CrossBoundary Advisory

October 2024

Leveraging capital markets **to mobilize institutional capital into Hydropower projects**

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Executive Summary

Large hydropower projects have faced considerable headwinds as an asset class due to long development timelines and high upfront costs, often exacerbated by extensive environmental and social (E&S) mitigation plans required. The five-year rolling average of newly delivered hydropower projects since 2016 exhibits a downward trend, with 2023 marking the lowest single-year of additional conventional hydropower capacity this century.[1]

Despite these setbacks, hydropower remains one of the world's largest and cheapest sources of renewable long duration energy storage and an increasingly important source of dispatchable energy that can enable the rollout of other, more intermittent sources. Continued investment in hydropower development and rehabilitation of existing assets is critical to the energy transition, including in emerging markets.

In these markets, governments have historically been the main financiers of hydropower projects but now face significant budget and borrowing constraints. As a result, unlocking private capital is becoming increasingly important to ensure continued investment in the sector. Green bonds present a significant opportunity that can be leveraged to mobilize institutional capital into the sector given the growing focus on ESG investments by the global investor community.

Green bonds are a fast-growing type of debt instrument used to fund projects that deliver environmental benefits. Issuers must commit to using the proceeds of such bonds for projects that advance climate mitigation and adaptation efforts according to established standards. Until recently, a comprehensive framework for the use of green bonds for hydropower did not exist, leading issuers to exclude hydro projects due to a lack of clarity over appropriate sustainability standards and concern over hydro's mixed E&S perception.

The release of the Climate Bonds Initiative's Hydropower Criteria and ESG Gap Analysis Tool in 2021 provided a comprehensive framework for developers to align their hydropower projects with the requirements of green bonds for the first time. Greater adoption of this framework can help reduce the E&S risk of projects and provide developers with access to a growing pool of private climate finance for hydropower projects.

With large ticket sizes and long-term, inflation-linked and countercyclical returns, large hydropower projects are well-suited to the needs of institutional investors like pension funds, large asset managers, and insurance companies. Combining this with the need to align with Net-Zero principles makes green bonds a highly relevant tool to finance these assets. High construction stage risks mean that these investors are unlikely to be involved in the pre-construction phase, however, green bonds can be leveraged to refinance operating assets, once they are de-risked. Unlocking these new financing pools into operational hydropower projects can then accelerate the period over which critical and scarce early-stage capital can be re-deployed into developing new hydropower projects.

Green bonds can drive increased hydropower investment and accelerate the global path to Net-Zero, but more needs to be done to increase their adoption, particularly in emerging markets. Donors, DFIs, and other development partners can play a critical role in this process by facilitating pioneer transactions that can demonstrate their viability. This could include identifying high-priority hydropower projects that would benefit from refinancing and engaging their sponsors to provide technical and transaction advisory assistance, support in deal structuring, ensuring compliance with the CBI Hydropower Criteria, and providing de-risking instruments including, potentially underwriting some of the transactions themselves. Through these and other steps, various development partners can play a vital role in reinvigorating and accelerating investment in large hydropower projects in emerging markets.

Throughout 2024, the CrossBoundary Power & Infrastructure team has worked across many asset classes and instruments in the energy transition sector, providing both buy-side and sell-side advisory. However, attracting new pools of capital into large hydropower projects has continued to be challenging. With the global push for decarbonization, hydropower has a critical role as a clean, reliable, and dispatchable energy source that enables the rollout of low-cost intermittent renewables, such as solar and wind.

Achieving the Paris Agreement's 1.5ºC temperature rise limit will require the installed hydropower capacity to be doubled (representing an additional 1,300 GW).[2] This is estimated to require USD $1.7 trillion in new investment into the sector, far outstripping governments' capacity to invest.[3] We believe the building blocks are now in place for capital markets to play a pivotal role in mobilizing capital from large institutional investors into this sector to be able to bridge the vast energy transition funding gap.

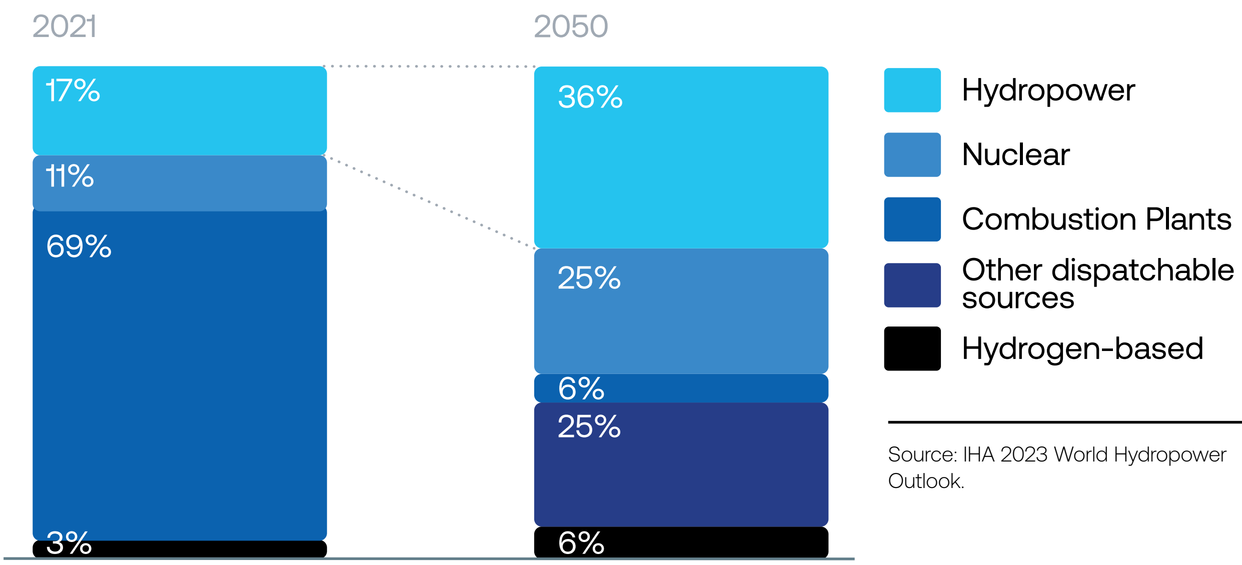
Hydropower can be the clean base load that enables more intermittent renewables

The costs of solar and wind power have declined precipitously over the last decade, enabling their broad-based adoption. In fact, the International Energy Agency projects that solar and wind will become the leading sources of global electricity generation by 2030.[4]

However, a critical limitation of these sources of power is that they are intermittent and thus non-dispatchable, and as they gain adoption and grow in terms of their composition of grids, particularly in emerging markets, grid operators need to ensure that grids remain stable and adapt to this new structure. This includes the need to also add dispatchable baseload power and/or storage sources to maintain system integrity.

Hydropower plays a critical role in this, currently accounting for over 94% of installed global energy storage capacity.[5] Moreover, its role as a baseload source of energy is projected to increase from 17% of dispatchable power in 2021 to 26% in 2050 (see Figure 1).

Figure 01 **Share of global electricity by dispatchable energy sources**



Source: IHA 2023 World Hydropower Outlook.

Hydropower, in short, is expected to play a growing role as one of the world's leading storage technology.

While the cost of batteries has been declining, and as a result their adaptation has been rising, batteries also have technological limitations of being most relevant for peaking or frequency stabilization, rather than for long duration energy storage (LDES. In many cases, hydropower can also be used for frequency regulation and grid balancing ancillary services, albeit with slower discharge times.[7,8] Hydropower remains a unique only low-carbon electricity-generating technology that can provide system flexibility within a range of sub-seconds to hours while also cost-effectively storing energy for days to months.[9]

While batteries have a 10-15 year expected operational lifespan, capacity typically declines by 2-4% each year, with most lithium-ion batteries degrading to 80% of their full capacity between 500 and 2,000 cycles.[10] Meanwhile the average life of hydropower assets are 100 years, or over 120 years for several, particularly large hydro structures, with nearly no capacity reduction and very low fixed operating and maintenance costs (typically 2-2.5% of installed costs[11] or $28.19 per kW of installed capacity per year.[12]

Overall, hydropower provides relatively low-cost electricity storage over its long lifetime, despite relatively high upfront construction costs and typically long development times. As of 2022, lithium-ion systems had an average levelized cost of storage of USD $356/kWh for a 100 MW, 10-hour battery system, whereas pumped-storage hydro, the dominant grid storage technology, had an average levelized cost of storage of USD $263/kWh for a 100 MW, 10-hour installed system.[13] This does not include costs associated with end-of-life decommissioning.

In sum, the benefits of hydropower assets go beyond their own ability to generate power, but truly as an enabler of increasing the grid's capacity to continue to absorb cleaner, and lower cost intermittent sources of energy. The challenge is not only that large hydropower projects are expensive to build, but also that the traditional financiers, i.e. governments, have highly constrained balance sheets, and as a result can no longer afford the price tag, particularly in large hydro that also have long lead times.

"Baseload hydro has an important role to play in the energy transition of emerging markets and innovative financing solutions alongside creative development models are needed to get key projects off the ground. In my experience of 28 years of hydro development in Africa, it is clear that business as usual will not suffice."

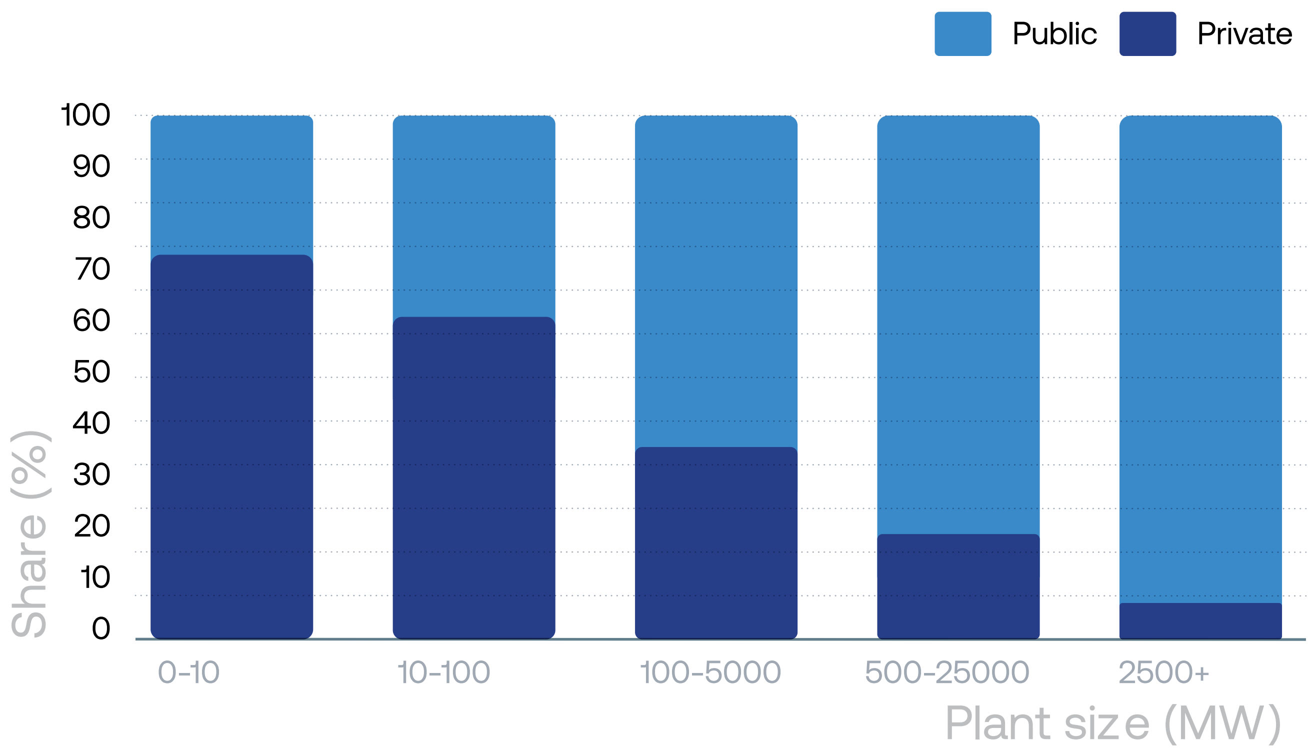
Christian Wright, Founder
Orion Infrastructure Advisor

Why private capital is critical

Much of the world's undeveloped hydropower potential is concentrated in Africa and Asia, with roughly 41% of the estimated 12,420 TWh/year of global feasible hydropower potential.[14] In fact, only 10% of Africa's estimated hydroelectric potential has been tapped as of 2023.[15]

Historically, the public sector has financed the build-out of large hydropower plants. To illustrate, while the private sector owns approximately 70% of the number of plants commissioned between 2000 and 2020, the public sector owns more than 70% of the total installed capacity (see Figure 2). This is particularly acute for large hydro where assets above 100MW the public sector owns between 60%-95% of installed capacity.[16]

Figure 02 **Share of hydropower ownership by plant size**

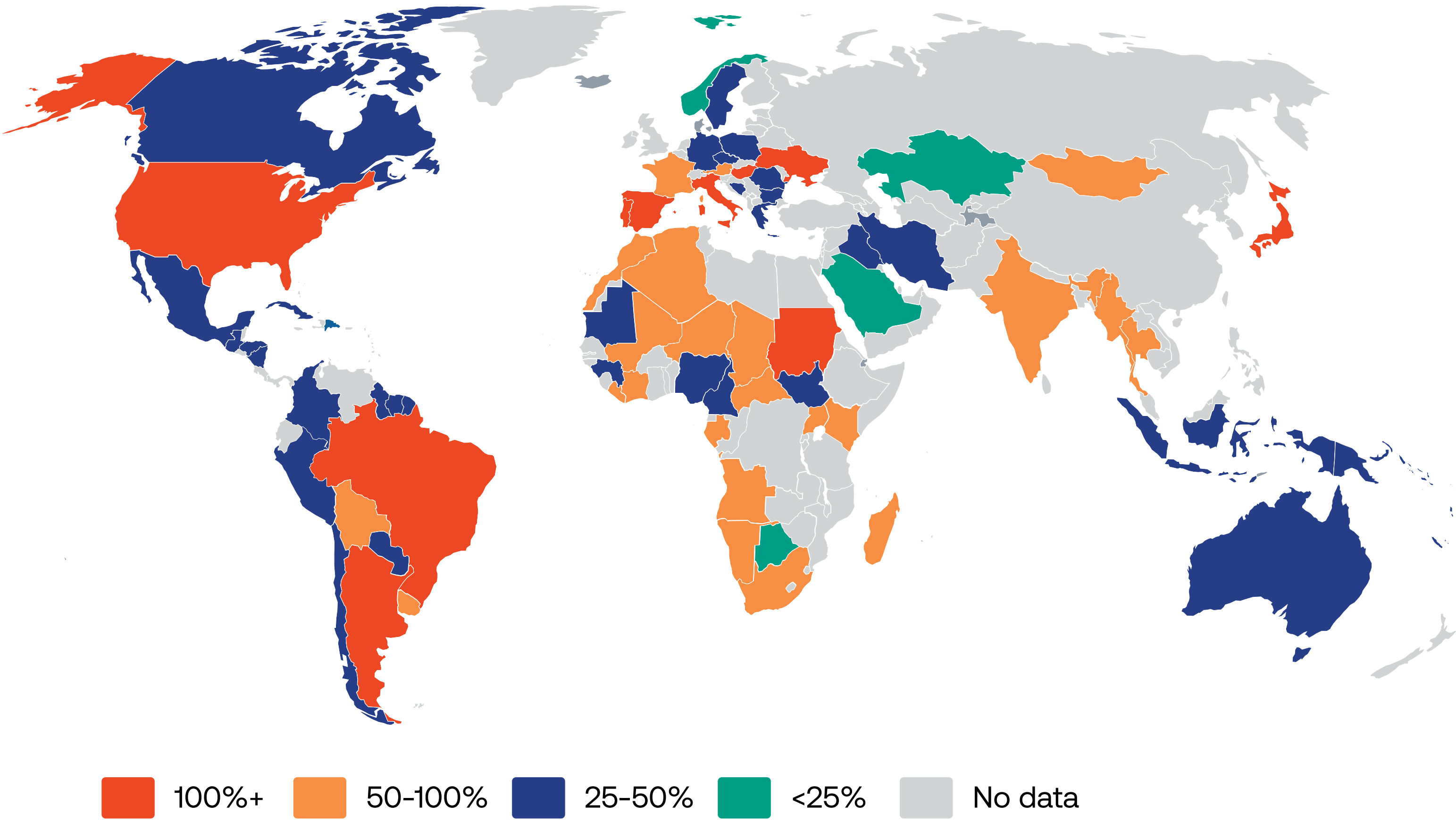


Source: Adapted from Hydropower Special Market report (2021), IEA.
Note: For plants commissioned between 2000 and 2020

Unfortunately, despite the untapped potential and critical need for new hydropower capacity, many governments in Africa and Asia face severe balance sheet constraints (see Figure 3). Their high debt-to-GDP ratios, coupled with an inflationary backdrop that has lift ed the cost of borrowing globally, combine to effectively lock local governments out of global capital markets. This prevents governments from issuing debt to finance large hydropower projects, even if the underlying economics of the projects under consideration are strong.

Figure 03

Global debt-to-GDP ratios



Source: IMF Central Government Debt as % of GDP (2022)

Natural alignment with institutional capital

Fortunately, large hydropower projects exhibit several key characteristics that should make them appealing to large pools of institutional capital, such as pension funds, sovereign wealth funds, and insurance companies. These attributes include:

- **Long-term, inflation-linked cash flows —** The average lifespan of large hydropower projects is nearly 100 years with some large hydropower projects operating for 120years+[18], enabling investors to match long-term liabilities with long-term cash flows; moreover, projects can have offtake agreements that are hard currency denominated, with embedded inflation adjustments, thereby providing predictable real returns.

- **Diversification benefits —** a real asset, hydropower projects are typically uncorrelated with listed equity and fixed income, providing a countercyclical source of returns and reducing portfolio risk.

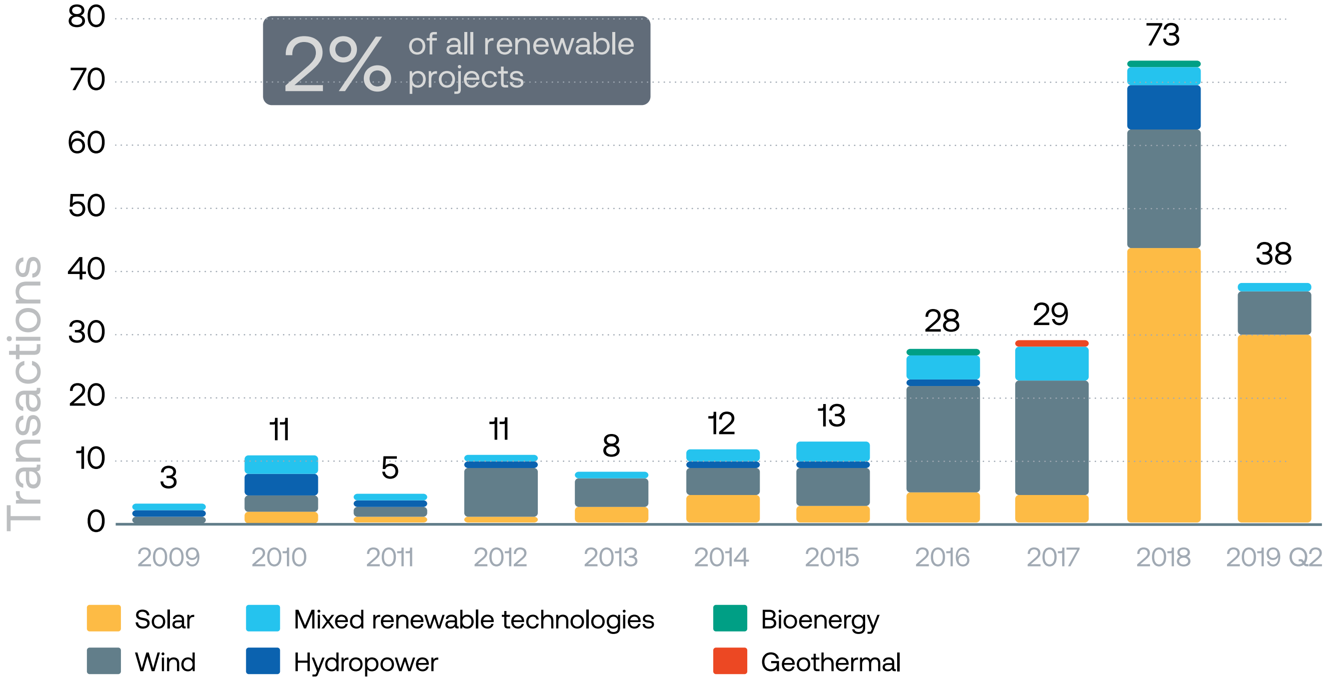
- **Sizable tickets —** Hydropower projects can absorb large investments, enabling institutional investors to deploy capital at scale and attain meaningful exposure to the underlying assets.

These institutions manage more than USD $70 trillion in investable assets globally, of which pension funds alone account for over half.[19] However, average target allocations to infrastructure for institutional investors is only 5.5 percent, or approximately USD $3.85 trillion.[20] Between 1990 and Q2 2019, IRENA found that only 2% of renewable energy project transactions involved institutional investors (see Figure 4).[22]

This under-allocation likely reflects the lower risk-adjusted returns of infrastructure as an asset class relative to alternatives. Global infrastructure portfolio returns averaged 7.1% in 2023 amid a challenging macroeconomic and interest rate environment, lagging the trailing three-year average return of 10.1%.[23] At the same time, a mismatch between the preferences of these investors for long-term stable returns from existing assets and the characteristics of the prevailing closed-fund investment vehicles used by most investors, which are more appropriate for newer and early-stage projects, is likely also contributing to a lack of institutional investor appetite for renewable energy and other infrastructure.[24]

Figure 04

Number of renewable energy project transactions involving institutional investors, by technology (2009-2019)



Source: IRENA analysis based on Preqin data (2019).
Note: "Mixed renewable technologies" include more than one type of renewable energy technology

However, with global rate cuts expected on the horizon, increased fiscal support for infrastructure, and a need to continue to deploy capital and liquidity, institutional capital is expected to continue to flow into infrastructure and renewable energy at an accelerated rate in keeping with long-term growth trends. This is particularly true if new investment vehicles can better target the needs of institutional investors by focusing on indirect investments into asset portfolios that focus on already operational assets, have sufficient liquidity, and can deliver sufficient long-term, inflation-aligned, risk-adjusted returns.

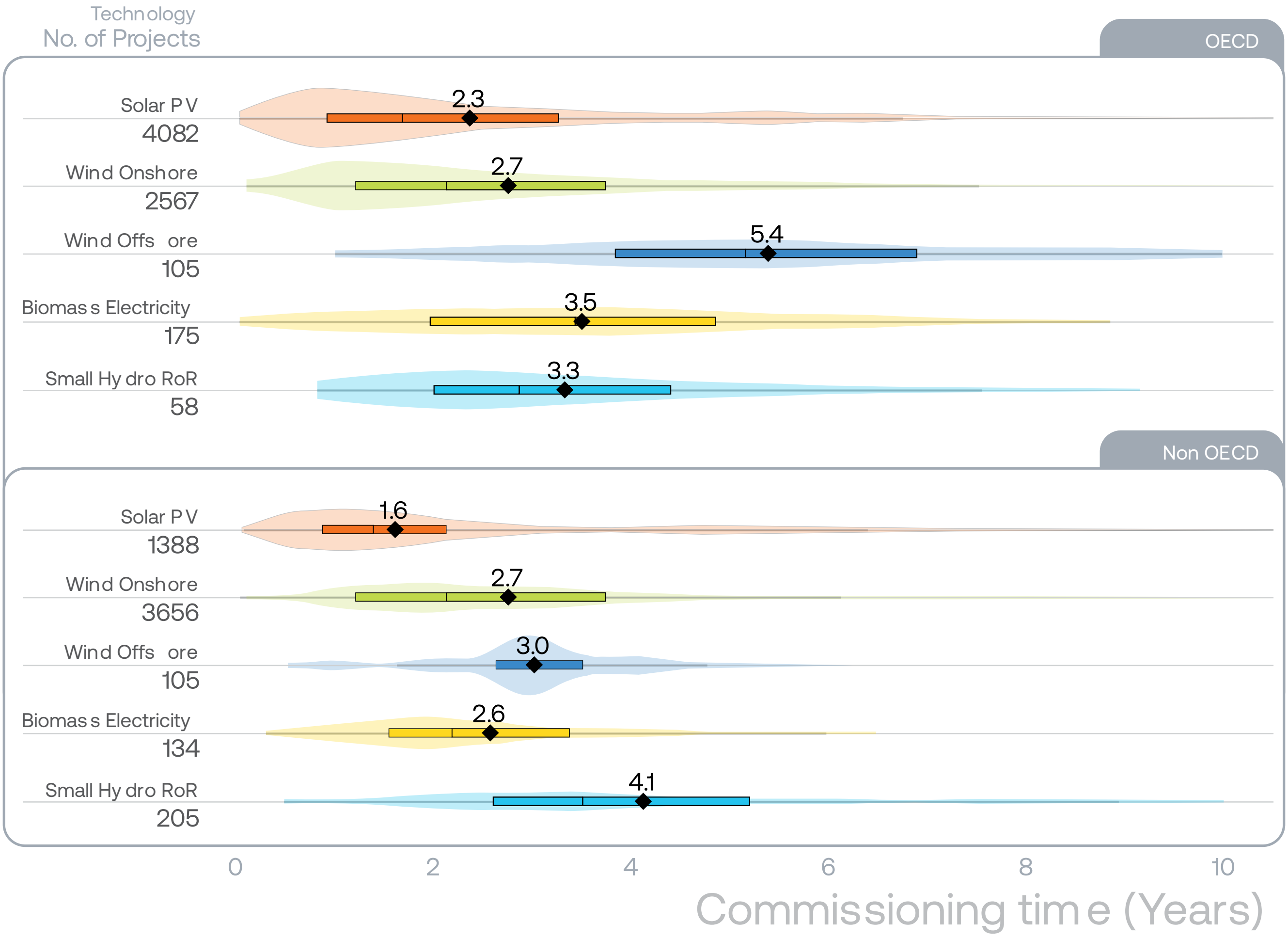
Sidestepping construction risks and delays by focusing on refinancing

Financing new renewable energy projects may be daunting for many institutional investors, particularly those who are new to the space. IRENA reports that, for investors new to renewables, portfolios of operating assets are preferred, given the lower risks involved, and they prefer to do so via indirect investments through funds or bonds where available, which can be done with fewer in-house resources or expertise compared to direct investments.[26]

Raising pre-construction project financing from institutional investors via capital markets is unlikely to be a winning strategy for several reasons. First, the cost and time overruns for large hydropower projects can be protracted, with project timelines often extending beyond 10 years depending on the size, complexity, and environmental risks.[26] Even for small run-of-river (RoR) hydropower projects, average commissioning time is high, particularly in non-OECD countries (see Figure 5).[27]

Figure 05

Average commissioning times for renewable energy technology projects commissioned between 2005 and 2022 in OECD and non-OECD countries



Source: Applied Energy

Not only is this a highly inefficient use of investors' capital, but it also injects a degree of political and regulatory risk, as governments can change over the development lifecycle and focus on different priorities. The longer the time that capital is tied up in unapproved and incomplete projects, the greater the return that investors will require and the higher the tariffs paid by consumers. In addition, the pre-construction period requires the understanding, evaluation, and mitigation of environmental, social and governance risk factors that can be significant, particularly for large hydropower projects with storage.

Several of these risks are however mitigated by developers during the development and construction phases. Large project developers—such as EDF, Engie, and Statkraft—will often partner with development finance institutions as they typically need to take on most of these construction risks.

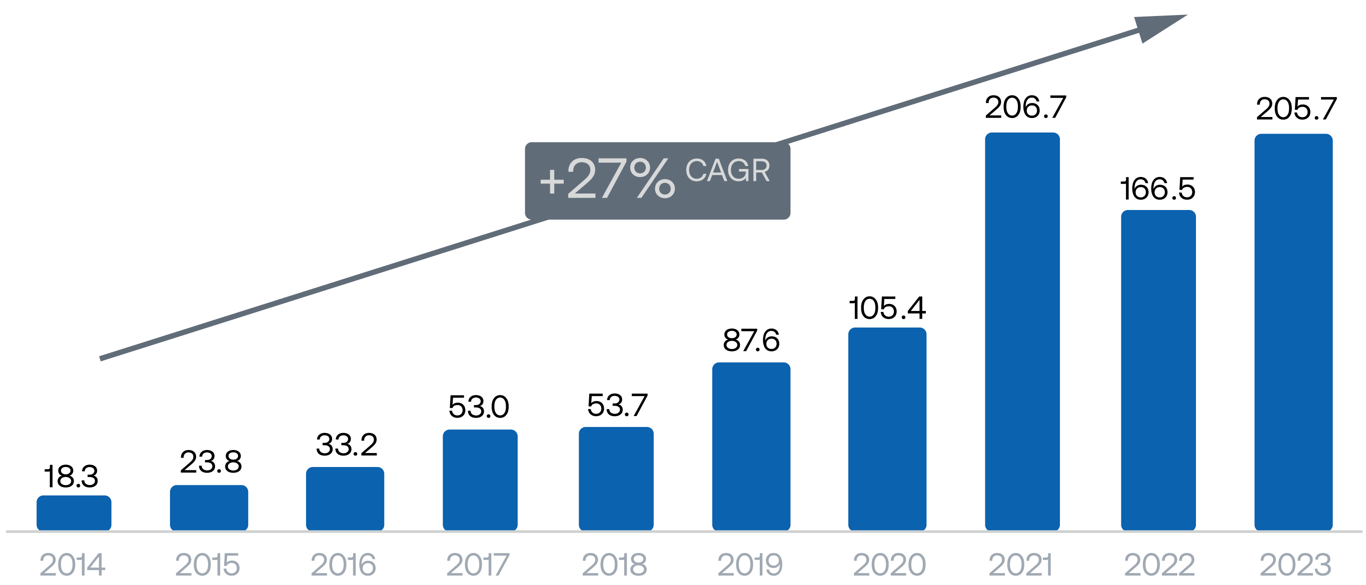
Institutional investors, given their risk appetite, are therefore best suited to enter into these transactions by re-financing these large hydropower assets post-construction, after they have been significantly de-risked.

Global capital markets are becoming more capable of delivering instruments that can compensate early-stage investors for the risks they take to bring renewable energy online, in exchange for providing institutional investors with long-term stable cashflow. An exciting development for institutional investors to contribute project financing for new or existing hydropower projects are through the rapidly growing market for green bonds.

Harnessing the potential of green bonds

Green bonds are fixed-income instruments that are dedicated to the financing or re-financing of clean energy and climate-related projects. They may be issued by sovereigns, corporates, or financial institutions. Since 2014, annual green bond issuance for clean energy projects has grown from USD $18 billion to USD $205.7 billion in 2023, mobilizing an aggregate of USD $953.9B in capital (see Figure 6)[28] in less than a decade. However, as of 2017, only about 2% of green bonds were for hydropower use.[29]

Figure 06 Green bonds issued for energy-related investments (US$B)



Source: Climate Bonds Initiative

While green bonds have been successfully financing solar projects for over a decade, attracting large pools of private capital, they have recently started being used to target other alternative technologies as well, such as geothermal and batteries (see Figure 7). EDF's issuance of the first-ever green bond for nuclear energy is a good indication of investors' and regulators' expanding appetite for leveraging green bonds for assets that have previously been marred with uncertainty about their "green" designation due to environmental impact concerns.

Figure 07 **Sample Green Bond Issuances for Renewable Energy**

Developer	Project country	Technology	Financing (USD $M)	Notes
SOLAR PACK	Malaysia	Solar	60	Solarpack secured US $60 million by issuing a green bond facility in Malaysia to refinance their 116 MW solar powerplant.[30] This marked the company's first green bond issuance, holding an AA2 rating and Tier 1 Environmental Benefit Rating.
Scatec	Egypt	Solar	334.5	In 2022, Scatec issued a 19-year green bond for US $334.5 million to refinance project debt for six solar plants in Egypt's Benben Solar Park (capacity of 380 MW).[31]
MASDAR	Emerging Markets / Global South	Multiple	1,000	Masdar raised USD $1 billion through its AA- rated second green bond issuance, following the success of its USD $750 million first green bond issuance in 2023. Overbooked by investors by 4.6x, the popular bonds will go towards financing greenfield renewable energy projects in emerging markets.[32]

Figure 07 continues next page...

Developer	Project country	Technology	Financing (USD $M)	Notes
energy DEVELOPMENT CORPORATION	Philippines	Geothermal, Batteries	102.5	EDC, the largest renewable energy company in the Philippines, issued a second tranche (PHP 6 billion) of its PRS Aaa-rated Fixed Rate ASEAN Green Bonds to support geothermal and battery expansion projects along with resiliency and maintenance CapEx initiatives.[33]
EDF	France	Nuclear	1,088	France's EDF launched Europe's first green bond for nuclear energy. With a nominal amount of EUR 1 billion, a 3.5-year maturity, and 3.75% fixed coupon, the proceeds will be used to refinance existing nuclear reactors and expand their useful life, in line with revised EU green taxonomy and legislation that classifies such projects as "green."[34]
NEDBANK	South Africa	Multiple	115	Nedbank concluded a R2.1 billion (USD $115 million) Tier 2 green bond aligned to ICMA green bond principles, with the proceeds going to fund private renewable energy projects in South Africa.[35]

Despite the overall growth in volumes, the uptake of green bonds for hydropower projects has been limited. Until recently, hydropower projects were excluded from issuing green bonds due to a lack of clarity in how the projects would fit within existing sustainability frameworks, as well as concerns over the potential for negative environmental and social (E&S impacts. For instance, large hydro projects—especially dammed projects —can have significant biodiversity and water quality impacts. In addition, they can often require the re-settlement of local communities that would be displaced from the flooding expected in the catchment area of the dam.

However, in March 2021, the Climate Bonds Initiative (CBI)—working in concert with key stakeholders in civil society and the hydropower sector—released a comprehensive framework for hydropower projects to be included in the Green Bond framework by developing clear and transparent screening criteria. The Climate Bonds Initiative Hydropower Criteria apply to:

- **Power stations** (run-of-river, impoundment, and pumped storage)
- **Applications** of in-stream technology
- **Existing infrastructure** dedicated to eligible facilities, such as dedicated transmission lines

To satisfy climate adaptation and resilience criteria for Climate Bond certification, CBI also requires developers to undertake an assessment using the ESG Gap Analysis Tool, carried out by an Accredited Assessor, and develop an Environmental and Social Action Plan (ESAP) to address any identified gaps, with limits to the number and severity of the gaps and timeline to address them.[36] If an issuer is unable to close any identified ga s within the stated timeframes (the majority of significant gaps closed within 12 months and all remaining significant gaps within 24 months), which must be confirmed by the Accredited Assessor, certification will be withdrawn.

Following the release of the Hydropower Criteria, in December 2021, the Costa Rican Electricity Institute (ICE became the world's first hydropower operator to obtain green bond certification for a hydro-backed bond under the newly released criteria.[37] The proceeds of the issuance went to refinance the 330MW Reventazon hydropower plant, which has a generation capacity of 1,465 GWh/year and supplies energy for 12% of Costa Rica's population. Despite its success, the ICE bond issuance remains one of the only examples of hydro-backed green bonds using the CBI Hydropower Criteria, demonstrating a lack of traction for using these instruments for financing or refinancing large hydro projects.

A few months later, India announced plans to issue the country's first ever green bonds amounting to USD $1.93 billion in 2022 to fund clean energy projects.[38] Noticeably, hydropower plants over 25 MW were excluded, signaling continued reluctance to include large hydropower projects in sovereign green bonds despite the fact that the Indian government in 2019 declared hydroelectric projects over 25 MW a renewable energy source and made it obligatory for power companies to use hydropower for a share of their supply.[39]

Figure 08

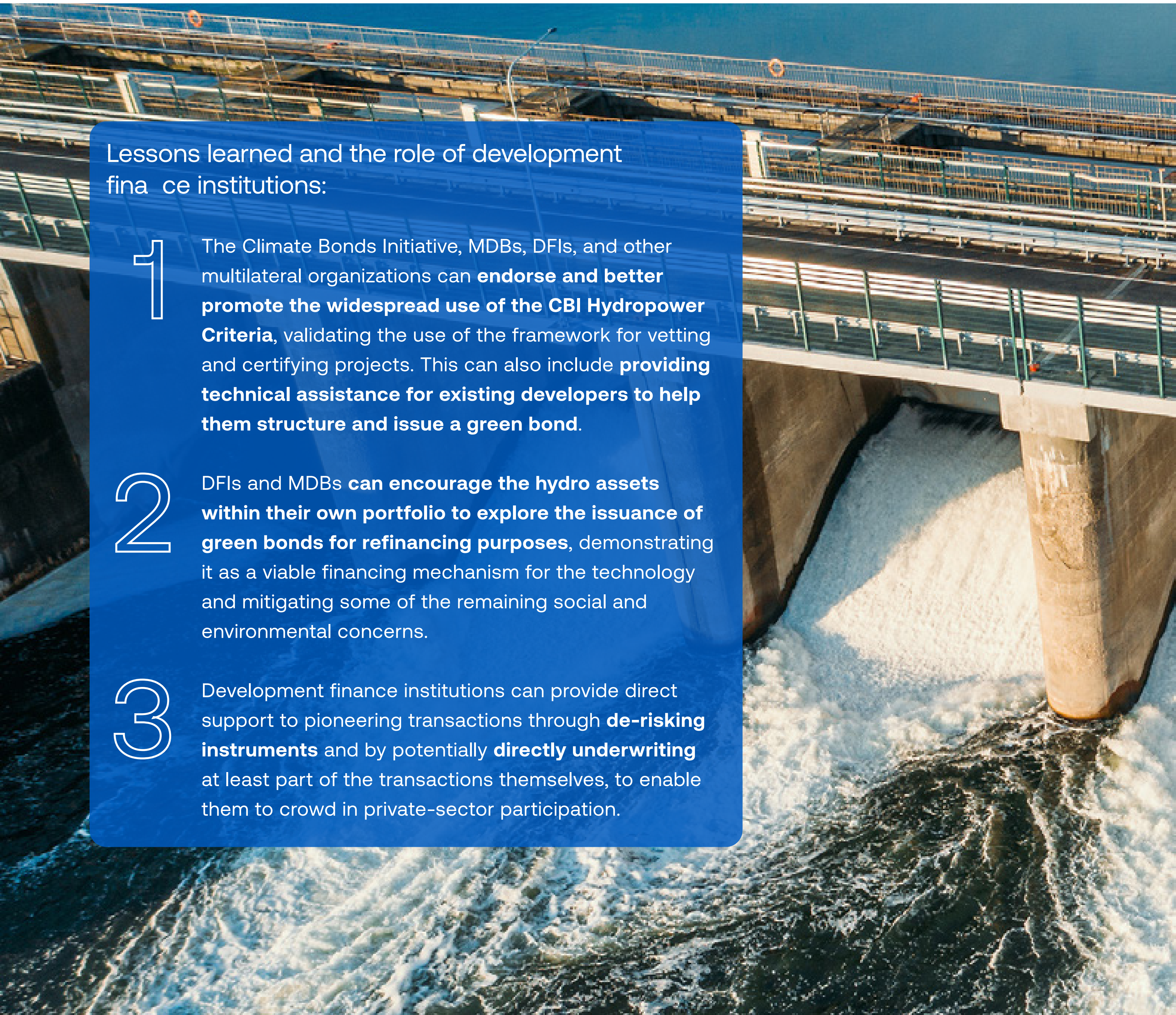
Sample Green Bond Issuances for Hydropower Projects

Developer	Project country	Financing (USD $M)	Notes
	Nigeria	23.6	North South Power issued Nigeria's first corporate 15-year Series 1 Green Bond valued at $23.6 million to fund the overhaul of a 150MW hydropower turbine and refinance NSP's short-term foreign debt.[40] The NSP bond was issued in February 2021, prior to the release of the CIB criteria, and was not CBI-certified.
ice	Costa Rica	150	The Costa Rican Electricity Institute (ICE) became the world's first hydropower operator to obtain green bond certification using the new CIB Hydropower Criteria, leveraging the proceeds to refinance a 330MW hydropower plant which supplies power to 12% of Costa Rica's population.[41]

Despite tepid enthusiasm so far, the potential for green bonds to accelerate the development of large-scale hydropower projects across underserved markets is enormous. We estimate that the market for clean energy-linked green bonds could reach USD $1.8 trillion by 2025.[42] With the CBI Hydropower Criteria providing standardized certificationof qualified projects, large-scale hydro project developers can take advantage of this growing asset class to tap into pools of private capital that are crucial for financing the path to Net-Zero emissions and mobilizing capital to underserved markets at scale.

To accelerate this potential, DFIs and donor organizations can play a pivotal role in strengthening the overall enabling environment for hydro-backed green bonds in the markets where they operate, helping to prepare projects for refinancing and adherence to the CBI Hydropower Criteria, supporting enabling legislation, and sponsoring projects with strong demonstration potential.

> *" I'm excited about the opportunity that Green Bonds present to attract global institutional capital into clean infrastructure in Emerging markets. However donors and DFIs will need to continue playing a de-risking role to enable this capital flow at scale."*
>
> *DFI Investment Director*



Lessons learned and the role of development fina ce institutions:

1. The Climate Bonds Initiative, MDBs, DFIs, and other multilateral organizations can **endorse and better promote the widespread use of the CBI Hydropower Criteria**, validating the use of the framework for vetting and certifying projects. This can also include **providing technical assistance for existing developers to help them structure and issue a green bond**.

2. DFIs and MDBs **can encourage the hydro assets within their own portfolio to explore the issuance of green bonds for refinancing purposes**, demonstrating it as a viable financing mechanism for the technology and mitigating some of the remaining social and environmental concerns.

3. Development finance institutions can provide direct support to pioneering transactions through **de-risking instruments** and by potentially **directly underwriting** at least part of the transactions themselves, to enable them to crowd in private-sector participation.

Conclusion

Buoyed by fiscal stimulus, a growing investor focus on delivering ESG impacts, and impending interest rate cuts by central banks around the world, infrastructure is poised to outperform as an asset class going forward compared to the past few years of geopolitical and COVID-19 induced inflationary headwinds. At the same time, institutional allocations to infrastructure are expected to continue to grow at a healthy clip, with this year's 42 basis-point year-over-year increase implying a potential USD $500 billion in additional institutional capital for infrastructure in 2024, based on an estimate of global institutional assets under management.[43] With stable, long-term, countercyclical, and inflation-linked cash flows and the ability to provide critical sources of renewable baseload power generation and energy storage, large hydropower projects are well-suited to the interests of ESG-minded institutional investors, provided that investment vehicles exist to facilitate the influx of this financing that also align to investor and developer interests.

Despite the apparent benefits of green bonds and some early success in emerging markets, these investment mechanisms remain underutilized, particularly for large hydropower projects. DFIs and donors operating in developing countries can play a pivotal role in cultivating an enabling environment in these markets that encourages the use of these innovative financing instruments. This can help channel deep pockets of private capital into the sector, particularly to refinance operating assets and recycle scarce development capital back into new projects faster.

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