declining to 0 gCO_2e/kWh in 2050, measured on a PCF (Product Carbon Footprint) basis, to a substation or network.
- EV charging stations and supporting electric infrastructure for the electrification of transport, subject to taxonomy eligibility under the transport section.
- Installation of T&D transformers that comply with the Tier 2 (2021) requirements from Regulation 548/2014 on the eco-design of small, medium and large power transformers and, for medium power transformers with highest voltage for equipment not exceeding 36 kV, with AAA0 level requirements on no-load losses set out in standard EN 50588-1.
- Equipment and infrastructure where the main objective is an increase of the generation or use of renewable electricity generation
- Equipment to increase the controllability and observability of the electricity system and enable the development and integration of renewable energy sources, this includes:
- Sensors and measurement tools (including meteorological sensors for forecasting renewable production)
- Communication and control (including advanced software and control rooms, automation of substations or feeders, and voltage control capabilities to adapt to more decentralised renewable infeed)
- Equipment to carry information to users for remotely acting on consumption
- Equipment to allow for exchange of renewable electricity between users
- Interconnectors between transmission systems are eligible, provided that one of the systems is eligible.

CLIMATE BONDS INITIATIVE - ELECTRICAL GRIDS AND STORAGE CRITERIA

The Climate Bonds Initiative (CBI) have developed criteria that must be met for grid related assets and projects to be awarded Climate Bonds Certification (CBI, 2021). The approach essentially adopts the criteria used in the EU Taxonomy. This includes the use of a rolling five-year average period that estimates grid carbon intensity and the carbon intensity of newly connected generation capacity (as described under the EU Taxonomy).

The approach does not consider a forward-looking element, for example including planned low carbon generation projects in the five-year rolling average. If included, this would be problematic for certification, with a principle in place of needing evidence of action, not pledges or promises. Specific problems of a forward-looking element for bond certification would include i) sufficiency of data on which to based forward looking period (which plan / scenario?), and ii) whether projects come to fruition (developers making multiple bids). The criteria of 67% of added capacity from the last five years is used because the data is clear, easy to obtain and verify, and generally not contestable.

COMMON PRINCIPLES FOR CLIMATE MITIGATION FINANCE TRACKING

The MDBs and IDFC have jointly developed a 'set of definitions and guidelines and a list of eligible activities that allow for consistent accounting and reporting of financial flows identified as climate change mitigation finance' (MDBs / IDFC, 2021). These are known as the Common Principles, and have been developed over the last 12 months or so.

This differs significantly from the EU Taxonomy, using a strong forward looking based approach that does not use binary criteria for financing, and relies on ex ante assessment of future proposals. It gives partial credit to grids with a significant and credible forward-looking share of renewable generation. This means a stronger requirement to assess credibility of plans for generation development. Key criteria for greenfield investments include:

- A transmission or distribution project dedicated to the evacuation of only very low carbon (VLC) electricity shall be fully eligible, except for dedicated evacuation of new nuclear power generation.
- If the activity involves an interconnection between electricity systems, the entity applying the Common Principles shall demonstrate that the investment will not significantly increase GHG emissions over the short or medium term.
- The increasing share of non-nuclear VLC electricity shall be reflected in the most recent power system development plan covering a planning horizon of up to 10 years and the financing shall be apportioned using the projected share of VLC electricity in the electricity being transported in the entire electricity system in which the activity will be undertaken at the end of the planning horizon [after 10 years].
- A decarbonisation plan can be used instead of a power system development plan. The criteria state that if the system planning horizon does not extend to 10 years but there is an officially recognised decarbonisation plan for the electricity system that extends up to 10 years, and the decarbonisation plan is consistent with the power system development plan, then the financing can be apportioned using the projected share of VLC electricity in the electricity system at the end of 10 years in the decarbonisation plan.

For investment in a grid project today, what is counted as climate finance is based on the share of VLC electricity on the system in the vicinity of 2030. For example, if renewable generation additions from today (2021) to 2031 are estimated to increase the share of very low carbon electricity dispatched to the grid to 30%, then 30% of the grid investment today will be counted as climate finance. This share does not increase even if all of the capacity additions to the system between now and 2031 are very low carbon, unless some portions of the new investment are dedicated to evacuation of electricity from new renewable energy generation plants. It is also important to note that under this approach, an increase in total renewable generation on its own would not allow for a project to be considered for climate finance accreditation unless it increased the overall share of low carbon electricity dispatched to the grid.

'Very low carbon electricity' includes renewable energy with low lifecycle GHG emissions, fossil fuel generation with carbon capture and storage or utilisation, or nuclear power. On interconnection of systems, the 'weighted average share of VLC electricity is used for apportioning the financing'. For mini- or micro-grids, the criteria listed in the first bullet point above applies. Finally, on storage, financing is apportioned according to the share of stored energy that is very low carbon.

For eligible brownfield projects, including those that modify existing facilities, equipment, appliances, systems or processes, need to 'demonstrate a substantial improvement in energy efficiency or a substantial reduction in net GHG emissions' through supply chain improvements, reductions in overall consumption e.g. reducing T&D technical losses, or implement 'measures to improve network stability to increase consumption of VLC electricity'.

Other institutions providing financing for grid projects have built on the Common Principles but with some adjustments. This includes accrediting projects as climate finance eligible not only on the basis of the resulting VLC share of the grid at the end of the power development plan planning horizon, but also based on VLC capacity additions resulting from the grid project. Such an approach allows for the prioritization of investments that maximize carbon reductions in the short-term instead of investments that might accelerate investments in fossil fuels power plants (even though overall the mix is on a decarbonization pathway). This is the approach, for example, that the Agence Française de Développement (AFD) has taken forward. Their criteria take into account the share of generation added that is renewable resulting from the investment, with the share of climate finance based on a 50% weighting applied to the percentage of renewable electricity on the grid in 10 years and 50% weighting on the renewable generation that is added on the short-term (5 years time maximum) as a result of the investment. For a project dedicated to access to electricity in a country, this can get 100% climate finance attribution where the projected share of renewable electricity is greater than 50% in 10 years time.

For brownfield investments under the AFD approach, substantial improvement in energy efficiency or a substantial reduction in net GHG emissions should mean 100% eligibility as climate finance (as per the Common Principles). Where the share of renewables in 10 years is projected to be less than the share of renewables at the time of investment decision, the eligibility is set at 90%. In other words, this is a 10% penalty for projects in those countries that are not committed to a decarbonisation pathway, and a recognition that such investments will not contribute significantly to a decrease in emissions in the longer term.

Box 2 provides an example of a project case study that both the EU Taxonomy and Common Principles is applied to, to help further illustrate the approaches and their differences.

BOX 2. Case study description - A greenfield high voltage transmission line is proposed in a given country

Following on from the description of the EU taxonomy and the Common Principles, here we provide an illustrative case study to further demonstrate how the criteria would be applied to specific projects.

Details of the system and specific project investment include -

- The current carbon intensity of the grid is over 400gCO_2e/kWh.
- Recent capacity additions in the last 5 years are, however, below 100gCO_2e/kWh, being predominantly renewables.
- The share of renewable generation in the grid system is 25%, but is projected to rise to 45% in 2031 based on the national power sector masterplan, largely enabled by new transmission line capacity.
- It is estimated that the new transmission line capacity, once commissioned, will allow for the evacuation of around 900 MW of new wind energy capacity additions. No new thermal plants are in the masterplan.

Under the EU Taxonomy, the above project is deemed to be 100% climate finance eligible because while the carbon intensity of the grid is well above the 100gCO_2e/kWh, the average carbon intensity of capacity additions over the last five years is below this threshold. However, this criterion is very sensitive. If recent capacity additions included any fossil generation, it is likely that the average carbon intensity would exceed the threshold, and climate finance eligibility would drop to zero.

Under the Common Principles, the criteria focuses on the projected share in 10 years time, suggesting that 45% of the investment could be considered as climate finance. (Note that if this was a dedicated transmission line connecting a specific renewable generation project to the grid, it would be 100% eligible). Under the AFD approach, equal weighting is given to the renewable share of evacuated generation renewable the RE share in the system in 10 years time, resulting in 72.5% climate finance for the project. This reflects that all capacity additions are very low carbon.

Under Common Principles, what is counted as climate finance for a grid project is based on the share of low carbon electricity on the system in the future. For example, if generation additions over the next 10 years increase the low carbon electricity share to 30%, then 30% of the grid investment today will be counted as climate finance.

4.

Assessing the regional coverage of climate finance attribution approaches

TAKING THE EXISTING approaches set out in the previous section, this section of the paper assesses the extent to which grid project investments in different parts of the world would be eligible for climate finance. If existing approaches result in relatively low levels of climate finance attribution in EMDEs, this could hamper efforts to mobilise the level of financial resource set out in section 2. Under the EU Taxonomy approach, we find that very few regions of the world have grid carbon intensities low enough to meet eligibility criteria. It is important to note that this approach was set up to assist with the decarbonisation of the EU economy, and therefore a limited reach in other regions is not entirely surprising. Under the Common Principles approach, we find that for many countries, climate finance attribution remains low based on the criteria used in this approach.

It is important to note we use proxy indicators in our analysis, thereby simplifying the approaches and their implementation. However, we believe the analysis does provide useful estimates of the geographic differences in climate finance eligibility.

CARBON INTENSITY - EU TAXONOMY APPROACH

The EU Taxonomy approach uses two criteria to assess whether a grid system is on a trajectory to 'full decarbonisation', and therefore whether project investment can be attributed as climate finance. We first consider the criterion of current grid carbon intensity (CI), which needs to be less than 100 gCO_2/kWh based on a rolling 5 year average (the other part of the criteria relates to CI of recent capacity additions). Based on this, we map the extent to which grid systems today are under this threshold, using estimates of total generation. In Figure 5, we aggregate countries into CI intervals based on their 2018 values. It demonstrates the substantial spread in CI across the world, with parts of Latin America and Sub-Saharan Africa having grids that emit 100 gCO_2/kWh or less while some countries in Central Asia produce 900 gCO_2/kWh or more in systems predominantly based on coal generation.

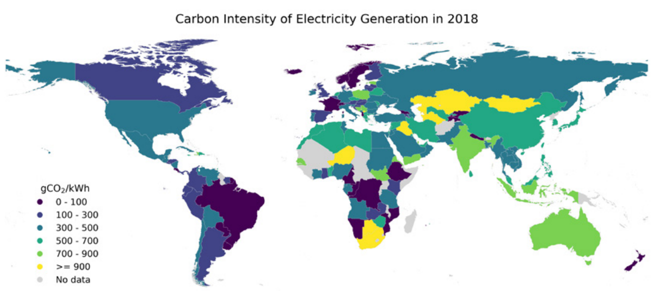


Figure 5. Carbon intensity of electricity generation by country in 2018, aggregated into intervals. *The EU Taxonomy criteria differs from the metric used above, using CI on a Product Carbon Footprint (PCF) basis, and considering all GHGs, based on the use of CO_2e. (Source data: electricity and emissions data for main producer electricity and CHP plants from IEA (2020b) and IEA (2020c), respectively)*

Figure 6 then takes these data and identifies which countries are compatible with different CI thresholds, based on a 5 year rolling average (2014-2018) as stipulated by the EU Taxonomy. Of particular relevance is the upper panel which highlights that just 4% of global generation has CI ≤ 100 gCO_2/kWh and therefore meets the Taxonomy's CI criteria. Furthermore, based on the rolling average, countries such as Brazil and Zambia are no longer compatible, based on systems becoming more carbon-intensive. The bottom panel of this figure shows the cumulative distribution of CI against global generation share. As noted earlier, only 4% of global generation falls below the 100 gCO_2/kWh. This only increases to 11% and 18% under the thresholds of 200 and 400 gCO_2/kWh respectively. Less than half of global generation is from grid systems with average carbon intensities of 500 gCO_2/kWh or less.

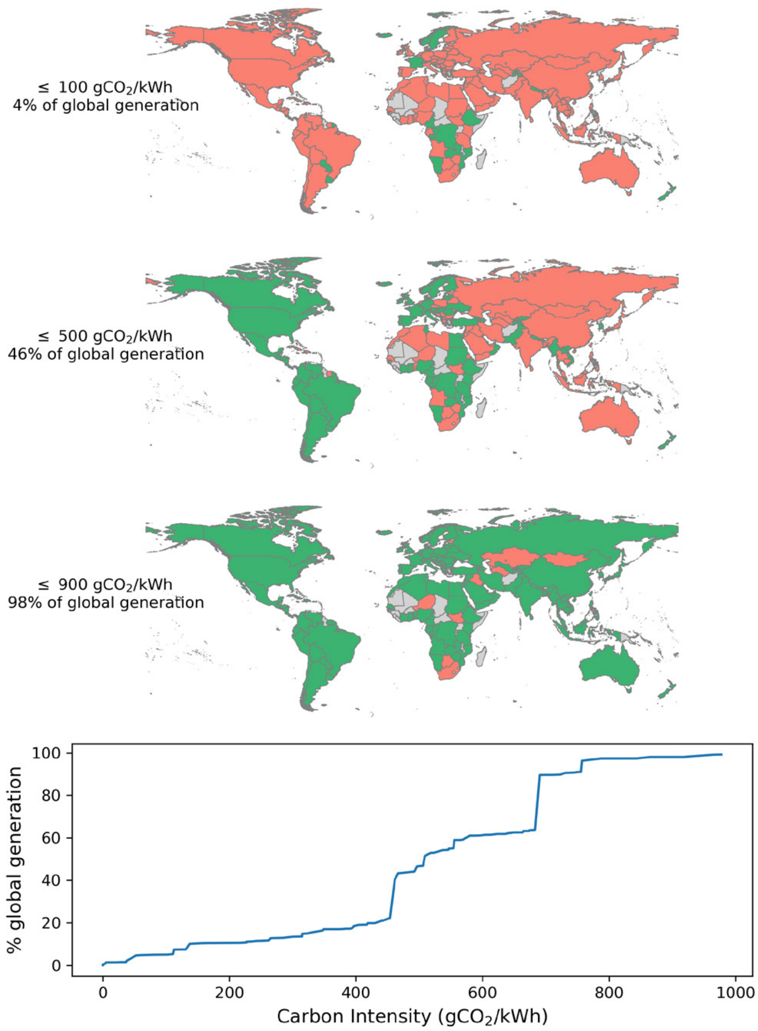


Figure 6. Thresholds of carbon intensity of electricity generation by country based on 5 year rolling average (2014-2018). *Countries shaded green are those below the stated threshold. The bottom panel shows the cumulative distribution of carbon intensity as a function of the share of global generation. (Source data: electricity and emissions data for main producer electricity and CHP plants from IEA (2020b) and IEA (2020c), respectively)*

Having established the level of generation meeting the threshold grid intensity, we next consider what this means for mobilising finance in different EMDE regions. We do this by applying the share of regional generation meeting the threshold to the required investment need in that region. Figure 7 shows the amount of investment needed under the IEA's Net-Zero scenario for EMDE countries (orange bars), and what could be attributed as climate finance. This analysis suggests low levels for climate finance eligibility, resulting in less than 10% of EMDE investment needs being realised (see blue 'Total' bar). While a simplified approach, based on only one part of the EU Taxonomy criteria, it usefully illustrates the gap that might emerge if using this approach alone.

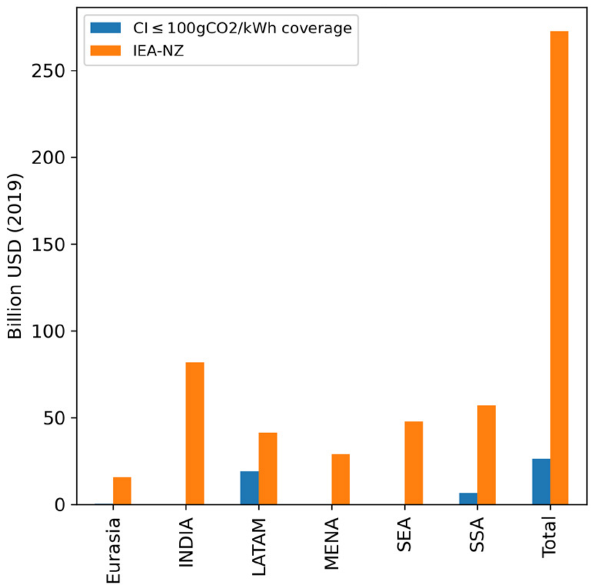


Figure 7. **Average annual grid investment needs for EMDE regions in the period 2026-30 under the IEA's Net-Zero scenario (orange), and the investment attributed as climate finance under the EU taxonomy grid carbon intensity criteria (blue).** *These estimates are a partial analysis, and do not include the criteria also takes into account the share of capacity additions that are below the 100 gCO$_2$ intensity threshold. This analysis also does not take into consideration investments made based on other criteria under this approach, as listed in Box 1 (Source: Authors' own calculations)*

The above analysis only includes one criterion from the EU Taxonomy approach. It is likely that regions would likely see higher estimates of eligibility based on the second criterion under the EU Taxonomy, which is determined based on the share of generation capacity additions (based on a 5 year rolling average) below the 100 gCO$_2$ intensity threshold being 67% or higher. Lack of data has limited our assessment of how this criterion would impact the estimates in Figure 7. However, some analysis has been undertaken to consider this criterion, by assessing the share of renewables of new generation capacity added between 2010-2019 (Figure 8). It is a simplified analysis that does not account for plant retirement, meaning the shares plotted below are likely underestimates. In addition, shares would also likely be higher if the time series for analysis started in 2015, as renewables have become substantially more cost-competitive compared to 2010. However, it highlights that this second criterion would have limited impact in increasing eligibility. Only Latin America (CSAM) exceeds the 67% threshold of new capacity additions below 100 gCO$_2$/kWh.

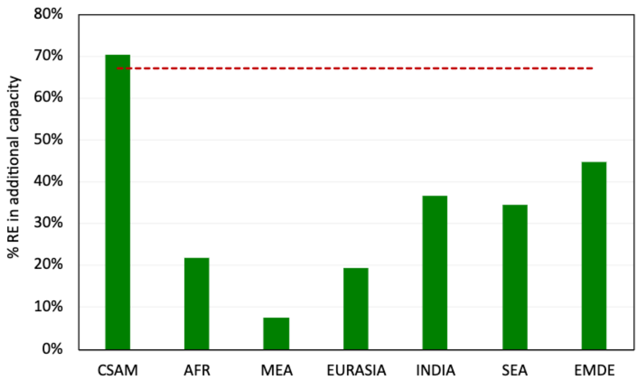


Figure 8. **Renewable generation as a share of the capacity added to regional energy systems for the period 2010-19.** *The red dashed line shows the eligibility threshold, which only the Central and South America region exceeds. These data likely underestimate renewable capacity additions as retirement of existing fossil generation plants is not accounted for (Source: Authors' own calculations, based on IEA (2020a)). Note that the region definitions used here from the WEO differ from those used in the WEI EMDE analysis (2021b).*

PROJECTED LOW CARBON GENERATION – COMMON PRINCIPLES APPROACH

While the EU Taxonomy focuses on carbon intensity of the grid system today and of recent capacity additions, the Common Principles apply an assessment of future very low carbon (VLC) generation deployment to consider climate finance attribution to project financing. Here we use data that comprises VLC generation shares for today (2017) and 2030 to assess how EMDE countries align with the relevant criteria from the Common Principles. The values for today are derived from IEA data while the 2030 projections are based on the Planned Energy Scenario from the REmap Global Renewables Outlook 2020 (IRENA, 2020). In this instance, we use renewable generation as a proxy for the broader VLC category, which seems reasonable given that renewables are likely to account for most VLC in coming years. We also use regional estimates for projecting planned renewable shares forward, given the absence of country specific estimates.

From Figure 9, it can be seen that this criterion would offer high fractions of climate finance for projects across sizable portions of Latin America and Sub-Saharan Africa. However, the bottom panel of this figure demonstrates that this high level of financing only covers a relatively small fraction of the total EMDE generation in 2017. This is because large countries such as India and China would only have 40% and 47% climate finance attribution while accounting for 10% and 50% of total generation respectively.

The climate finance attribution shares in Figure 9 have been applied to the investment needs from the IEA's Net-Zero analysis (IEA, 2021a) to highlight the levels that could be attributed as climate finance under the Common Principles. Figure 10 highlights that for most regions the % shares are lower than 50%, mainly falling in the range of 15-41%; the exception is Latin America at 64%. The overall share of investment that is determined climate finance attributable is less than 40%.

It is important to note that this analysis does not differentiate between green and brownfield investment, as such information is not available in the investment needs assessment by the IEA (2021b). This is important as the approach for brownfield investment, as described earlier, uses different criteria to those used here for greenfield investments. Nevertheless, it still usefully highlights the broad coverage of this specific approach in relation to climate finance attribution.

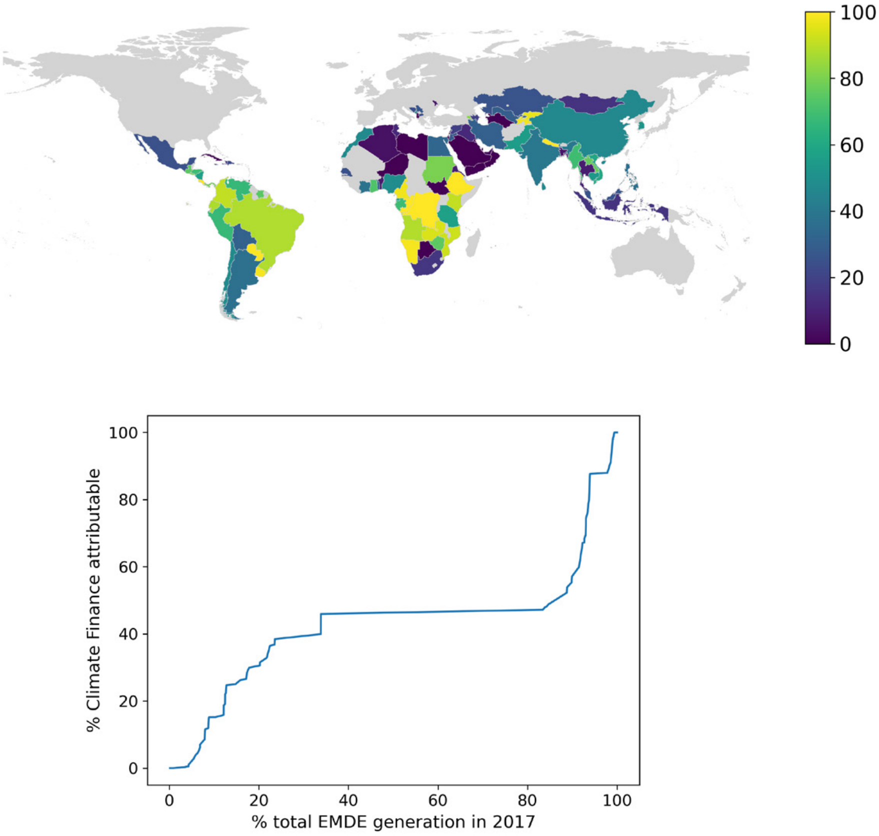


Figure 9. Climate finance attribution for EMDE countries based on the Joint MDB methodology and 2030 renewable share which we use as a proxy for very low carbon generation. The bottom panel shows the cumulative distribution of climate financing as a function of the share of total EMDE generation. *(Source data: IEA (2020b), IEA (2020c) and IRENA (2020))*

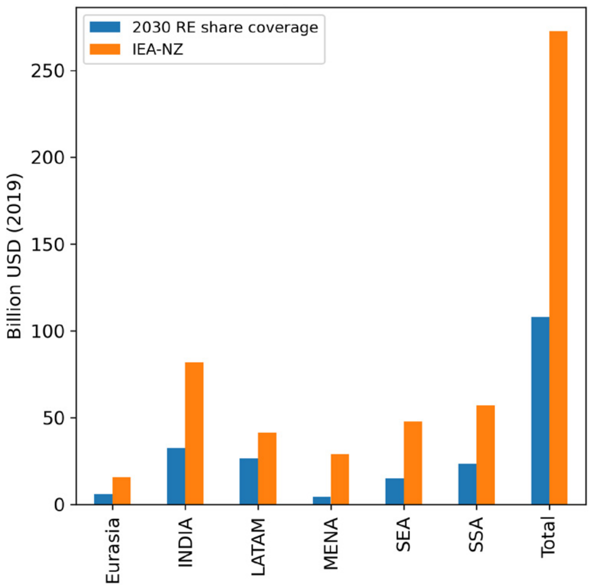


Figure 10. Average annual grid investment needs for EMDE regions in the period 2026-30 under the IEA's Net-Zero scenario (orange), and the investment attributed as climate finance under the Joint MDB approach (blue).

(Source: Authors' own calculations)

In summary, this analysis highlights that for many EMDEs, the existing approaches provide low levels of climate finance attribution, which could limit the necessary investment over the next decade - and result in a financing gap. The problem is that the approaches will not direct finance towards those countries that most need it to strengthen their grid systems and make them fit for higher shares of variable renewables. Rather it could steer climate finance towards countries with lower carbon intensities who may already be in a better position for expanding low carbon generation. Development finance institutions should therefore consider revisiting or adjusting their approach in the future to increase coverage, as we discuss in the next section. Given that these approaches, particularly the Common Principles, has only just been established, monitoring the effectiveness of this approach over the next 1-2 years will be important.

5. Addressing the climate finance gap for grids

WHILE VARIOUS APPROACHES have been established for attributing project funding as climate finance (section 3), the resulting coverage of grid systems appears limited due to the criteria used (section 4). There is therefore a concern that such approaches may not be able to mobilise the necessary investments given the scale of the challenge. In this section of the paper, two specific issues are considered for increasing climate financing for grid investments.

Firstly, we consider how existing forward-looking approaches such as the Common Principles can be further developed to increase future funding of grid projects. While it is a key objective of development finance institutions to ensure that grid investments will actually enable system decarbonisation, there may be opportunities for adjusting criteria to increase eligible projects.

Secondly, organisations providing concessional financing specifically for climate projects will be key to helping mobilise investment for grid projects. However, established approaches such as the Common Principles are not transferable, as organisations like the Green Climate Fund (GCF) do not consider climate finance attribution but rather other criteria that guides prioritisation of financing. This includes the impact on emission reductions, country-based needs, and the climate resilience of infrastructure. This highlights the different purposes of institutions, from those who only focus on climate-focused projects and provide concessional financing, to those who are more market-focused and make investments that require a financial return. Given the need for alternative approaches, this section makes proposals for such organisations.

REFLECTING ON EXISTING APPROACHES TO ASSESSING CLIMATE FINANCE ATTRIBUTION

For EMDE countries, our analysis in section 4 suggests that existing approaches may constrain financial institutions from selecting grid projects that are needed, either because of criteria that screens projects out due to high carbon intensity of existing generation (EU Taxonomy) or suggests low levels of climate finance attribution based on future shares of low carbon electricity dispatched (Common Principles).

As these relatively new approaches are rolled out, it will be important to monitor whether they are unlocking the required investment in EMDEs or not. If they are not, there could be scope for revisiting the approaches in due course. In particular, this means a greater focus to explicitly assess the enabling role that grid investments can play in accelerating this shift to renewables. The Common Principles already move in this direction by including an assessment of expected future levels of renewables, but could be adjusted to better reflect the enabling role of grids.

There are two areas of the Common Principles that could be considered further that may enable an increased coverage of climate finance attribution for grids. Firstly, when considering greenfield projects, current criteria could be broadened to give more credit to the share of generation additions that are enabled by the grid investment. This could be similar to the AFD approach described in Section 3, which provides equal weighting to both the share of VLC generation of new generation enabled by the project in the short-term, and the resulting low carbon share on the system as a whole in the medium term.

In some cases where climate finance attribution is unclear, a more detailed project appraisal might be needed which could use modelling to better understand how increased capacity on the grid system would enable the addition of VLC generation on to the grid.

For example, a 50 TWh system generation today generates 20% VLC. Additional generation of 5 TWh over the next 5 years, of which 90% is VLC, is enabled by a large investment in grid capacity. This would increase the VLC share of the system to 26%, and be the climate finance attribution number.[1] However, if equal weighting was given to the VLC share of generation additions, this would increase the climate finance attribution estimate to 58%.[2] Such an approach allows for finance institutions to differentiate between grid investments that maximize carbon reductions and those that might increase investments in fossil fuels power plants, and should not receive climate finance attribution.

Secondly, an expanded interpretation might be considered for what types of grid project are considered as being 'dedicated' to increasing renewables. The Common Principles state that - 'A transmission or distribution project dedicated to the evacuation of only VLC electricity shall be fully eligible, except for dedicated evacuation of new nuclear power generation.' A simple interpretation of this is a 'dedicated' line that physically connects only VLC generation (not including nuclear) to the grid system. However, a more nuanced definition of 'dedicated' would allow this rule to be applied more broadly to include for example grid projects that primarily enable VLC evacuation through increased grid capacity, even if they do not physically connect specific greenfield VLC projects to the grid. Further discussion is needed by organisations applying the Common Principles, but relaxing the definition of 'dedicated' could be a relatively simple way to allow for a wider range of enabling grids projects to benefit from higher levels of climate finance attribution. Different terminology could also be considered, moving away from 'project dedicated' to 'infrastructure needed', for instance.

If the Common Principles were to reconsider these definitions, there is of course the challenge of determining the climate impacts of additional grid capacity, in order to assess eligibility from

[1] 26% is calculated as follows: [{(0.9 VLC share of additions * 5TWh) + (0.2 VLC share of existing grid * 50TWh)} /55]
[2] 58% is estimated based on the following: [(0.5 * 90% VLC share of additions) + (0.5 * 26.4% VLC share of future grid system)]

the point of view of effectiveness and impact related to other potential investments. Further work is needed to determine whether commonly applied eligibility criteria could be developed to target renewable-enabling grid investment. In some cases where climate finance attribution is unclear, a more detailed project appraisal might be needed which could use modelling to better understand how increased capacity on the grid system would enable the addition of VLC generation on to the grid. This could be particularly relevant for climate funds whose eligibility criteria go beyond climate finance attribution and require climate mitigation and adaptation impacts of proposed grids projects to be estimated. These approaches are described in the following section.

APPROACHES TO CAPTURE WIDER APPRAISAL CRITERIA RELEVANT TO CLIMATE FUNDS

For organisations such as climate funds who are dedicated to disbursing concessional finance for climate mitigation and adaptation projects in EMDEs, analysis often needs to go beyond simply assessing climate finance attribution. For example, the GCF has a broader range of criteria on which to appraise projects that includes the project impact on emission reductions, whether the project will lead to 'paradigm shift' (e.g. full system decarbonisation), help achieve other sustainable development goals, is demand-led by the country receiving the funding, and prioritises projects that are most effective (see Box 3).

This range of criteria calls for a strong forward-looking approach to give an ex ante assessment of prospective grid projects. In order to make transparent the underlying assumptions and analyses for such an assessment, it will be helpful to understand what factors influence the assessment and in what way. As such it is useful to present a method of principle

For organisations such as climate funds who are dedicated to disbursing concessional finance for climate mitigation and adaptation projects in EMDEs, analysis often needs to go beyond simply assessing climate finance attribution.

for modelling and scenario building. For example, an ex ante assessment of the level of renewable generation evacuation in the future enabled by additional grid capacity, and the associated emission reductions at the system level, may be difficult to assess without a modelling approach. Other broader impacts beyond emission reductions can also be assessed through modelling such as how additional VLC generation could assist broader decarbonisation of the economy, how the investments support better climate resilience and ability to resume services rapidly in case of climate hazards, and other sustainable development goals e.g. energy access. It can also help rank and prioritise projects which is important for determining the most effective use of finance.

In addition to ex ante estimates, ex post monitoring of impact achieved is equally important. This involves determining and verifying the actual emissions reduction resulting from a given investment. In this regard, coordination between financing institutions on monitoring would be important in order to correctly attribute impacts without issues such as 'double-counting'.

BOX 3. Green Climate Fund (GCF) Investment criteria[3]

Under their investment framework, GCF have developed a set of criteria to provide guidance for the development, assessment and approval of projects. These are crucial for ensuring that financing is provided for projects or programmes that meet the aims of GCF, in supporting countries to transition towards low carbon, climate resilient economies.

Criteria include:

- Impact potential. Focused on the expected reductions in emissions resulting from the intervention.
- Paradigm shift potential. This is about achieving impact that is not confined to a single project but which can be replicated and scaled to increase impact. For example, this would be about seeing a vision for a full decarbonisation of the grids.
- Sustainable development potential. Recognising the potential co-benefits of interventions, this criterion concerns identifying additional social, economic or environmental benefits. For grids, this might be about increased energy access, or more reliable electricity supply for industry, or enhanced grid resilience.
- Needs of the recipient. This criterion is about establishing the needs of financing for the recipient country.
- Country ownership. This highlights the need for interventions to be demand-led and aligned with country objectives e.g. delivery of the NDC commitment
- Efficiency and effectiveness. This both represents the cost-effectiveness of the intervention but also the extent to which it can leverage other funding e.g. from the private sector.

For a model-based, forward-looking approach, an initial assessment of the country's plans for power sector development, as per the Common Principles, could be a useful first step. This can help determine (as far as possible) that financing is going into a system where there is a credible overall plan for decarbonisation.[4] Otherwise, there is a risk that fossil generation projects will be supported inadvertently. However, for this approach, this should not be considered as a binary screening criterion as there may be instances where the prospect of financing could help reorientate planning goals towards a system that is more climate compatible. It is also worth noting that only 20% of EMDEs require least-cost system planning (IEA, 2021b), so while encouraging the introduction of system planning, it is important to recognise that not all countries will have such planning documents.

To provide an ex ante assessment against a broader range of criteria, such as the impact of a grid investment on VLC generation evacuated and / or emission reductions (carbon intensity), we propose two levels of model-based analysis. They include a representation of a country's electricity system, including its current status and future plans. These could be planned additions to power generation capacity, power-purchasing agreements, or energy access targets.

The first level of model-based analysis uses a standardised, rapidly deployable modelling framework. This capacity expansion approach is based on energy system modelling (ESM), using optimization, to estimate the impact of a grid investment on a range of outcomes. The ESM would use a standardized representation of a power system, comprising different types

[3] GCF investment criteria can be found here - https://www.greenclimate.fund/projects/criteria
[4] What determines the credibility of a forward-looking plan or strategy could be agreed amongst the wider investment community, with harmonisation potentially taken forward by the IFI TWG under the UNFCCC.

of power plants and a grid connecting them to the rest of the system. This configuration can be used to test the impact of including a given grid investment by comparing it to the counterfactual, without the grid investment. Comparing the two cases across a range of indicators, such as overall emissions reduction (million tonnes of CO_2), grid emissions intensity ($MtCO_2$/MWh), and share of renewables (%) allows for the impact of the grid investment to be quantified.

Using standardized templates will also allow for a comparison between different investment options within and between power systems

Such an approach could be designed to be rapidly deployed. This would be done using published and transparent standardized datasets and model templates that require minimal customization (see Box 4 below for an example). Using standardized templates will also allow for a comparison between different investment options within and between power systems. If of interest, it can also be used to understand the level of carbon price that might be needed to help incentivise such an investment. This will help provide the relative value of different grid investment cases, including grid expansion, extension, and mini-grids. Overall, this approach aims to maximise ease and speed of its application to make ex-ante estimations of grid investment impacts.

This approach can be used for both greenfield and brownfield cases. Greenfield grid projects will be represented by an additional connection in the model between the existing grid, the proposed grid project, and any power plants that may be connected by the proposed grid expansion. Brownfield projects will instead be represented by an upgrade of existing transmission capacity. The model will be optimised to determine the least-cost system over a given time period (e.g. one or more decades). The approach in this section would include limited spatial and temporal resolution. In such an approach, the grid system would be aggregated into demand and supply nodes, and hourly data would be included as representative time periods. Making simplifying assumptions on both will allow for rapid deployment and will be less prone to data gaps. The use of the capacity expansion modelling approach has recently been demonstrated for a proposed interconnector between the Gulf States and India, and is further described in Box 4 below.

An additional level of assessment would be to use a more detailed power system modelling analysis that assesses how the system would operate to reliably meet demand under different scenarios. This can be important when considering what grid investment are needed to ensure security of supply is maintained when increasing the levels of variable renewable power in the system. This could be applied for projects where the funding level is large and over a specific threshold or is of a complex nature that requires more detailed modelling. In this instance, a spatially explicit economic dispatch model (EDM) can be used, based on a standardised framework which is tailored to a country or region (group of countries) relevant to the specific project being considered.

Infrastructure data, such as generation capacity type and location together with grid topology, would be used to configure the framework to represent the design of the system(s) at a high spatial resolution. The EDM would also capture the technical detail of thermal plant operation and, with its hourly temporal resolution, accurately represent variable renewables like wind and solar. The overall aim being to model the system(s) of interest as comprehensively as possible and provide highly accurate operational insights on emission reduction, grid intensity and share of renewables. The additional level of detail will also allow for results across a wider range of indicators. This includes the hourly operation of electricity storage assets, grid congestion, and marginal prices for electricity generation, among others.

MODELLING APPROACH		
Characteristic of approach	**Capacity expansion**	**Electricity dispatch**
Customization	Partial	Full
Level of effort	Moderate	High
Level of detail in results (accuracy)	Moderate	High
Model complexity	Energy system model (ESM) based on a standardized template. Requires basic knowledge of ESMs	Detailed power system model developed based on specific grid investment case. Requires in-depth knowledge of power system models.
Spatio-temporal resolution	Medium	High
Country dataset	Default	Country-sourced
Impact on grid emissions intensity	Yes	Yes
Impact on RE integration (e.g., curtailment)	Yes	Yes
Impact on grid congestion	No	Yes

BOX 4. Example of Standard Assessment (Capacity Expansion): A techno-economic and financial analysis of a GCC–India undersea electricity interconnector (Shivakumar et. al (2021))

In this study, we presented the use of OSeMOSYS-Global model as a model generator to carry out a techno-economic and financial analysis of installing a new interconnector between the six Gulf Cooperation Council (GCC) states, India, and South-East Asia. In the current version of the model, the maximum capacity of the interconnector is assumed to be 25 Gigawatts and can be built between 2028 and 2050. In addition, three potential sites for a solar PV farm that can be built together with the interconnector are considered. The analysis is based on a techno-economic model that aims to minimize the total costs of the GCC and India's electricity systems from the present until 2050. The model is subject to a set of constraints and policy considerations such as India's renewable energy deployment targets and the emission reduction goals set by GCC countries and India in their Nationally Determined Contributions (NDC) in the Paris Agreement.

Such model-based analyses are typically data-intensive, and there is a risk of bottlenecks, with some of the required datasets not always accurate, updated, or even available. However, several relevant datasets that are publicly available and widely used for modelling analyses have already been identified for this purpose, and efforts are being directed to improving and broadening coverage of these. Where possible international datasets can be used, such as for power plant costs and efficiencies. Other, more country-specific, datasets such as planned additions to power generation capacity are difficult to substitute. However, the model-based analyses can still provide a useful baseline that incorporates all available and accessible data regarding a country's electricity system.

A comparison of both modelling approaches is provided in the Table to the left.

Figure 11. Hourly bi-directional trade volumes across the GCC–India interconnector in 2050 (Primary x-axis: Hours [0-24]; Secondary x-axis: Months; Y-axis: Gigawatt-Hours [GWh])

This study provides an initial analysis of the GCC–India interconnector. The techno-economic case for a GCC–India interconnector is clear: an interconnector is part of the least-cost 'optimal' power system in 64 of the 75 scenarios studied. Bi-directional trade between the two regions can contribute towards reducing costs and emissions across a range of scenarios. The overall trade volumes are influenced by the location of the solar PV farm; locations further to the west contribute towards higher trade volumes in the GCC->India direction. Finally, the role of storage was found to complement rather than substitute the GCC–India interconnector, with both combining towards meeting India's peak load.

The financial case for the GCC–India interconnector is less clear. Of the projections developed for the scenarios from the techno-economic model, only a small number are immediately investible. However, the non-investible scenarios show a shortfall in investment attractiveness consistent with the difference between the techno-economic models and financial models.

Further expanding the geographic scope could help improve the overall feasibility of the GCC–India interconnector. For instance, the GCC is well-positioned to act as an electricity trading hub between Southeast Asia, India, and the African power pools (regional power grids and electricity markets). Another avenue for further exploration is to identify policy/market conditions to encourage such 'system optimal' investments that are risky from an investor's perspective. For example, a price cap and floor arrangements underpinning such projects would help reduce the investment risks (and therefore the cost of capital). This finding highlights the role of concessional and government financing, which could improve the financial case for projects with clear system-wide benefits.

REFERENCES

CBI (2021). Electrical Grids and Storage Criteria: The Electrical Grids and Storage Eligibility Criteria of the Climate Bonds Standard & Certification Scheme, Climate Bonds Initiative, August 2021, https://www.climatebonds.net/standard/electrical-grids-and-storage

CPI (2020). Updated View of the Global Landscape of Climate Finance 2019 [Rob Macquarie, Baysa Naran, Paul Rosane, Matthew Solomon, Cooper Wetherbee]. Climate Policy Initiative, London. https://www.climatepolicyinitiative.org/publication/updated-view-on-the-global-landscape-of-climate-finance-2019/

EU Technical Expert Group on Sustainable Finance (2020a), Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020, https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf

EU Technical Expert Group on Sustainable Finance (2020b), Taxonomy Report: Technical Annex - Updated methodology & Updated Technical Screening Criteria, March 2020, https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

IEA (2021a), World Energy Investment 2021, International Energy Agency, Paris. https://www.iea.org/reports/world-energy-investment-2021

IEA (2021b), Financing Clean Energy Transitions in Emerging and Developing Economies 2021, International Energy Agency, Paris. https://www.iea.org/reports/financing-clean-energy-transitions-in-emerging-and-developing-economies

IEA (2021c), Net Zero by 2050: A Roadmap for the Global Energy Sector, International Energy Agency, Paris. https://www.iea.org/reports/net-zero-by-2050

IEA (2020), World Energy Outlook 2020, International Energy Agency, Paris.

IEA (2020b), World Energy Balances 2020 Edition, International Energy Agency, Paris.

IEA (2020c), World CO2 Emissions from Fuel Combustion (detailed estimates) (2020 edition), International Energy Agency, Paris.

IRENA (2020), Global Renewables Outlook: Energy transformation 2050, International Renewable Energy Agency, Abu Dhabi, April 2020. https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020

MDBs / IDFC (2021). International Development Finance Club. Common principles for climate mitigation finance tracking. https://www.eib.org/attachments/documents/mdb_idfc_mitigation_common_principles_en.pdf

OECD, Climate Change: OECD DAC External Development Finance Statistics. https://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/climate-change.htm

Shivakumar et. al (2021), A techno-economic and financial analysis of a Gulf-India undersea electricity interconnector, 2021. https://doi.org/10.21203/rs.3.rs-690329/v2

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