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Research article

Mapping the evolving complexity of large hydropower project finance in low and lower-middle income countries

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Abstract: The structure and key actors in large hydropower project financing has changed considerably over the past 50 years, particularly in low and lower-middle income countries (LICs and L-MICs). Exclusively public projects, typically financed by the host country government with support from multilateral development banks (MDBs), have become less common, while public-private-partnerships (PPPs) and new forms of bilateral finance arrangements have become more prevalent. However, fully privately financed projects with no public or MDB finance remain unusual in large hydropower projects. This paper traces the evolution and complexity of hydropower financing in LICs and L-MICs from the early 1970s to the present day, showing how the types and roles of various actors have changed over time and how new types of financing packages have surfaced to meet the growing need for large energy infrastructure projects. Examples from various LICs and L-MICS are used to describe the features of three of the most commonly used models of hydropower project financing: fully public finance, PPPs, and new bilateral finance. Comparative assessment of the key characteristics of different financing models and their strengths and limitations is provided to enable LICs and L-MICs to make informed choices over the allocation of their scarce financing resources in their struggle to balance urgent development needs with long-term sustainability objectives and economic impacts.

Keywords: hydropower; project finance; developing countries; sustainable development; risk; sustainability

JEL Codes: G32, O16, O19

1. Introduction

The majority of the world's untapped techno-economically feasible hydropower potential is situated in low and lower-middle income countries (LICs and L-MICs)[1]. In these countries, sustainably developed large hydropower projects could provide stable, low-carbon, cost-effective electricity to under-served populations and a growing industrial base, while also delivering a range of additional benefits such as flood control, irrigation and potable water reservoirs associated with multi-purpose projects (IEA-ETSAP & IRENA, 2015; World Energy Council, 2015)[2]. Large hydropower could also perform an essential role in stabilising the electricity grid and providing electricity storage as these countries increase their intermittent renewable electricity generation capacity (IEA-ETSAP & IRENA, 2015; World Energy Council, 2015). However, lack of available financing for large hydropower projects could negatively affect the ability of these countries to take advantage of their natural resources for social and economic development.

Over the past 50 years, the availability and types of financing that is accessible for LICs and L-MICs for large energy infrastructure projects has changed radically. In the 1970s to 1990s, most large hydropower projects in LICs and L-MICs were developed using primarily public sector funding, with equity investment from the host country government and debt finance from multilateral development banks (MDBs). From the 1990s onwards, public sector funding for such projects has dwindled—a process that has taken place in the context of broader political and economic changes, including an ideological shift towards greater reliance on the private sector in development finance and the emergence of countries such as China and South Korea as key players on the global economic and political stage.

In 1999, it was estimated that some $15 billion of investment annually would be needed for hydropower projects in LICs and L-MICs (Briscoe, 1999). At the same time, MDBs were shifting away from financing such projects on the grounds that they can generate revenue, and public sector funding ought to be directed to sectors like health and education that could not be self-funding. However, the shift to a greater use of private financing in LICs and L-MICs seemed unlikely: between 1990 and 1995 private finance supported just 7% of new hydropower projects in such countries (Briscoe, 1999). This was explained by the reluctance of the private sector to invest in

[1] Low income countries (LICs) and lower-middle income countries (L-MICs) are definitions used by OECD and the World Bank. Since July 2019, a country has been classified as low-income (LI) or lower-middle income (L-MI) if its Gross national income per capita is US$3,995 or below. The term low and lower-middle income countries (LICs and L-MICS) is used to refer to all countries that meet this criterion.

[2] A large dam, as defined by the International Commission on Large Dams (ICOLD, 2011, p3), is "a dam with a height of 15 metres or greater from lowest foundation to crest or a dam between 5 metres and 15 metres impounding more than 3 million cubic metres".

hydropower projects in unfamiliar markets because of the perceived political, commercial and financial risks, particularly the concern about the long-term payment risk (IFC, 2015). The need for substantial investment to cover set-up costs, such as the various investigations that need to be completed before construction can commence, further increases the level of risk, as the losses will be high if a project fails to reach financial closure (for more detail on the process of achieving financial closure, see Markkanen and Plummer Braeckman (2019)).

To address these challenges, financing models that enable greater private sector contribution but retain some form of MDB involvement emerged. Instead of granting large amounts of concessionary debt to the governments in LICs and L-MICs, MDBs assumed a new role that focuses on leveraging financing for projects in from private sources. This attitude is now also reflected in the World Bank's Maximizing Finance for Development (MFD) approach approved in 2017 (World Bank, 2017b). Under the MFD agenda, techniques such as "blended finance" (IFC, 2017) and complex multilateral guarantees for PPPs are becoming pivotal for large energy infrastructure projects in LICs and L-MICs, including hydropower. Thus, most PPP-financed projects in LICs and L-MICs involve a complex mix of investors, lenders, public finance and guarantees, and multiple legal agreements. The high degree of complexity makes PPP projects slow and cumbersome, with each project taking several years to achieve financial closure.

In some more recent financing arrangements, the debt financing for new projects comes predominantly (or exclusively) from export credit agencies, such as China Exim Bank. Under these arrangements, it is not unusual for the vast majority of debt to be provided by just one financing agency directly to the host country government. These bilateral financing arrangements herald a return to simpler, faster, financing models (with fewer actors and more clearly defined roles), but with radically different dynamics and implications[3]. Whereas earlier bilateral finance typically included some grant element from a high-income country to a low-income country, or export credit finance for a small proportion of project cost, the "new" bilateral arrangements entail commercial debt or export credit issued for the vast majority of the project's total costs by a middle-income country to a low-income country. These financing arrangements thus come with a different set constraints and risks, such as the absence of strong safeguards and increased government indebtedness for the countries that access them. Due to the dominant position of China in this field, what we term here as "new bilateral finance" is elsewhere often referred to as "Chinese finance"[4].

In order to understand the extent and implications of the changing financing landscape on LICs and L-MICs, this paper maps out the three most commonly used models of hydropower finance: fully public, PPP, and new bilateral finance. Each of these models has strengths and limitations, which influence their

[3] Bilateral finance from country aid programmes or export credit agencies (such as that provided by KfW or Hermes) is not new and has long been used in large infrastructure projects. "New" bilateral finance, however, is coming from different countries, such as China and Korea, and in significantly greater quantities than that previously available. In the late 1990s, bilateral aid was dominated by funds from Japan (Tirpak & Adams, 2008). The detailed analysis of the incentives for countries like China to provide this new bilateral finance is not covered in this paper, but is discussed in other research such as Chen et al. (2016) and Hensengerth (2013).

[4] See Heiser et al. (2018) for a detailed explanation and discussion.

availability and suitability for large hydropower projects in these countries. The aim of the paper is to provide a comparative analysis of the short-and long term fiscal and economic implications of the various financing models to governments in LICs and L-MICs, to better enable them to make informed decisions that balance their urgent development needs with long-term sustainability objectives.

This paper draws on a non-systematic literature review and desk-based analysis, which was carried out as part of a larger research project on sustainable hydropower development in LICs and L-MICs. The research that feeds into this paper concentrated primarily on the role of finance, including the changing availability of different types of financing, the relative complexity or simplicity of the different financing models, and the implications of different financing models for the host countries. In addition to the literature review the research involved the mapping of the financing arrangements of a range of hydropower projects. The primary purpose of this mapping exercise was to develop a comparative analysis of the strengths and limitations of the different financing models that are available for LICs and L-MICs.

The desk-based research enabled us to identify three main financing approaches and their common or typical characteristics, which we illustrate through examples from LICs and L-MICs in South and Southeast Asia and sub-Saharan Africa. The examples are drawn from varying geographical and political contexts in countries with low electrification rates and high development needs, in order to contextualise the discussion in the sustainable development discourse using real world examples.

The analysis presented in this paper focuses exclusively on the financing of large hydropower projects which are grid connected[5]. Although small-scale hydropower projects and micro-hydropower plants are helpful for decentralised electricity generation and micro-grids (Pepermans et al., 2005), these projects generally have an entirely different financial structure.

In the next section of this paper, we provide a brief overview of hydropower project development over time and discuss how large hydropower projects can facilitate sustainable socioeconomic development in countries with low electrification rates. Section 3 focuses on fully publicly funded projects with an example from Zambia, while Section 4 describes PPPs with examples from Cameroon and Lao PDR. Section 5 sheds light on new types of bilateral finance, with examples from Ghana and Uganda. Section 6 discusses the relative strengths and limitations associated with each of the three financing models, with conclusions offered in Section 7.

2. Hydropower as a tool for sustainable socioeconomic development

Hydropower is an important and reliable source of renewable energy. Providing 16% of electricity worldwide (IEA, 2018; IRENA, 2019), hydropower is used in some 160 countries, and accounts for more than 50% of total electricity generation in at least 35 countries (IEA-ETSAP & IRENA, 2015). Even after recent increases in intermittent renewable energies such as wind and solar, hydropower still accounts for over 50% of renewable electricity globally (IRENA, 2019) and over 95% of the world's operational electricity storage. As such, hydropower is an important enabler for

[5] For an explanation of how project size affects financing options, see Markkanen and Plummer Braeckman (2019).

the deployment of other renewable energy systems and the development of sustainable electrification programmes in countries with low electricity access rates (World Energy Council, 2015).

Reliable energy supply and productive use of electrification are essential prerequisites for economic development (Blimpo & Cosgrove-Davies, 2019). However, access to modern energy services remains incomplete in many parts of the world, especially in South and Southeast Asia and sub-Saharan Africa (IEA, 2017; World Bank & IEA, 2015). In both continents, inadequate electricity supply is exacerbating inequalities and causing frequent electricity outages, hindering economic development (Blimpo & Cosgrove-Davies, 2019; MIGA, 2018; World Bank, 2018). In Southeast Asia, 65 million people live without electricity and 250 million are reliant on solid biomass as a cooking fuel (IEA, 2017). In 2000–2014, electricity access rate in South Asia increased from 57% to 80%, yet over 250 million people in India still lack access to electricity (World Bank, 2017a). In sub-Saharan Africa, only 43% of the population have access to electricity, and the total number of people without electricity access has increased over the past decade as population growth has outpaced the improvements in grid extensions (Blimpo & Cosgrove-Davies, 2019). In large parts of both Africa and Asia, indoor and outdoor energy-related air pollution associated with the use of biomass in cooking and heating continues to present major risks to public health while also contributing to rising carbon dioxide (CO_2) emissions (IEA, 2017) and deforestation (World Bank, 2017a; World Bank & IEA, 2015).

As shown in Figure 1, the untapped potential for hydropower remains high in many LICs and L-MICs with low electricity access rates (IEA-ETSAP & IRENA, 2015; World Bank Group, 2014). In Nepal, for example, the electricity access rate is around 50% in urban areas and below 25% in rural areas (World Bank & IEA, 2015), while nearly 99% of the country's 90,000 MW hydropower potential remain unexploited (Alam et al., 2017). In sub-Saharan Africa, more than 90% of the available economically feasible hydropower potential for energy generation remained unharnessed in 2013, in spite of a sustained and chronic power crisis throughout the region (Corfee-Morlot et al., 2019; World Bank, 2017a; World Bank & IEA, 2015)[6] with negative implications for health, employment and economic growth (Blimpo & Cosgrove-Davies, 2019).

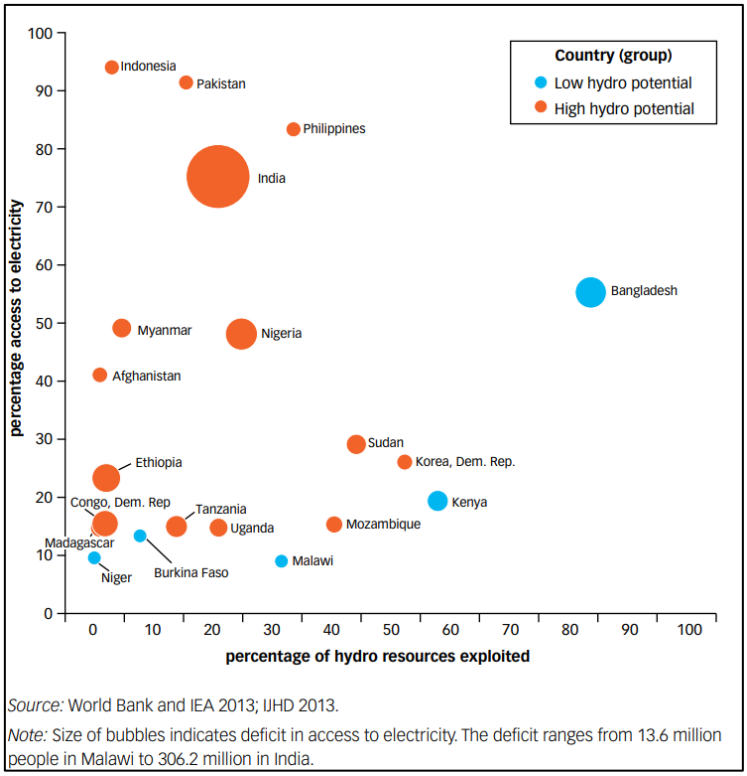
Large hydropower projects can foster sustainable economic growth and improve electricity access rates without forcing LICs and L-MICs to compromise their commitment to the Paris Agreement (Cheng et al., 2020; World Energy Council, 2015). Unlike small-scale, off-grid solutions which have been widely utilised to improve energy access in rural areas, large hydropower projects supply cost-effective, low-carbon electricity to densely populated urban areas and industries. For example, the Bujagali hydropower project in Uganda nearly doubled the country's electricity supply, while Nachtigal hydropower project in Cameroon[7] is expected to increase Cameroon's electricity supply by 30% (World Bank, 2018) and help ease the frequent power outages (MIGA, 2018).

Large hydropower projects can also deliver a range of additional benefits such as flood control, irrigation and potable water reservoirs associated with multi-purpose projects (IEA-ETSAP & IRENA, 2015; World Energy Council, 2015). Better utilisation of the untapped hydropower potential

[6] The economically feasible hydropower potential of a country will change over time, as there are changes in technology and the cost of energy from other sources (IRENA, 2012).

[7] For definitions of terms such as "financial closure", see Markkanen & Plummer Braeckman (2019).

in LICs and L-MICs can facilitate progress towards the broader United Nations Sustainable Development Goals (SDGs): directly for SDG7 (access to affordable, reliable, sustainable and modern energy for all), and indirectly for SDG8 (decent work and economic growth), SDG9 (resilient infrastructure and inclusive and sustainable industrialisation), SDG 1 (no hunger), SDG2 (eradication of poverty) and SDG6 (clean water and sanitation).



Source: World Bank and IEA 2013; IJHD 2013.

Note: Size of bubbles indicates deficit in access to electricity. The deficit ranges from 13.6 million people in Malawi to 306.2 million in India.

Figure 1. Hydropower potential, access to electricity and access deficit in 20 LICs and L-MICs in 2013. Source: Reproduction from World Bank Group (2014) Live Wire: A Knowledge Note Series for the Energy & Extractives Global Practice 2014/36 (page 2).

However, the full range of benefits from better utilisation of untapped hydropower potential is likely to materialise only if the development and financing of new projects is socially, economically and environmentally sustainable. This entails incorporating global best practice through a framework such as the Hydropower Sustainability Protocol (IHA, 2015; Locher et al., 2010) or development bank standards such as the International Finance Corporation's (IFC) performance standards (IFC, 2015) and equator principles (Equator Principles, 2013). New hydropower projects in LICs and L-MICs must also be financed is a way that makes the electricity from these projects accessible and affordable to local consumers without crippling the host country government finances.

3. Fully public projects

Until the 2000s, the majority of large hydropower projects in LICs and L-MICs were predominantly publicly funded. These projects involved combining support from MDBs or bilateral

aid agencies with national public finance from various sources, ranging from development financing to quasi-commercial government-owned utilities and parastatals (Oud, 2002).

Although financing from MDBs was available to all countries that were eligible for international assistance, more large projects were developed in middle-income countries with fast-growing economies, such as Brazil, China and India (Bottelier, 2007; Zimny et al., 2013). For example, the 1960 MW Koyna Hydropower project in India, which was commissioned in several stages from 1962 to 1981, was financed entirely by loans from the Government of India to the Maharashtra State Government. The World Bank provided the Government of India with a loan in US dollars to cover the foreign exchange portion of the cost, which the Government of India then on-lent to the project (World Bank, 1962).

In Zambia, the Itezhi-Tezhi hydropower project was built in 1974–1977 with a combination of a World Bank loan, a Government of Zambia loan and internal resources of the government-owned power company, ZESCO. In the absence of a special purpose company, the World Bank funds were lent to ZESCO rather than to the project (World Bank, 1973). As a result, the project's financial structure was relatively simple, as shown in Figure 2. In common with most projects of the time, the project was divided into separate civil works and electro-mechanical contracts through competitive bidding (so called "traditional contracting").

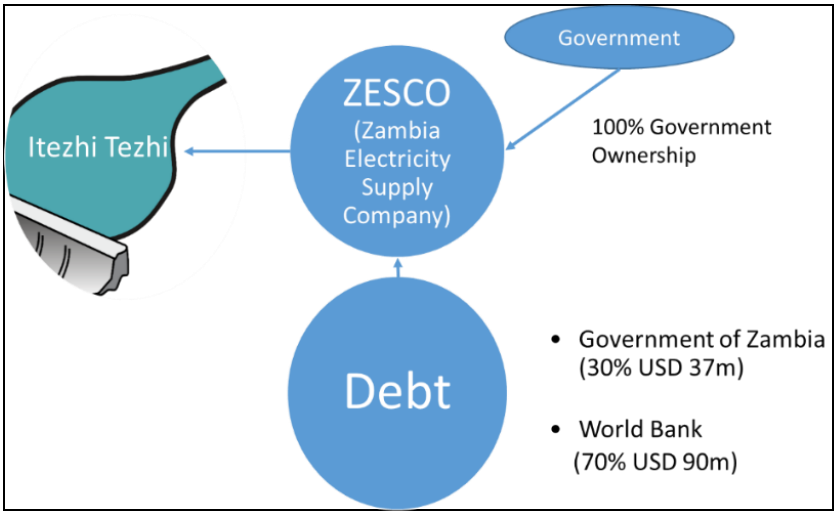


Figure 2. Financing structure of Itezhi Tezhi hydropower project, Zambia. Source: Authors' own work, drawing on data from World Bank (1973).

From the 2000s onwards, fewer hydropower projects in LICs and L-MICs have been financed exclusively by the public sector. Even in Brazil and India, where many projects were previously developed with government funding (sometimes with World Bank support), most projects now have some private sector involvement. A notable exception to this is China, where wholly public sector mega-projects are still being constructed, although more recently these rarely involve MDB finance. For example, the $6.3 billion, 16,000 MW Baihetan hydropower plant (expected to be completed in 2021) is jointly financed by three government-owned agencies: the China Development Bank, the China Construction Bank, and the Yangtze Power Company (a subsidiary of the China Three Gorges Corporation) (Poindexter, 2017).

4. Public-private partnerships (PPPs)

The shift towards greater involvement of private finance does not entail simply replacing the previously prominent financiers (such as an MDB) with a private provider, as no single institution will accept the risk of such a project alone, especially in a LIC or an L-MIC. The PPP financing arrangements for large hydropower projects therefore tend to involve a large number of banks who all take on a proportion of the debt obligation and, consequently, share the risk. In a typical "blended finance" model, resources are pooled by blending official development assistance (ODA) and domestic public funds with commercial finance. These syndicated loans are used especially by development finance institutions (including bilateral development banks) to broaden their co-financing structures and methods. Syndicated loans can also reduce transaction costs by harnessing the due diligence capacity of a multilateral development bank or another lead arranger on behalf of a group of investors to increase the pool of prospective debt financiers in unfamiliar country contexts (IFC, 2017). Another example of the "blended finance" model would be Collective Investment Funds (CIVs), such as United Overseas Bank's ASEAN China Investment Fund III, which made a $25 million private equity investment in Vietnam's largest private hydropower company (Bitexco Power, 2016). Although CIVs are still unusual in hydropower financing, they may play a greater role in the future.

On the equity side, the host country government or a government-owned utility is replaced by a range of private sector investors. While the host country government often retains a share of the ownership under a PPP finance structure, this tends to be significantly smaller than in a typical publicly funded project. Successful examples of private (or public/private) finance for large hydropower in poorer countries tend to find equity investors from other parties involved in the project, such as a major contractor or the off-taker.

The complexity of a typical PPP project financing structure is illustrated in Figure 3 for the 1075MW Nam Theun II project in Lao PDR, which was commissioned in 2010. The financing package for this project involved the Government of Lao PDR, four MDBs, four export credit agencies, French bilateral funds from two agencies, nine international commercial banks, and seven Thai banks (Merme et al., 2014; Porter & Shivakumar, 2010). The loans were syndicated into two packages: one for Thai banks and one for international banks. The loans from the nine OECD banks were backed by guarantees from Multilateral Investment Guarantee Agency (MIGA), International Development Association (IDA) and Asian Development Bank (ADB) (Merme et al., 2014). The level of complexity becomes even more apparent when the links the various forms of financing by some agencies are highlighted. The ADB, for example, provided three different types of funds: grant funds of $20 million to help fund the Government of Lao PDR's equity contribution; a project loan of $50 million; and a partial risk guarantee of $42 million. Some actors also assumed multiple roles in order to secure financial closure for the project: EDF were both the principal shareholder and the principal contractor, and the Electricity Generating Company of Thailand was both an off-taker and a shareholder.

PPP projects often involve a "for-profit" special purpose company (SPC)[8], which is set up to bring together various equity investors. Most of the debt required for the project is typically lent

[8] Also known as a Special Purpose Vehicle (SPV).

directly to the SPC. However, some debt may still be issued to the host country government, in particular where the loan is of a sovereign nature and the host country government owns shares in the SPC. Ownership models such as BOOT (Build Own Operate Transfer[9]) allow private sector equity investors to generate income from the hydropower project for the duration of a pre-agreed concession period, which enables them to repay the debt and generate a profit before the asset is returned to the host country government ownership. In common with many PPPs, such as Nam Theun 2, the BOOT ownership model was used in the Nachtigal hydropower project in Cameroon, where a special purpose company (Nachtigal Hydro Power Company—NHPC) was set up by the equity investors to deliver the project, with debt issued by multiple lenders to the NHPC under a 35-year BOOT concession agreement (shown in Figure 4).

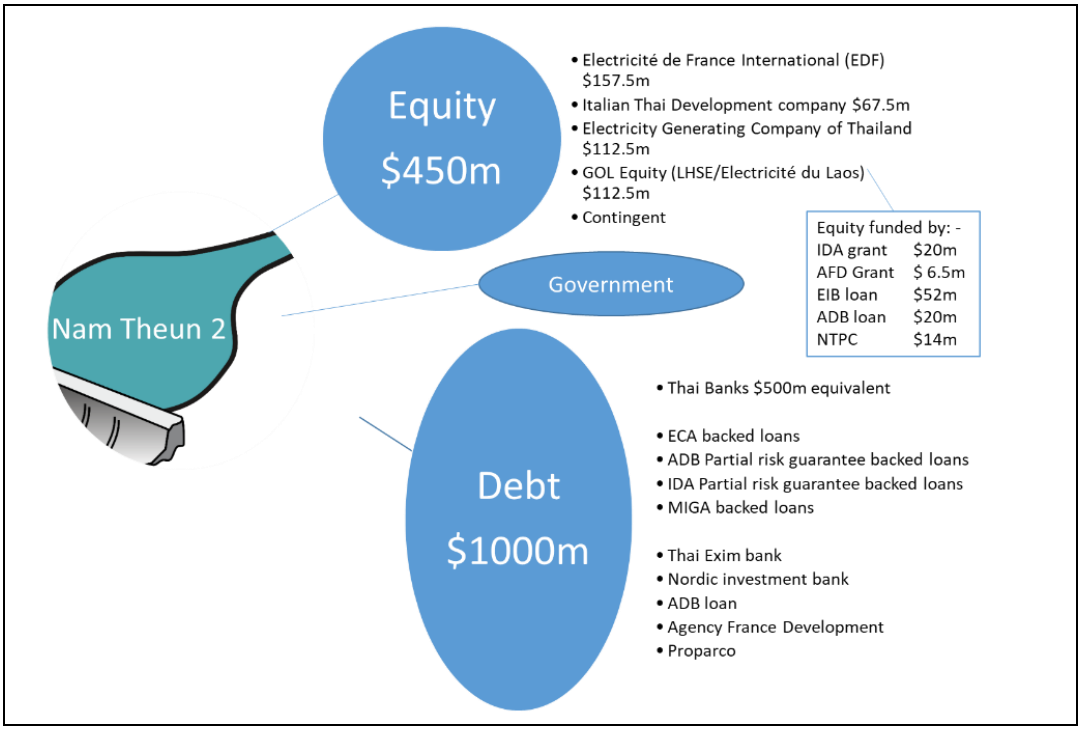


Figure 3. Financing structure of the Nam Theun 2 hydropower project, Lao PDR. Source: Authors' own work, drawing on data from World Bank (2005).

[9] See Markkanen and Plummer Braeckman (2019) for a full description of various ownership models used under a PPP project financing structure, including BOOT and BOT.

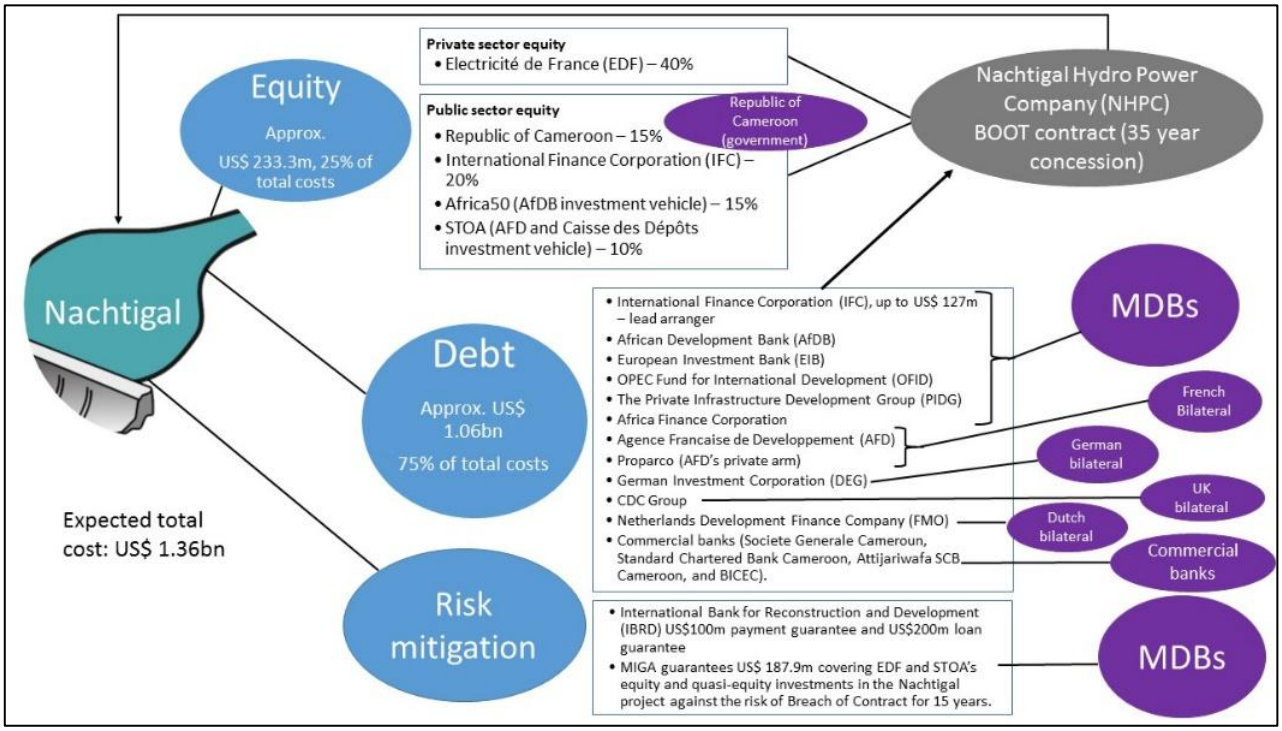


Figure 4. Financing structure of the Nachtigal hydropower project, Cameroon. Source: Authors' own work, drawing on data from multiple sources, including African Energy (2018) on equity investment distribution of shares, World Bank (2018) and MIGA (2018) on guarantees, and Ingram (2018) on total (estimated/expected) cost of project and sources of deb.

5. "New" bilateral finance

New forms of bilateral finance originate predominantly (but not exclusively) from upper-middle income country export credit agencies or development banks, such as the Brazilian Development Bank (BNDES), the China Exim Bank and China Development Bank. Given China's dominant position in utilising this financing approach, this form of finance is often referred to as "Chinese finance". China's prevailing position in his field is particularly evident in the hydropower sector: although the precise figures on Chinese investment in hydropower are difficult to obtain, one estimate puts the five-year rolling average investment of Chinese finance in hydropower worldwide at $4.4 billion (Gallagher, 2018).

Bilateral finance transactions typically involve only two parties: one financing agency (which is often an export credit agency) and the host country government. Occasionally, a small proportion of the debt is issued by a commercial bank from the same country as the financing agency and, for the poorest countries, some or all of the debt may be issued at a reduced interest rate (Br ätigam, 2011). All the debt is lent directly to the host country government and tends to cover the vast majority of the costs of the project (often up to 85%). There is rarely any MDB or other international agency involvement or oversight.

The bilateral financing arrangement for the 183 MW Isimba hydropower project in Uganda, depicted in Figure 5, demonstrates several features that are typical of the new bilateral finance. First, the small number of actors means that it can be very quick to achieve financial closure. With a debt to equity ratio of 85/15, Isimba went from concept to commissioning in less than six years. The debt was provided by China EximBank loan with requirements for payment guarantees from the Ugandan Government (Eberhard et al., 2016), and equity investment came from the Government of Uganda (Dreher et al., 2017) (see Figure 5).

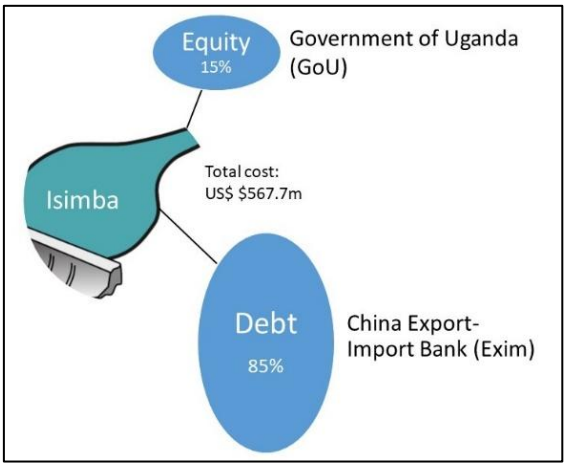


Figure 5. Financing structure of the Isimba hydropower project, Uganda. Source: Authors' own work, drawing on data from Meyer et al. (2018) and ODI (2016).

Second, the government-led public procurement that awarded the Engineering, Procurement and Construction (EPC) contract for Isimba to Chinese firms "tied" the finance to the skills and technology of these firms (ODI, 2016). However, the arrangement into which the Government of Uganda (GoU) entered with China International Water and Electricity Corporation (CWE) stipulated that the CWE contractors be hired only as builders, with no longer-term role as the hydropower project's owner or operator. This arrangement means that the Ugandan government acquired control over the hydropower plant as soon as it became operational. From this point onward, the Ugandan government, through the Uganda Electricity Generation Company Ltd. (UEGCL), assumed the responsibility for ensuring that local workers are appropriately trained and capable of taking over the operation of the plant. The government also assumed the responsibility for all operations and maintenance costs that are not covered by guarantees. Third, to protect against insolvency, the Eximbank required 45% of the loan to be in the form of an export buyer's credit with floating interest rate (equal to LIBOR + 3.5%) and the loan to be predicated on Uganda's oil reserves (Eberhard, 2016).

National natural resources were also used to collateralise financing for the 400MW Bui hydropower project in Ghana. The Bui project, which reached financial closure in 2008 and was completed in 2013, was collateralised with earnings from cocoa exports in a structured deal with the China EximBank. The Government of Ghana provided US$60 million in equity (Authority, 2011) and received two credits from the China Exim Bank for the Bui Dam: a concessional loan of US$263.5 million and a buyer's credit of US $298.5 million (Figure 6). These loans were secured

against the proceeds from the sale of 30,000 tonnes of cocoa a year to China until the project generates enough funds from the sale of electricity to cover the loan repayments (Hensengerth, 2013; Obour et al., 2016). Unlike Isimba, the arrangements for the Bui dam took a long time to negotiate because Ghana was reluctant to commit to a link to cocoa exports (Hensengerth, 2011).

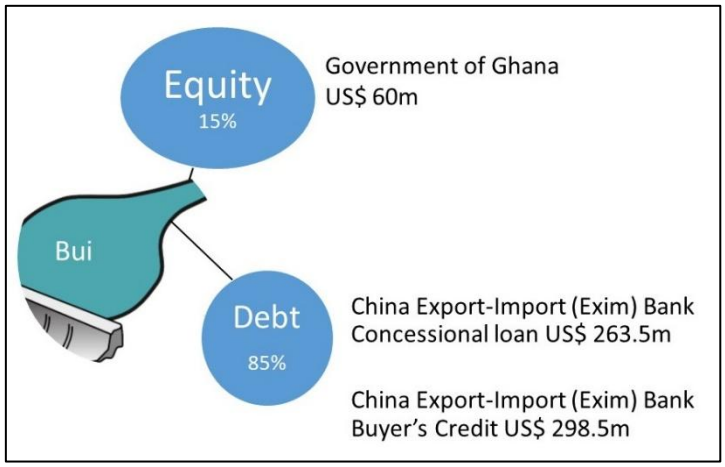


Figure 6. Financing structure of the Bui hydropower project, Ghana**.** Source: Authors' own work, drawing on data from Obour et al. (2016).

6. Discussion

The three financing models that are (or have been) most widely used for hydropower project development in LICs and L-MICs each have strengths and limitations, as summarised in Table 1.

6.1. Strengths and limitations of fully public projects

In the second half of the 20th century, fully public financing enabled developing countries to harness their natural resources to meet growing industrial and domestic demands for electricity at low cost, while also improving energy security and self-sufficiency and reducing vulnerability to energy market price fluctuations (Mott MacDonald, 2009). Multipurpose reservoir dams facilitated a wide range of other benefits, including irrigation, flood control, and recreation (World Energy Council, 2015). One of the main benefits of public financing was that the host country government was in control of the ownership and operational aspects of the projects from the start, which allowed them to set the electricity price to maximise economic benefits and productive uses.

However, large energy infrastructure projects are costly to develop and can absorb a substantial proportion of a county's available investment and borrowing potential, disadvantaging other sectors of the economy (Plummer Braeckman et al., 2019). Consequently, the poorest countries which were less able to harness public funding built comparatively few hydropower projects during the second half of the 20th century when large amounts of public sector financing were directed to such projects. Although projects such as Owen Falls in Uganda (World Bank, 1961) and Nkula in Malawi (World

Bank, 1977) went ahead, there were competing development priorities for the poorest nations' allocation of development finance.

6.2. Strengths and limitations of PPP financing

More recently, PPP financing have enabled large hydropower projects in LICs and L-MICs to be developed in circumstances where the host country government lacks funds to undertake them on their own, and where sufficient concessionary lending is not available from MDBs. The conditionality of MDB involvement functions to ensure that high standard social and environmental impact assessments are undertaken and followed through with appropriate mitigation and management measures. The limited time period of a concession means that infrastructure assets financed through a PPP eventually transfer to state ownership.

However, the ownership structure and financial flows are more complex under a PPP model than either of the other approaches. Owing to the perceived level of risks associated with large hydropower projects in LICs and L-MICs, and the risk-averse nature of private sector investors and financiers, private sector involvement in these countries tends to be conditional on MDB guarantees, insurance, and legal agreements, including a long-term power-purchase agreement (PPA) and concession agreement. The amounts that various financiers are willing to invest or lend for any specific project in a LIC or L-MIC also tend to be lower than would be the case in an OECD country. Subsequently, it is not unusual for PPP-financed large hydropower projects in LICs and L-MICs to have a complex mix of both public and private sector institutions, and for the various actors to assume multiple roles in an attempt to raise the sufficient funds. This complexity can be problematic for two reasons. First, one actor assuming multiple roles can create conflicts of interest, which require careful management to ensure transparency. Second, these projects often take several years to reach financial closure (Eberhard et al., 2016).

Many governments also lack the resources and capacity to negotiate the best deal possible with multiple lenders under a PPP arrangement, resulting in projects that do not maximise the potential economic benefits for the host country. For example, PPP financing is generally not readily available to fund the expansion to existing grid infrastructure, and the need for the SPC to generate a sufficient return on investment during the concession period can result in electricity tariffs that are too high for local consumers to afford. It is possible to address these challenges effectively with a concerted effort and commitment on the part of the host country government. For example, the 250 MW Bujagali hydropower project in Uganda was developed at a time when few PPP projects had been successfully concluded in Africa. An innovative PPP financing arrangement involved splitting it into two separate but interconnected projects: the physical hydropower project (which was awarded to a SPC and financed through a PPP) and the interconnection project, which was financed as a public project by the Government of Uganda with loans from The African Development Fund and Japanese International Cooperation Agency (AfDB, 2019).

Whilst the approach used for Bujagali enabled the hydropower project and the related energy transmission infrastructure to be developed, it was also slow and expensive (Eberhard et al., 2016; Plummer, 2013): after 13 years of negotiations followed by a five-year construction period, the project was finally commissioned in 2012, with an estimated price tag of $1.3 billion. As a result,

Bujagali yielded expensive electricity when compared with the national electricity tariff, and anticipated decreases in tariff proved impossible. However, once the power project was operational and the risk profile was substantially reduced, the Government of Uganda was able to refinance the project. The outstanding debt was consolidated into a new debt package by a consortium of public- and private-sector investors (with Multilateral Investment Guarantee Agency and International Development Agency guarantees). The longer tenor (repayment period) of this loan reduced annual debt service, a saving which was passed on to consumers, cutting the cost of electricity generated by the plant by 30% (IFC, 2018).

6.3. Strengths and limitations of new bilateral finance

New bilateral finance offers a simpler financing option for LICs and L-MICs that are frustrated by the delays and complexity associated with the PPP structure. Given the economic benefits for the lending country, financing from new bilateral financing agencies is more plentiful and more easily accessible than concessionary debt from MDBs. From a contractual point of view, the simplicity of the bilateral financing arrangements means that they usually take less time to arrange. The loan is made directly to the host country government, who will own the project from the beginning. There is no privately-owned SPC who will need the security of a power purchase agreement or a concession agreement. Public sector procurement rules can be sidestepped, and the environmental and social impact assessment requirements may rely solely on the host country's own protocols and capacity instead of the often complex criteria imposed by MDBs or multiple financiers under a PPP financing structure.

As a result, as long as the host country government is willing to comply with the conditions offered by the financing agency, bilateral finance can enable LICs and L-MICs to develop their energy infrastructure faster, while also providing their citizens with access to electricity at a lower cost. For example, Isimba took only six years from concept to commissioning, a third of the time that it took to develop the nearby PPP-financed Bujagali. As the delays feed into the costs, quicker financial close and construction can translate into lower electricity tariffs. In the case of Bujagali and Isimba, it is widely expected that the cost of electricity generated by Isimba will be significantly lower than Bujagali. However, whether or not this price difference materialises—or is passed on to end consumers—remains to be seen (Meyer et al., 2018; ODI, 2016).

In spite of offering these advantages, new bilateral finance arrangements come with conditions and constraints that can have long-term implications for the host countries. The fact that the financing is generally tied to the source country's contractors reduces the host country's choice over materials and technologies, and limits the scope for competitive procurement, raising concerns over reduced transparency (ODI, 2016). The host country government that assumes ownership of the project as soon as it becomes operational will also need to assume the responsibility over the operations and maintenance of a project that may be using technologies with which they are not familiar. Furthermore, this transfer of ownership upon commissioning can tempt contractors to cut costs during construction by compromising quality, as they will not be around if problems are discovered after the project commences operation, and their long-term guarantees of project performance are limited (Le, 2017).

The high level of debt that countries take on to finance large infrastructure projects may become a cause for concern, especially if several large projects are being developed simultaneously. In Uganda, Isimba is one of many large infrastructure projects (including road, rail and hydropower developments) that are either planned or under construction, to be built by Chinese firms and financed by Chinese lenders. The loan repayments for the various projects will overlap, requiring a separate government sovereign guarantee and resulting in a heightened level of indebtedness for Uganda, raising the risk that project-related revenues may be insufficient to support future debt servicing (ODI, 2016). To secure themselves against the risk of non-payment, the China Exim Bank predicated the loan for Isimba on Uganda's oil reserves, and issued 45% of it in the form of an export buyer's credit with floating interest rate. While these arrangements helped Isimba to achieve financial closure in a situation where it might have otherwise be considered "at risk" of insolvency, they have actually increased rather than reduced Uganda's economic vulnerability. This is because the oil market is highly volatile and the floating interest rate means that the interest on the loan may increase substantially over time if market conditions become unfavourable, exposing Uganda to possibly unaffordable interest payments (Eberhard, 2016; ODI, 2016). The risk associated with high indebtedness may become even more pronounced in the aftermath of the Covid-19 pandemic, the economic impact of which is expected to be particularly severe in LICs and L-MICs. Although international organisations such as World Economic Forum (WEF, 2020) have already called for a debt moratorium for developing countries—a request that MDBs will most likely comply with in extreme circumstances—the private sector is likely to be less forgiving and the response of new bilateral financiers is at present unclear.

New bilateral financing arrangements can also allow compliance with international environmental protection requirements and social responsibility guidelines to be circumvented, with potentially negative impacts. Chinese hydropower contractors, for example, have been content to allow host government agencies to take full responsibility for the assessment and mitigation of the social and environmental impacts of projects undertaken in turnkey arrangements with Chinese contractors and financiers (Hensengerth, 2013). While leaving the responsibility for impact assessment and management to the host country government may seem logical, a lack of capacity or institutional bias can lead to poor and delayed implementation of protocols, or even the overlooking of social and environmental impacts (Hausermann, 2018; Kirchherr et al., 2016). In Ghana, the Bui hydropower project, which was financed through a bilateral loan from China, has been subject to criticism by commentators who argue that the World Bank and international agencies declined financial support for the project due to its perceived social and environmental threats, including the flooding of over a fifth of the Bui National Park (Hensengerth, 2013; Obour et al., 2016; Yankson et al., 2018). However, China Exim Bank is increasingly adopting standard corporate social responsibility policies and is beginning to work with MDBs and bilateral agencies to gain greater exposure to international best practice (China Exim Bank, 2016; Gugler & Shi, 2009; Hensengerth, 2013).

Table 1. Strengths and limitations of three financing models for large hydropower projects in LICs and L-MICs.

	Public finance	PPP finance	New bilateral finance
Strengths	Simple Government retains control and can ensure economic benefits are secured and that sustainability targets are met. Long-term financial gains of the project accrue to the public sector and/or can be used to keep electricity tariffs affordable. MDB involvement can set a benchmark for country standards for sustainability.	Enables the construction of infrastructure for development despite limits on government investment and borrowing. Long-term financial gains of the project may partially accrue to the public sector and/or can be used to subsidise tariffs for vulnerable groups. MDB involvement can set a benchmark for country standards for sustainability.	Simple Enables the construction of new public sector infrastructure for development, often in an accelerated timeframe. Long-term financial gains of the project accrue to the public sector
Limitations	Large projects absorb a substantial proportion of available public investment, limiting investment in other sectors. Limited availability of public funds and concessionary debt finance for energy infrastructure projects. MDB involvement perceived as causing delays. Governments may lack capacity and regulatory frameworks to manage environmental and social impacts without support from MDBs.	Need to negotiate complex packages and contracts may over stretch government capacity. Governments may lack capacity to negotiate a deal that would maximise economic benefits to the host country. Overall complexity causes delays. Can be perceived as diluting government control of natural resources and allowing the private sector to profit from natural resource exploitation.	Government may lack capacity to protect the host country interest or may have a poor negotiating position Increases government indebtedness. Need to service debt may prevent the implementation of affordable electricity tariffs. Lack of regulatory framework on social and environmental impacts may mean these are overlooked or not adequately mitigated. Can be perceived as foreign political interference in domestic affairs and natural resources.

Note: Source: Authors' own summary drawing on data from multiple sources.

7. Conclusions

In this paper, we have described and compared the advantages and limitations of three financing models that are available, or have previously been used, for large hydropower development in LICs and L-MICs. The purpose of this analysis is to support informed public sector decision making in these countries as they consider the optimal development of their natural resources. Some smaller countries may only build one major infrastructure project each decade, and analysis such as presented here can assist them to navigate the changing landscape for infrastructure finance. To date, PPPs and new bilateral finance have been successfully used to finance several large hydropower projects across many LICs and L-MICs, but the full implications of utilising these financing models

has not been systematically explored. Many of the long term impacts of the choice of financing model are not immediately obvious and may be overlooked when under intense pressure to increase electricity generation capacity.

The majority of the untapped but technologically feasible hydropower potential is located in LICs and L-MICs, where it could be utilised to support environmentally sustainable socioeconomic development. At present, many of these countries are under multiple pressures to improve energy access, to facilitate economic growth, and to decarbonisation existing and future energy supply. Sustainable hydropower with equitable benefit sharing would enable them to progress towards various SDGs, including both environmental and socioeconomic goals. Hydropower could also support greater integration of intermittent renewable sources into the energy mix by providing energy storage and preserving grid stability.

However, low credit rating and limited financial resources in LICs and L-MICs make it difficult for these countries to harness their natural resources for socioeconomic development, especially through large infrastructure projects that require substantial upfront investment. Traditionally, such projects were funded with concessionary debt from MDBs and other public sector sources, although some financial input from the host country was still required. Over the past 30 years, the availability of public sector financing for large energy infrastructure projects has dwindled, and most new large hydropower projects in LICs and L-MICs are developed either with significant private sector involvement under the PPP model or with debt financing under new bilateral arrangements. Although MDBs remain active in hydropower project development in LICs and L-MICs, they are increasingly directing their limited resources to leveraging finance from the private sector through credit enhancement mechanisms, such as guarantees.

The extent to which LICs and L-MICs can benefit from PPPs and new bilateral finance depend on their ability to negotiate a deal that enables them to maximise the economic benefits from a project, and to minimise the potentially adverse aspects associated with each financing model. Policy initiatives such as a crackdown on corruption, reductions in red tape, and a clear regulatory framework for private investment and tariff setting could enable these countries to attract more private sector finance, making PPPs simpler and faster. Capacity building among government officials and better awareness of the full implications of some of the conditions that are included in the bilateral agreements could enable LICs and L-MICs to negotiate better deals with PPPs as well as bilateral lenders. For the future of hydropower development in these countries to be socially, economically and environmentally sustainable, it is essential to better equip the national governments to avoid exploitation of their natural resources for financial gain by foreign companies and governments without closing these economies completely to the potential development opportunities offered by private sector and bilateral finance.

LICs and L-MICs need to be adequately supported to access finance for projects that can address their needs without compromising their progress towards a zero carbon future. One of the key challenges is to develop financing models that ensure that the electricity generated from hydropower will be accessible and affordable to local consumers, without crippling the host country government’s finances. In this context, there is a pressing need for further research to better understand the private finance sector’s attitude to risk and consider why it remains so challenging, complex and time-consuming for large hydropower projects in LICs and L-MICs to obtain finance. In undertaking this

research, the goal should be to simplify and thus accelerate the process of putting a PPP financing package in place. Future research should also consider the relationship of hydropower to intermittent renewables and green finance initiatives, such as green bonds, and the extent to which these synergies can be used to enhance the opportunities for project finance.

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Conflicts of interest

All authors declare no conflicts of interest in this paper

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