Concessional Financing for an Affordable Power Sector Transition

The bottom line. This Live Wire assesses the extent of concessional financing needed to bring to zero the incremental costs of power sector decarbonization in select low- and middle-income countries. Those costs are higher for countries with high shares of emission-intense electricity generation, limited competitiveness of renewable electricity generation, and limited options for firm, flexible low-carbon electricity generation. Concessional financing needs also depend on the cost of commercial capital in a country. Countries with a relatively low cost of commercial capital require more concessional finance to ensure that the country is not worse off by pursuing power sector expansion together with decarbonization.

How is concessional finance tied to power system decarbonization and access to electricity?

Concessional finance can free up capital to transform the power system

Universal access to affordable, reliable, and sustainable energy is foundational to eliminating poverty and achieving shared prosperity on a livable planet. Universal access to electricity with these features, in turn, depends on a prudently paced energy transition away from heavy reliance on fossil fuel-based electricity generation and toward greater use of renewable electricity in on- and off-grid solutions. Achieving the energy transition in low- and middle-income countries will require a vast expansion and transformation of existing infrastructure (World Bank 2023). In the 2016–20 period, power sector investments in low- and middle-income countries, excluding China, averaged $240 billion annually. To meet the targets set out in the Sustainable Development Goals (SDGs), annual investments must quadruple to $1 trillion by 2030.

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1. Concessional finance is defined here as financial resources offered at submarket rates, in line with the definition used in World Bank (2023) and IEA and IFC (2023). Concessional financing needs may be justified for other reasons, ranging from the need to further increase electricity access to positive development impacts of infrastructure roll-out, which were not covered in this analysis.
Concessional finance can play several roles in advancing the energy transition. Here we focus on covering the costs of cross-border externalities, which will help ensure that power sector decarbonization is affordable to low- and middle-income countries. Power sector decarbonization—that is, bringing power system greenhouse gas emissions down to zero (or near zero)—typically increases direct power system costs compared with a least-cost power system expansion scenario without decarbonization targets.

Our work provides valuable insights into the use of concessional financing to expand and transform the power sector in a manner consistent with the energy transition.

Here we assess the volume of concessional financing required to bring the incremental direct costs of power system decarbonization—the difference between expansion and operation costs with and without carbon constraints—to zero using select low- and middle-income countries with a range of technical and financial characteristics. The analysis presented here is intended as a first high-level assessment. In a follow-up work, we will take a more granular, country-level approach to assess more precisely the needs for concessional financing in different types of investments designed to meet decarbonization targets.

How does one estimate the concessional financing needed to address cross-border externalities in low- and middle-income countries?

Our approach determines the concessional financing required to zero out the incremental direct costs of power system decarbonization

The methodology determines the amount of concessional finance needed to make the present value of total supply costs (direct power system costs) equal under an unconstrained least-cost scenario and a decarbonization scenario. In the decarbonization scenario, the aim is to significantly lower power system greenhouse gas emissions over the next 20–25 years versus the unconstrained least-cost scenario. We assume that the amount of concessional finance in the capital structure of investments in a power system can be increased to a point where the drop (or “decrement”) in annual capital amortization payments matches the incremental costs of decarbonization, as illustrated in figure 1.

Two methodological approaches are discussed below. Approach 1 assumes all concessional resources directed to power system investments correspond to debt priced below typical rates for loans from the International Bank for Reconstruction and Development (IBRD). In approach 2, all concessional resources are grants. In both cases, the concessional resources are assumed to replace nonconcessional debt and equity in equal proportions. The nature of the concessional resources (low-cost debt or grants) affects how much each dollar of concessional finance will lower the cost of capital and, thus, the value of the annual capital amortization payments.

The results allow us to reach several conclusions confirming the conclusions of World Bank (2023). Before discussing conclusions, we note that our simplified methodology has some limitations.

We assumed concessional finance is used for the sole purpose of zeroing out the incremental direct costs of power system decarbonization. In reality, concessional finance spurs economic development and eases barriers to infrastructure investment. Therefore, injections of concessional finance have value even under the unconstrained

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2. Except where otherwise noted, values are denoted in present-value terms (2023). In the unconstrained least-cost scenario the costs of power system expansion and operation are optimized for the sole purpose of lowering the direct costs of power supply, without taking decarbonization targets or the costs of greenhouse gas emissions into account. The emissions targets were taken from analyses covered in Country Climate and Development Reports (CCDRs) over the 2023 and 2024 fiscal years. The CCDRs showed various levels of ambition for power system decarbonization, but the minimum ambition was an 80 percent reduction in greenhouse gas emissions in the power sector by 2040 over the scenario without emission targets.

least-cost scenario in countries where high financing costs hamper investment in infrastructure, including the power system.

We also assumed that concessional resources are used only to finance capital expenditures. In reality, concessional resources may also be used to fund other types of expenses, including fixed and variable operational spending (e.g., operating and maintenance, fuel purchases, and so on).

We ignore intersectoral interactions that could increase the need for concessional finance. Such interactions could influence the need for concessional finance, even if zeroing out the incremental costs of decarbonization is assumed to be the only goal of the concessional finance injected. Efforts to decarbonize an entire economy will affect local capital markets and change the mix of financial resources across sectors. For instance, relatively low-cost public finance that had historically been directed to the power sector could be channeled to other activities with higher opportunity costs of capital. The resulting increase in the costs of capital for the power sector could increase the need for concessional financing.

We employed a simplified model of concessional financing. The impact of concessional finance can be maximized by adjusting the mix of financing instruments (grants, low-cost debt, and low-cost guarantees, among others) to meet the needs of individual countries and activities. Also at play are the donors’ risk appetites and the amounts of concessional finance available. Maximizing impacts per monetary unit of concessional capital may involve cutting the residual risks perceived by private capital. These
dynamics are not captured by our simplified approach, which does not involve a full modeling of cash flows to lenders and investors. Instead, the methodology is based on estimates of changes in weighted average costs of capital (WACC) and their effect on capital amortization payments.

The approximations introduce distortions in our analyses and constrain the choice of the variables plotted in the next section. But our work provides valuable insights into the use of concessional financing to expand and transform the power sector in a manner consistent with the energy transition.

**What factors affect the incremental direct costs of power system decarbonization across countries?**

*Higher capital costs generally raise the incremental direct costs of decarbonization*

Power sector decarbonization usually requires a shift toward capital-intensive technologies, such as renewable generation, storage, and grid investments. Therefore, incremental costs of decarbonization tend to be higher in countries with higher capital costs.

Many countries with lower per capita income also exhibit high costs of capital for any type of investment. This is illustrated in figure 2, showing country-risk premia and per capita gross domestic product (GDP) for twelve countries included in our study. Per capita income is not necessarily a good predictor of country-risk premia. In addition, as expected, there are middle-income countries with high-risk premia and low-income countries with relative low risk premia. The prevalence of higher country-risk premia among low-income countries however suggests that, in many of these countries, higher costs of capital will lead to higher incremental decarbonization costs.

But other factors also increase incremental decarbonization costs: low demand growth, high current shares of emissions-intensive generation, poor cost competitiveness of renewables compared to fossil-based generation, and limited access to firm, flexible low-carbon generation.

Other factors besides the cost of capital could affect the incremental costs of power system decarbonization. Figure 3 illustrates this effect. The figure’s vertical axis depicts the required reduction in the present value of annual capital amortization payments needed to zero out the costs of decarbonization. This reduction in annual capital amortization payments corresponds to the purple arrow (“Decrement in direct power system costs from injection of concessional finance in the capital structure”) in figure 1. The horizontal axis shows the WACC for investments in generation and storage.

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4. Here, the premia represent the additional returns required to invest in the target country relative to the United States.

5. Five of the countries studied are eligible for loans and grants from the International Development Association (IDA); the other seven borrow from the International Bank for Reconstruction and Development (IBRD). The values of per capita GDP at purchasing power parity (PPP) in 2022, expressed in 2017 dollars, were obtained from the World Bank’s DataBank, a public database (https://databank.worldbank.org). The value for 2022 was not available for one of the countries; therefore, only 11 values are plotted.

6. In figure 3, this variable is shown as a percentage reduction of the present value of annual spending on capital amortization to facilitate comparison across countries.

7. The graph shows the estimated country-specific WACC for investment in renewable energy (RE) generation, storage, and thermal generation with carbon capture and storage. The WACCs were estimated with aid of a capital asset pricing model and country-dependent assumptions, including the country-risk premia plotted in the figure 2. The assumptions used for
Figure 3 shows that countries with relatively low costs of capital could have relatively high incremental decarbonization costs (and thus high necessary reductions in annual capital amortization payments through concessional finance injections to minimize incremental direct power system costs from decarbonization), and vice versa. Among the countries included in the assessment, the main reasons for high incremental decarbonization costs include:

- **Low demand growth and a high current share of emissions-intensive generation assets.** Higher incremental decarbonization costs are seen in countries with lower growth in demand and higher initial shares of recently commissioned emissions-intensive generation assets. In such cases, low-carbon assets need to replace more-polluting assets from the initial years of the forecasting period (e.g., in the next 5–10 years) to meet stringent decarbonization costs include:

- **Limited-cost competitiveness of renewables compared with fossil-based generation.** Renewable generation is more competitive in countries where the (opportunity) costs of fossil fuels are higher. Such countries will already have large amounts of renewables-based generation in the unconstrained least-cost scenario, lowering the incremental cost of the decarbonization scenario before injection of concessional finance.

- **Limited access to firm, flexible low-carbon generation.** Lower incremental costs of decarbonization are seen in countries with access to lower-cost renewable sources that have operational flexibility in their power system—and in countries with comparatively lower variability of low-carbon generation and thus lower demand for operational flexibility from other resources.8

Naturally, other factors may affect the incremental costs of decarbonization. Some of these are not captured here.

**Countries with relatively low costs of capital could have relatively high incremental decarbonization costs... and vice versa.**

8. Hydropower, energy storage, or even the transport and storage of captured carbon dioxide at relatively low costs can provide operational power system flexibility from low-carbon resources. Lower intrinsic variability may stem from highly complementary variable renewable resources (either from different primary energy resources or from resources with complementary availability patterns potentially located in remote geographical locations) connected to a highly interconnected grid.
Figure 4. Share of concessional finance in the capital structure of new facilities needed to zero out the incremental costs of decarbonization

As a function of targeted decreases in the present value of annual capital amortization payments for different countries using only concessional debt (variant 1, left panel) or only grants (variant 2, right panel)

More concessional finance is required if concessional debt (which must be repaid by the borrowing country) is used rather than grants. This is true for any predefined set of uncertainties. In future work, the team will assess the types of risks affecting different types of investments (among them renewable energy, storage, grids, and energy efficiency) to clarify financing options and explore the need for concessional finance across the entire energy sector in selected pilot countries undergoing the energy transition.

In reality, the concessional resources directed to any single country are unlikely to be composed entirely of concessional debt or grants. A mix of these two instruments (low-cost finance and grants), together with guarantees, constitutes a blended-finance solution that is more likely to occur in the current context, where concessional resources are limited.

By definition, if financial transfers consist entirely of grants and displace market-priced equity and debt in a project’s capital structure, the share of concessional resources is

owing to limitations in methodology or data. For example, electricity costs rise when the renewable resources are located far from the existing transmission grid.

**What do higher incremental decarbonization costs imply?**

**Generally, a need for more concessional finance**

The volume of concessional finance needed to offset the incremental costs of decarbonization tends to grow in line with these incremental costs. This unsurprising result merely indicates that if the goal is to minimize the increase in direct power system costs borne by final consumers, concessional finance transfers should be larger for countries where incremental decarbonization costs are greater. Figure 4 shows that the relationship holds whether concessional finance is provided entirely through debt priced below market rates or entirely through grants.
identical to the targeted reductions in annual amortization payments (in percentage terms). This explains the perfectly linear relationship on the right panel of figure 4. The relationship is not linear if concessional resources take the form of low-cost debt.

Only ten points are plotted in the left panel of figure 4, even though our assessment covers 12 countries. The two countries not shown in the figure have high target reductions in capital spending as well as relatively low costs of capital, so concessional debt alone cannot have a large enough effect to offset incremental decarbonization costs. That is, concessional debt financing in excess of 100 percent of the capital structure would be needed to achieve the decarbonization targets in the power sector. If the international community is to provide concessional financing to these countries with the goal of canceling out the incremental costs of decarbonization, costs beyond capital expenditures would need to be covered.

**What do higher market-based capital costs imply?**

*The impact of each dollar of concessional finance on incremental costs of decarbonization grows with the difference between market-based capital costs and the cost of concessional resources*

The left panel of figure 4 shows that countries with similar targets for lowering capital costs may require varying levels of concessional debt. For instance, the three countries with targets ranging between 30 percent and 40 percent have shares of concessional debt in the capital structure ranging from 53 percent to a whopping 97 percent.9

The different shares of concessional debt are explained by the difference between the commercial cost of capital and the cost of concessional debt for each country. The average real cost of U.S.-dollar-nominated IBRD debt is around 3.5 percent per year for the IBRD countries in our sample.10 The cost of commercial capital before concessional finance injections ranges between 9.3 percent and 30.1 percent per year, depending on the country. This means that replacing (part of) the original capital sources with concessional debt will lower the capital cost by a value ranging from 5.8 to 26.5 percentage points per dollar of concessional debt contracted, depending on the country. Other things being equal, the total volume of concessional debt required in a country where each unit brings an annual reduction of 26.5 percentage points in the cost of commercial capital will be less than in a country where the corresponding reduction is 5.8 percentage points.

**Countries with similar targets for lowering capital costs may require varying levels of concessional debt.**

Although this conclusion is to be expected, the international community may need to bear it in mind when evaluating the balance between actual financial costs and expected impacts of offering concessional debt to various low- and middle-income countries. Other things being equal, the total required nominal loan volumes, in U.S. dollars, will be comparatively higher for countries with lower prevailing costs of commercial capital. But the financial transfer (“donation”) per U.S. dollar extended from the international community to the country is also lower (as a function of the prevailing cost of capital for the target activity in the lending country). Reciprocally, the volumes of concessional finance will be lower for countries with higher prevailing costs of commercial capital. However, the donation value of each dollar lent will be higher, implying a higher perceived cost for the donor and a greater benefit for the borrower.

**Where do we go from here?**

*Stay tuned for future analysis!*

The team is deepening its analysis of concessional finance for the energy transition, both to address the limitations described above and to expand the scope of the analysis with targeted deep dives in several pilot countries.

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References


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