Green Grids Initiative Working Paper

Mobilising climate finance for grids: Taking stock of current financing approaches

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Summary

This paper is a follow up to the *Climate Finance for Grid Investments in Emerging and Developing Economies* report published in October 2021, in collaboration with the Green Grids Initiative (GGI) Finance Working Group (WG). The 2021 GGI paper detailed how climate finance is pivotal to meeting large investment requirements in grid infrastructure across emerging and developing economies (EMDEs). It also highlighted that current investment in grid infrastructure needs to increase from current levels of $70 to $300 billion by the end of this decade. This is considered critical for enabling the supply of low carbon electricity to meet growing energy needs whilst reducing GHG emissions.

However, there is a recognition that approaches on climate financing by international financing organisations may be too restrictive to enable the investment scaling required. The 2021 paper estimated that only 40% of the required investment level in 2030 would qualify as climate finance, potentially hampering efforts to mobilise the large-scale financing needed in EMDEs, and steering investment away from countries who most need it to decarbonise.

This follow-up paper revisits the question of whether adopted approaches on climate finance eligibility are fit-for-purpose. It focuses on the perspectives of the finance community on the current approaches to climate finance, including benefits, challenges and potential changes to increase climate financing. It also highlights the role that modelling can play in identifying investment opportunities and assessing potential impacts of investments, focusing on interconnection projects.

The following key proposals emerge from this paper -

1. Climate finance criteria have the potential to enhance investment opportunities by making grid projects investable. However, they may be too restrictive in the case of EMDEs, regions where grids are yet to be fully scaled. Relaxing criteria may be necessary but will still need to ensure that the investments made also drive decarbonisation.

2. Discussion around changes to criteria are very much live in the International Finance Organisation (IFO) community. Proposals for relaxing criteria and increasing climate finance for a wider range of projects include -
    i. Incorporating forward-looking criteria in the EU Taxonomy based approach
    ii. Reviewing aspects of the Common Principles approach, to relax definitions of projects ‘dedicated’ to evacuating renewables, and to provide a weighting in the criteria to capacity additions, not just the final share of low carbon generation.
    iii. IFOs using Common Principles considering the use of lower thresholds of climate finance attribution in regions that require investment to kickstart system decarbonisation.

3. Energy system modelling tools have the potential to increase climate finance, based on their use to estimate the long-term, system-wide impacts of grid investments and to rapidly assess the impact of a specific investment on the system. This includes renewable generation uptake, overall costs, and GHG impacts in future years. Such insights may be not only be useful to IFOs – but to in-country or regional stakeholders wanting to assess possible pipeline grid projects.

The above proposals are not prescriptive but put forward to feed into the ongoing discussions on approaches being undertaken taken by a range of IFOs on climate financing of grid projects.

1. Introduction

Grids are a crucial component in meeting existing and future energy demand needs. Increasing and optimising the flow of capital to clean energy sources is heavily dependent on the availability of large-scale grid infrastructure, which suggests that scale and pace of investment in electricity grids is crucial to facilitate the net zero transition.[1] This is particularly the case for Emerging Markets and Developing Economies (EMDEs).

EMDEs face unique challenges in respect of required investment, as they account for the largest share of current energy demand growth, representing c. 60% of global energy demand growth in 2019.[2] Additionally, EMDEs are forecasted to experience an average annual electricity demand growth per capita of 2.2% up to 2030 in IEA Stated Policies Scenario.[3] Emissions forecasts for the region are projected to follow the same trajectory unless effective action is taken to build a low carbon energy system. Coupled with the frequent occurrences of extreme weather events, this has put a strain on existing grid infrastructure[4], exacerbating the underlying pressure to both upgrade and scale electric grids in order to tackle these challenges.

However, there are several obstacles in driving and facilitating investment in grid infrastructure within EMDEs, which includes improving long-term investor confidence, dealing with regulatory uncertainty, and attracting private sector investment. These barriers have led to the decline in investment in transmission and distribution in EMDEs from 2015 to present day (Figure 1), with this decline compounded by the COVID-19 pandemic.[5] This underinvestment in existing grid infrastructure has led to increased likelihood of system losses, higher risk of renewables curtailment, and more frequent power outages. In contrast, there has been an acceleration of renewable energy generation in EMDEs[6], raising concerns that the investment in grid infrastructure is not keeping pace with this growth.

Presently, energy investments within EMDEs are highly reliant on government sources of finance. State-owned utility companies are often dependent on tariffs and government appropriations to finance capital investment, as well as the operation and maintenance (O&M) of electric grids.[7] However, these sources will not be sufficient for meeting the required grid investments, with the demand for investment outpacing the sector's ability to finance and build new projects. The IEA projects that over 70% of clean energy investments in future scenarios globally will be privately financed, especially in renewable power and efficiency.[8]

As such, to encourage long term investor confidence and leverage existing public sector investments within grid infrastructure, the use of blended capital from development finance institutions, such as concessionary finance, is pivotal in de-risking grid infrastructure and stimulate further investment within the sector. There has been a gradual shift in investor sentiment, with a greater emphasis on both sustainable returns and outcomes across all asset classes. Grid investments are becoming a

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[1] Brown, G., Chan, B., Clone, R. and Cutler., Z. (2022). Upgrade the grid: Speed is of the essence in the energy transition. Mckinsey and Company. Toronto.
[2] IEA (2021). Financing Clean Energy Transitions in Emerging and Developing Economies. International Energy Agency, Paris. June 2021.
[3] IEA (2022b). World Energy Outlook 2022. International Energy Agency. Paris. October 2022.
[4] D'Aprile, P., Geissmann, T., López, F.P., González., J.R. and Tai., H. (2021). How to increase grid resilience through targeted investments. McKinsey & Company. December 2021.
[5] IEA (2022a). World Energy Investment 2022. International Energy Agency. June 2022.
[6] Ibid
[7] USAID (2022). Strengthening Utilities and Promoting Energy Reform (SUPER): Climate Finance for Electric Utility Investment. March 2022.
[8] IEA (2021b). World Energy Outlook. International Energy Agency. Paris. October 2021.

focus for investors mobilising climate finance. Finance institutions are now beginning to pivot to grid investments, with a view that they can help optimize renewable energy sources and enable GHG emission reductions.

As highlighted in the previous GGI working group paper,[9] there has been an increased focus in the investor community on how new grid project investments can be counted as climate finance. This has given rise to two main approaches for attributing climate finance to grid projects, the EU Taxonomy,[10] 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.[11]

As highlighted in the previous paper, the approaches used may risk constraining financial institutions from selecting grid projects in EMDEs 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). These risks slowing down the pace of grid investments in EMDE countries.

In this paper, we first take stock of the experiences of different international financing organisations (IFOs), project developers and development banks in implementing such approaches. Given the limited time these approaches have been in use, it is useful to reflect on experiences. We have therefore elicited the experiences of a cross section of IFOs through conducting a survey, with a view to learnings from experiences to date. This overview of practice also provides useful information to stakeholders interested in financing approaches, and the different pathways for climate-compatible grid financing,

Secondly, we consider the role that energy modelling could play as an additional tool for the finance community but also country stakeholders exploring opportunities for viable grid projects. We consider the case study of interconnection projects in Southern Africa, known as ZiZaBoNa (Zimbabwe, Zambia, Botswana and Namibia), to highlight why such modelling is useful – and the implications of different climate finance attribution approaches for these interconnection projects.

This report is structured as follows. We first set out the need to scale up grid investment to meet existing and future broader climate commitments, as well as discuss the current challenges faced by the investor community. In section 3, we then detail the existing approaches to determining climate compatible grid investment projects, and reflections on their use. Section 4 provides insights on the role of energy modelling in screening potential projects for investments, and how this works in practice with a case study on the ZiZaBoNa cross-border interconnector project. Finally, section 5 sets out proposed ways to enable more grid investments in EMDEs.

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[9] Pye, S., Shivakumar, A., and Price, J. (2021). Climate finance for grid investments in emerging and developing economies. Climate Compatible Growth Programme, November 2021.

[10] EU Technical Expert Group on Sustainable Finance (2020a). Taxonomy: Final report of the Technical Expert Group on Sustainable Finance. March 2020.

[11] IDFC (2021). Common Principles for Climate Mitigation Finance Tracking. https://www.eib.org/attachments/documents/mdb_idfc_mitigation_common_principles_en.pdf

2. The challenges for scale-up of grid investment

The energy transition towards a low carbon pathway is highly dependent on the scale and pace of grid investments. Bloomberg New Energy Finance (BNEF) estimates that grid investments globally need to increase by 3.4% annually, equating to roughly an extra $401 billion by 2050 (relative to 2020), to accommodate renewable energy technologies.[12]

In recent years, there has been a preference from investors to finance generation projects rather than grid investments. This is especially the case for EMDEs, where there has been a gradual decline in annual grid investments, reflected in Figure 1, where annual grid investments reduced by c.40% since 2015, while investments in renewable power generation increased by 30% over the same period.

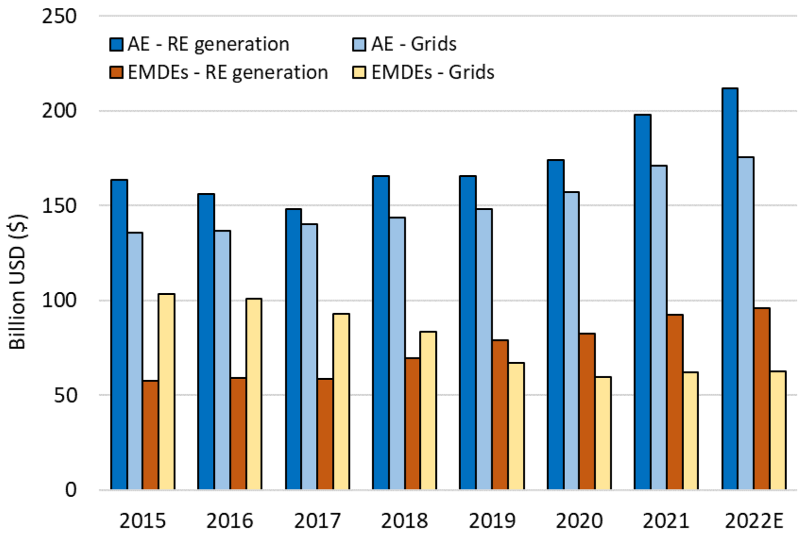

Figure 1. Average annual investment in the power sector by geography and category, 2011-2022. Source: adapted from IEA (2022a). Note that 2022 is an estimated value, AE is 'Advanced Economies'.

In contrast, advanced economies have seen increasing grid investments of c. 14% between 2015 to 2022. These trends illustrate the challenges for investment in electricity grids in EMDE countries, where financing grid projects can be difficult. This has resulted in a large share of grid investments being sourced from government sources, with many utility companies under predominantly public ownership via state owned enterprises (SOEs).[13] This has put growing pressure on government budgets, which represent 80% of total EMDEs grid investments, and many near term projects stalling due to lack of funds.[14]

There are a range of challenges that investors face in deploying capital to finance grid investments, including the following:

*Lack of solid creditworthiness from utilities***.** Historically, utilities located in EMDEs have often been viewed as high-risk borrowers and have low credit ratings. Consequently, it has meant that it is more

[12] Hale (2021). World needs $14 trillion in grid spending by 2050 to support renewables - report. S&P Global. February 2021.
[13] USAID (2022). Strengthening Utilities and Promoting Energy Reform (SUPER): Climate Finance for Electric Utility Investment.Strengthening Utilities and Promoting Energy Reform (SUPER): Climate Finance for Electric Utility Investment. March 2022.
[14] Gridworks Partners (2022). Gridworks Perspectives: How to Boost Private Investment in Transmission. June 2022.

costly for debt and equity investments in EMDE countries compared to advanced economies, with capital investments being up to seven times more expensive in EMDEs.[15] As such, this can act as a deterrent in encouraging further investment from the private sector.[16]

The need for patient capital. The approval process to obtain finance can be a time intensive process for utility companies, with the Rocky Mountain Institute's Climate Finance Access Network (CFAN) suggesting that approval process from major funds could take up to four years with utility companies challenged in preparing and packaging grid projects into financially viable assets.[17] This may result in utility companies often being discouraged to seek climate finance and seek to obtain urgent forms of capital.

Global supply chains disruptions. Severe supply shortages in recent years have delayed the supply of key raw critical materials needed for grid infrastructure, such semi-conductors. These delays can cause inflationary pressure and lead to overall increases in component costs, thereby impacting economic feasibility of projects.[18]

*Pipeline projects have extensive lead times. C*onstruction of electric grid are extremely capital intensive and require to extensive lead times from the initial investment decision to commissioning. Couple with the growing shortage of technical personnel, this is likely to result in further delay project lead times.[19]

Availability of sufficient data. Investors have stressed lack of information and data, for instance data on anticipated project performance. This can act as an additional barrier in mobilising further private investment.[20]

Political decisions around end-user tariffs and private ownership / operation of assets. Grid investments, like many infrastructure investments are often subject to country risks due to political sensitives related to foreign direct investments within publics and vulnerabilities to local currency due to tariffs and user fees. Investments in less mature markets have a higher associated regulatory and country risk, due to possibility of country specific factors eroding the profitability of conducting business.[21]

By providing a basis for designating project investments as climate finance, it is hoped that grid projects will be viewed as more attractive by finance organisations looking for sustainable investment opportunities, which is important in view of the above challenges. However, there is a risk that climate finance criteria add more barriers to investing in grid projects in EMDEs. The preceding CCG-GGI paper, published in 2021[22], highlighted that only 40% of required investment in

[15] IEA (2021b). World Energy Outlook 2021. International Energy Agency. Paris. October 2021.
[16] USAID (2022). Strengthening Utilities and Promoting Energy Reform (SUPER): Climate Finance for Electric Utility Investment.Strengthening Utilities and Promoting Energy Reform (SUPER): Climate Finance for Electric Utility Investment. March 2022.
[17] Ibid
[18] Brown, G., Chan, B., Clone, R. and Cutler., Z. (2022). Upgrade the grid: Speed is of the essence in the energy transition. Mckinsey and Company. Toronto.
[19] Ibid
[20] USAID (2022). Strengthening Utilities and Promoting Energy Reform (SUPER): Climate Finance for Electric Utility Investment. March 2022.
[21] Norges Bank Investment Management. (2015). Infrastructure Investments in Less Mature Markets: Discussion Note. May 2015.
[22] Pye, S., Shivakumar, A., and Price, J. (2021). Climate finance for grid investments in emerging and developing economies. Climate Compatible Growth Programme, November 2021.

2030 into EMDE grid infrastructure would qualify as climate finance (under the Common Principles). This relatively low coverage would mean that many grid projects in the region could lose out on investment due to strict criteria. For grids dominated by renewables today, this is not a barrier, but for those that are dependent on fossil fuels, this adds an additional barrier.

The community of IFOs needs to consider how their criteria for grid projects can both safeguard the credibility of what is designated climate finance while ensuring that EMDEs, in particular, can gain much needed access to finance. In the next section of this paper, we use a survey to elicit the perspective of different organisations involved in grid investment / financing, to explore their perspective on the current approaches used.

3. Approaches to determining climate compatible projects

Across the IFO community, there are a range of approaches in play in respect of how grid projects are identified and taken forward for financing, including on eligibility for climate finance. These differences reflect the different modes of financing, from those providing concessionary financing from dedicated climate funds (for example, GCF), to loans from MDBs, to organisations providing accreditation for the issuing of climate bonds (for example, the Climate Bonds Initiative (CBI)).

There are two main approaches in play that set criteria on whether a project investment can be designated as climate finance. The EU Taxonomy sets a threshold known as technical screening criteria that helps guide what investments can be considered climate finance or not.[23] The Common Principles, adopted by the Multilateral Development Banks (MDBs) and International Development Finance Club (IDFC), are 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.[24]

The EU Taxonomy, adopted by the CBI uses criteria to identify whether a project is eligible or not. Criteria focuses initially on the current intensity of the grid, which needs to be lower than 100 gCO_2/KWh for projects to eligible. If not below this threshold, a second eligibility criterion is considered, to check whether at least 67% of new capacity additions on the grid (in the last 5 years) are below this threshold. The use of carbon intensity metrics for the existing grid, as opposed to projections of future carbon intensity, reflects the need for projects to be verifiable.

The Common Principles approach uses a forward-looking approach. For new greenfield investments to be eligible, the grid system must be projected to be reducing its carbon intensity over the next 10 years. The % attribution of the project investment as climate finance is based on the share of low carbon generation on the system in 10 years. This is assessed against a power system plan, or if unavailable, a decarbonisation plan. MDBs will take a view as to whether they think that the share of investment identified as climate finance meets a level that is deemed sufficient to proceed with the project. The AFD uses the Common Principles as a basis but for transmission projects, only weights the share of low carbon generation after 10 years at 50%, and also gives 50% weighting to the low carbon generation that is enabled at the time of the project commissioning.

A cross-comparison of the methods is provided in Appendix 1.

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[23] EU Technical Expert Group on Sustainable Finance (2020a). Taxonomy: Final report of the Technical Expert Group on Sustainable Finance. March 2020,

[24] IDFC (2021). Common Principles for Climate Mitigation Finance Tracking. International Development Finance Club.

Based on the survey undertaken (see Appendix 2), we summarise the perspectives from a range of IFOs on the approaches used to consider whether a grid project investment can be designated eligible for climate finance.

Benefits of climate finance approaches

A key stated benefit of the approaches is that they allow for grid projects to be classified as climate finance, which would not be the case in the absence of such approaches. This is because grid projects are an enabler of system decarbonization, not direct contributors to emission reductions, and therefore are challenging to designate as climate finance without clear criteria.

A further benefit of the approaches is that, in general, they provide clarity on what projects are eligible. For example, the Common Principles criteria is based on a clear requirement for increasing shares of low carbon generation over a 10-year period, demonstrated in credible national plans (power master plans or decarbonization plans). For the EU Taxonomy approach, used by the CBI, again the approach can be argued to be based on clear criteria, and crucially for bond certification, verifiable based on observed capacity additions on the system. Once a grid is deemed eligible, almost any investment within it is eligible, resulting in low verification costs and strong inclusivity across potential projects.

Finally, the relative consistency of approaches across organisations, notably for MDBs, ensures a common understanding of requirements across those countries and organisations seeking financing for grid projects.

Challenges of approaches

There is a recognition that the current approaches do favour those countries with lower carbon intensity grids or those with higher current and prospective shares of low carbon generation. There is therefore a risk that EMDE countries that need investment in grids do not receive financing due to their current higher carbon intensity, or because the percentage attribution (under Common Principles) is not deemed high enough to take a project forward. Arguably, systems that are already low carbon may be in less need of climate finance than grids that are higher carbon but need investment to expand.

The problem for EMDEs is that much of the capacity expansion has not yet taken place, but rather is expected to do so in the coming years. Therefore, a focus on historical or existing system (as per the EU Taxonomy) makes investments in many grid systems difficult, where their current status is high carbon.

In addition to general challenges concerning approach coverage, there are some technical challenges that have been flagged by respondents. Firstly, a barrier for the EU Taxonomy based approach is when considering a sub-national component of the grid, finding data can be difficult (with datasets predominantly held at the national level). An additional challenge raised is where the grid is highly meshed (multiple connections within the system) and therefore identifying the role of a specific project in evacuating renewable electricity may be difficult to estimate. This particularly concerns the AFD criteria on weighting attribution of climate finance to renewables brought online at the time of commissioning a transmission line.

Potential changes to approaches

Following a period of adopting and implementing approaches, the survey also asked what specific changes to approaches were under consideration, motivated by challenges faced to date. After a two-year period, MDBs are in a period of evaluation of the eligibility criteria under Common Principles. This includes considering whether eligibility criteria may be too strict, in that they favour systems that are already low carbon. Criteria around dedicated transmission lines and other criteria could be reconsidered, for example, relaxing the definition of a new transmission line dedicated to the evaluation of very low carbon generation.

Other organisations are considering extending criteria to ensure specific projects are fully eligible for climate finance. For example, AFD are considering 100% eligibility for small-scale consumer interconnection infrastructure enabling installation of local renewable energy systems.

Based on the EU Taxonomy approach, the CBI are also considering how they could include forward-looking criteria, so that the coverage of potential grid projects increases. This could include incorporating a forward-looking element, such as the pipeline of near-term projects into the criteria on capacity additions. However, the challenge is ensuring that the criteria used can be easily applied, and are fully verifiable and robust.

The role of modelling

In the survey, participants were also asked about the role of modelling as part of their approaches to determining financing of grid projects. This question was motivated by a view (see next section) that modelling could play an important role in identifying key projects for investment – and the emission reduction potential of those projects.

It is important to note that none of the eligibility criteria require modelling. The clarity of the criteria and the consistency of their application could risk being undermined by the introduction of modelling. Once a project has been deemed eligible or sufficiently eligible, modelling would then focus on financial modelling to assess economic feasibility of projects, and on technical modelling (e.g. PLEXOS) to understand system wide impacts of the project. This would be done as part of a detailed assessment of whether to go ahead with financing the project.

4. Insights from modelling to inform project screening

In this section of the report, we highlight a role that modelling could play specifically for the screening of interconnection projects for financing. For interconnection projects, it is harder to determine the specific impact that they would have on the carbon intensity of both systems that are being interconnected so modelling could play a useful role.

The modelling described in this section allows for a rapid assessment of the impact of specific investment on a system, in terms of renewable generation uptake, overall costs, and GHG impacts in future years, compared to a counterfactual without such an investment. It is aimed at pre-screening of multiple options, to identify possible candidate projects but does not replace a detailed power system feasibility assessment using a tool such as PLEXOS, which will be required prior to financing.

The utility of this approach has been demonstrated in early feasibility studies of an interconnector between the Gulf region and India.[25]

There is also value in this approach not only for IFOs but also for country or regional stakeholders wanting to assess possible projects, for which they may be seeking finance.

The OSeMOSYS Global model

OSeMOSYS Global is a free, modelling tool that allows users to identify least-cost pathways to decarbonize the global energy system. It is open source uses open-data, and is publicly accessible via http://osemosys.global/.[26]

Unlike existing models, OSeMOSYS Global can create complete representations of energy systems for the entire globe or any user-defined country or region. Inter-connections between these can then be analysed. The level of detail and geographical scope are fully flexible and determined by the user. In summary, OSeMOSYS Global can be used to:

- Model the expansion of energy systems for any set of countries or regions.
- Create regional, national, or sub-national representations for 255 global geographic areas.
- Choose any combination of powerplant technologies, inter-connectors, and regions to build your model.
- Interface directly with typical utility power planning tools such as PLEXOS.
- Visualize investments, hourly electricity generation, costs, and trade flows in an interactive web platform.

Modelling case study: ZiZaBoNa

In this paper, OSeMOSYS Global has been applied to techno-economically assess a set of cross-border interconnectors between Zimbabwe, Zambia, Botswana, and Namibia techno-economic – collectively known as the ZiZaBoNa interconnector project. All four countries are part of the Southern African Power Pool, a framework for regional electricity trade between twelve countries, extending up from South Africa to DR Congo. The ZiZaBoNa project consists of three sections:

- Zimbabwe – Zambia [101 km]
- Zimbabwe - Botswana [76 km]
- Zambia – Namibia [231 km]

[25] Shivakumar, A., Kruitwagen, L., Weinstein, M., et al. A techno-economic and financial analysis of a Gulf-India undersea electricity interconnector, 13 July 2021, Preprint (Version 2) available at Research Square.
[26] Also see https://github.com/OSeMOSYS/osemosys_global

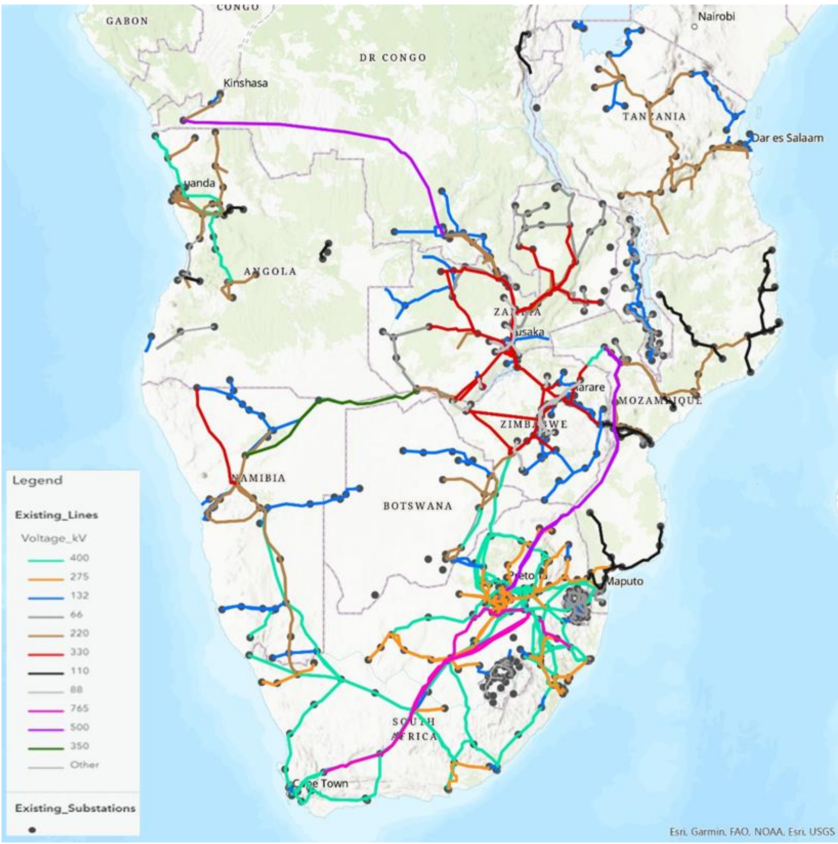


Figure 2. SAPP Grid Map (Source: https://www.sapp.co.zw/)

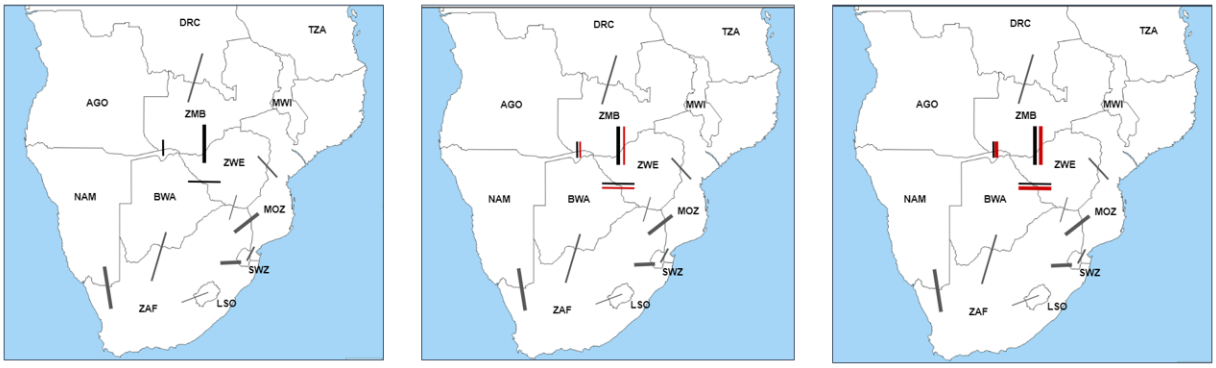
The objective of the ZiZaBoNa project is to:

- Provide an alternative wheeling path between North and South. It will allow for alternate routes for electricity trade from the hydro-rich regions such as DR Congo and Zambia to demand centres in South Africa
- Decongest the Central Transmission Corridor for enhanced power trade among SADC countries

OSeMOSYS Global has been applied as a potential 'pre-screening' tool here. It aims to estimate the long-term impact of the ZiZaBoNa project on the region's emissions, costs, and renewables penetration. A summary of the model setup is as follows:

- 12 countries: Angola (AGO), Botswana (BWA), DR Congo (DRC), Tanzania (TZA), Mozambique (MOZ), Malawi (MWI), Namibia (NAM), Eswatini (SWZ), South Africa (ZAF), Zambia (ZMB), Zimbabwe (ZWE)
- Model horizon: 2020-2050
- 48 sub-annual time slices: 6 seasons x 8 dayparts
- Power plant capacity expansion:
    - All existing power generation and cross-border transmission capacity included
    - Power plant capacities are free to be installed across the SAPP
    - No new cross-border transmission capacity is allowed to be built, unless specified

The model was applied to three main cases, or 'scenarios': 'Without ZiZaBoNa', 'With ZiZaBoNa (3x300MW)', and 'With ZiZaBoNa (3x1000MW)'. In the first scenario, the SAPP electricity system is built without the ZiZaBoNa. The other two scenarios include the ZiZaBoNa, one with its planned capacity of three sections of 300MW each, the other an expanded case of 1000MW sections. These two cases are compared against the first, which is considered the 'counterfactual'.



Without ZiZaBoNA | With ZiZaBoNA (3 x 300MW) | With ZiZaBoNA (3 x 1000MW)

Figure 3. Selected scenarios modelled using OSeMOSYS Global

The model results are summarised in Table 1 below. It shows that under 'least cost' conditions, a system with the ZiZaBoNa leads to lower emissions as compared to one without it. Specifically, it contributes to 1% and 4% lower emissions across the SAPP system over the entire modelled period for the 'With ZiZaBoNa (3x300MW)' and 'With ZiZaBoNa (3x1000MW)' respectively. This is achieved without an increase in the average cost of electricity generation, nor any explicit decarbonisation targets.

Table 1. Key results metrics from OSeMOSYS Global scenarios

		Without ZiZaBoNa	**With ZiZaBoNa (3x300MW)**	**With ZiZaBoNa (3X1000MW)**
Emissions	*Million tonnes of CO2-eq.*	2217	2187	2129
Emissions reduction	*%*	-	1%	4%
Cost of electricity	*$/MWh*	22	22	22
RE Share	*%*	53	54	55
Total electricity trade	*TWh*	61	65	85

The lower emissions, and higher renewables share, comes from an increase in the hydropower electricity generation in the system. The electricity systems of three of the four countries connected by the ZiZaBoNa are hydropower-dominated, with Botswana the only exception. With the additional interconnector capacity, this hydropower generation can contribute to the overall SAPP electricity mix, displacing other fossil fuel sources. At the very end of the time horizon, a relative reduction in solar is observed, due to less capacity requirement given overall system efficiency gains. However, in all cases, solar capacity increases in absolute terms, given it's cost-effectiveness.

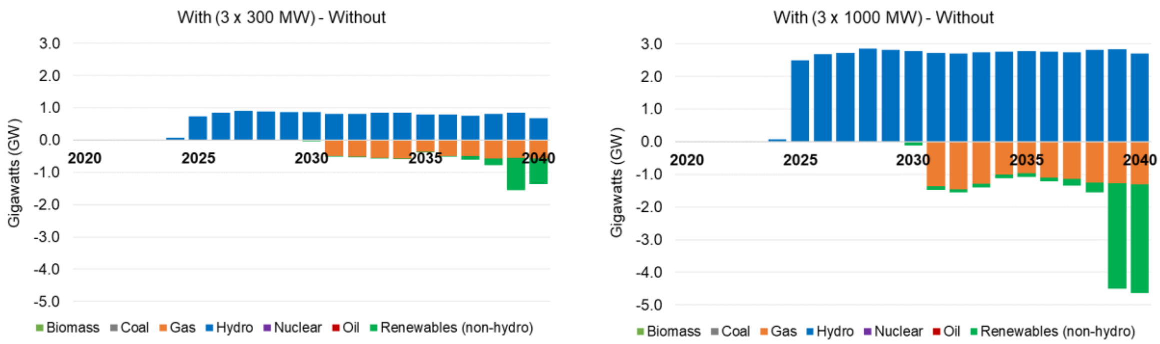


Figure 4. Comparison of generation capacities between 'With ZiZaBoNa' and 'Without ZiZaBoNa' cases between 2020-2050

The modelling results show that ZiZaBoNa can play a role in lowering overall emissions by up to 4%, with no increase in the average cost of electricity generation. It can be a 'no regrets' investment – it leads to lower emissions in a pure 'least-cost' pathway as well as a decarbonization one.

The project was also assessed against sets of climate finance eligibility criteria, as summarized in Table 2. The ZiZaBoNa project is practically 100% eligible under the climate finance criteria considered. This is primarily since three of the four countries included in the project are hydropower dominated electricity systems. In other interconnector cases, there may be issues with the 'weighted average of VLC' criterion. This did not show up here due to the relatively small size of the fossil-fuel dominated Botswana system, but may do so if a large electricity system with a low VLC share is connected to a smaller high VLC system.

Table 2. Application of climate finance criteria to the ZiZaBoNa project

	Criteria	**ZiZaBoNa eligibility (installed in 2025)**
Common Principles (plus AFD approach)	Where 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 weighted average share of VLC electricity across both systems is used for apportioning the financing	Overall emissions **increase in BWA but are lower overall.** Furthermore, emissions with the interconnector are lower than the counterfactual. 1. ZWE-ZMB: ~99% eligible 2. ZWE-BWA: ~93% eligible 3. ZMB-NAM: ~99% eligible
EU Taxonomy	Interconnectors between transmission systems are eligible, provided that one of the systems is eligible	1. ZWE-ZMB: Eligible [both ZWE and ZMB are eligible systems] 2. ZWE-BWA: Eligible [ZWE is an eligible system] 3. ZMB-NAM: Eligible [ZWE is an eligible system]

This case study shows the application and potential use of energy systems modelling as pre-screening tool for climate finance eligibility assessments. The modelling tool discussed is easy-to-use, pre-loaded with relevant datasets, and rapidly provides system-wide results on emissions reductions, costs, and renewables penetration.

5. Options for increasing climate finance for grids

Going forward, it will be crucial that IFOs use approaches that are inclusive of those EMDEs that will require large-scale grid investment in the coming years for decarbonisation, both in country systems but also interconnection between countries. In this section, we highlight several issues that we think will be important in helping mobilise more climate finance, and which can feed into ongoing discussions across the financing community.

Revisiting existing climate finance criterion across both the EU Taxonomy and the Common Principles

There is a concern, reflected by different organisations via the survey, that climate finance criteria may be too stringent, and may need relaxing to increase coverage of eligible projects. This was highlighted as a concern in the previous 2021 CCG/GGI Paper.[27] As organisations take stock of the approaches used, there are several ideas to relax criteria whilst maintaining credibility of approach.

- For the EU Taxonomy approach, the criteria that states that grid eligibility can be based on a system where more than 67% of newly connected generation capacity is below the generation threshold value of 100 gCO2e/kWh. Criteria could be relaxed to not only consider the previous 5 years of data, but to consider planned investments. This could be 2-3 years of planned generation project investment, and 2-3 years of historical. The question would be how far forward planned projects could be considered, and at what stage of the planning process should they be. Further research to assess the impact of this on project coverage of this amended approach would be useful to understand if this change is impactful.

- For Common Principles there are a few elements that could be considered.
    i) Currently, for MDBs, greenfield investments have climate finance attribution determined completely based on the share of low carbon generation in 10 years. This could be amended so that a 50% weighting was given to the share of capacity additions that were very low carbon (VLC) in the next 10 years. Therefore, if a system started at 20% VLC in 2022, reached 50% VLC in 2032, but all the capacity additions added were VLC, then rather than having an attribution estimate of 50%, it would be 75%.
    ii) There is also the option of using the approach adopted by the AFD for transmission projects, which puts a 50% weighting on the VLC that is evacuated by the project at the time of commissioning. This tends to favour those lines that are more important for the evacuation of renewables. However, there are some challenges when determining this share when the grid is highly meshed.
    iii) A transmission or distribution project dedicated to the evacuation of only very-low-carbon electricity (excl. nuclear) is deemed to be fully eligible. The interpretation of this could be relaxed, to also include projects that *in the main* evacuate VLC. This may be particularly important for those projects where grids are more meshed, making it difficult to determine if project is 'dedicated'. There could also be consideration of changing this text to say what is not eligible i.e. rule out projects, including those that have a share of coal generation.

- For organisations using Common Principles, it will be for them to determine at what climate finance share of total investment they feel that a project should be taken forward. It is

[27] Pye, S., Shivakumar, A., and Price, J. (2021). Climate finance for grid investments in emerging and developing economies. Climate Compatible Growth Programme, November 2021.

unclear what the threshold is for MDBs or how this differs between organisations. There could be some consideration of using lower thresholds in some regions that are more fossil intensive, and for which investment is required.

There is recognition that climate finance criteria can be an enabler of investments in grids but requires flexibility so that specific countries do not get overlooked. This flexibility, however, needs to be balanced against the need for ensuring credible criteria that will lead to system decarbonisation, and which have clarity of approach and are easily implementable.

The potential role for modelling in the screening process for investments and / or identification of projects and their impacts

In addition to potential changes to criteria, there is also a potential role for energy systems modelling to play an important role in project identification and screening, for both financing organisations and countries who may be looking for financing. As highlighted by the ZiZaBoNa case study (and earlier Gulf Indian study),[28] this type of modelling provides a useful analytical framework for deriving key metrics, including emission reductions, that provides a first estimate of the potential for a given project over the mid to long term.

For IFOs, this can provide a project screening tool for rapid insights on the potential impacts of a grid project on the system, across a range of metrics. For organisations such as GCF, who want to understand the wider impacts of strategic interventions and crucially the emission reductions, but who may not have the capacity to undertake specific modelling, this could prove to be a useful tool. For MDBs and other organisations that undertake more detailed modelling when assessing feasibility, this modelling could still provide a useful early screening approach. This would help address the criteria set out in the Common Principles that states that 'the entity applying the Common Principles shall demonstrate that the investment will not significantly increase GHG emissions over the short or medium term.'

This modelling can also provide useful information for governments, utilities or regional power pool organisations as to the impacts of different interconnector projects. This could help support efforts to identify and apply for finance of such projects. This modelling using OSeMOSYS Global is focused on interconnections projects. Intra-country modelling is also possible using this tool but is available only for certain large electricity systems for now (e.g. China, USA, India). This open-source tool can be adapted to the frameworks and platforms used by different IFOs to screen projects.

[28] Shivakumar, A., Kruitwagen, L., Weinstein, M., et al. A techno-economic and financial analysis of a Gulf-India undersea electricity interconnector, 13 July 2021, Preprint (Version 2) available at Research Square.

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Appendices

Appendix 1. Overview of different approaches to determining climate finance for grid projects

	Common principles	**AFD approach**	**EU taxonomy**
Overview	Principles that set out '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'	Based on Common Principles approach	Framework developed to help project developers and investors 'navigate the transition to a low-carbon, resilient and resource-efficient economy'
Organisations using approach	MDBs, other members of IFDC	AFD	CBI
Approach to designating investment as climate finance	A system that is increasing its share of *very low carbon electricity* over the next 10 years	A system that both accounts for the share of low carbon generation added based on a new project, and its share of *very low carbon electricity* over the next 10 years	All electricity transmission and distribution infrastructure or equipment in Systems which are on a trajectory to *full decarbonisation.*
Criteria - general	**Greenfield:** 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]. **Brownfield:** Eligible 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'.	**Transmission:** Financing apportioned based on weighting % low carbon on line at commissioning climate at 50% and % low carbon energy (incl. nuclear) in the national system in a 10-year horizon **Distribution:** Financing apportioned based on % of low carbon electricity in the national grid in a 10-year horizon.	*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 gCO2e/kWh, 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 gCO2e/kWh measured on a PCF basis, over a rolling five-year average period.
Criteria – direct connection	Transmission or distribution project dedicated to the evacuation of only very low carbon (VLC) electricity (excl. Nuclear) shall be fully eligible	Full eligibility of low-carbon electricity transmission projects to climate finance	Fully eligibility for direct connection, or expansion of existing direct connection, of low carbon electricity generation below the threshold of 100 gCO2e/kWh declining to 0 gCO2e/kWh in 2050, measured on a PCF (Product Carbon Footprint) basis, to a substation or network.

Criteria - interconnection	Where 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 weighted average share of VLC electricity across both systems is used for apportioning the financing	Weighted average (by the size of the two systems in terms of electricity production, in MWh) of the low-carbon energy percentages of the two systems over a 10-year horizon	Interconnectors between transmission systems are eligible, provided that one of the systems is eligible
Criteria – mini/micro-grids	Isolated mini-or micro-grids that are not connected to the transmission system may be treated like network investments associated with generation. Financing is proportional to the share of very-low-carbon energy in the mini-or micro-grid.	Mini-grids projects: Production side - only investments in RE are eligible Network side – financing apportioned based on % of RE injected into the mini-grid in a 10-year horizon Connections side: if the % of RE on the mini-grid over 10 years is greater than 50%, these investments qualify at 100% climate finance, otherwise the finance apportioned is equal to the % RE on the mini-grid at this time	
Criteria – storage / other		Access project by network extension/densification (excluding mini-grids, but including a distribution project with connections for households that do not have access to electricity: electricity access projects located in countries where the electricity mix is more than 50% low-carbon energy by 10 years qualify at 100%. The others qualify with the rule of the % of RE in the mix by 10 years	
Criteria type	Forward-looking, eligibility criteria determining % climate finance		Historical data, binary criteria
Evidence needed of grid decarbonisation	Ex-ante assessment of forward-looking power system plans (or national decarbonisation plans), using a 10 year planning horizon	Ex-ante assessment of forward-looking power system plans (or national decarbonisation plans), using a 10 year planning horizon	Assessment of historical or current year published data on grid intensity or capacity additions

Appendix 2. Survey sent to Working Group members

The following questions were included in a survey sent to GGI Climate Finance Working Group members during October 2022.

- What is the name of your organisation?
- What type of organisation are you?
- What region(s) do you focus on?
- What types of financing do you provide for grid projects? (e.g. loans, private equity, bonds etc.)
- What are the main challenges to grid financing in LMICs that you face? (This is in general, not just related to climate finance)
- In summary, what is your approach (methodology) to determining a climate finance attributable grid project investment?
- Using this approach, what are the specific steps of assessing a grid project, from initial consideration to final investment decision? Please could you provide case study examples to help better understand the process of implementation.
- What are the advantages of this approach?
- What are the challenges with implementing this approach? Please use case studies to help elaborate on key challenges.
- From experience of implementing this approach, what aspects of your approach (if any) are you re-considering? Please outline any challenges associated with possible changes.
- Is there a subsequent process of monitoring, reporting and verification after the investment has been made? What does this look like?
- Is modelling used as part of the decision-making process? If yes, what type of model and what are its main outputs?
- Is there any additional information that you would like to add that you think is pertinent to the above issues?