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Perceptions of risk in relation to large hydropower projects: a finance perspective

A working paper by the Cambridge Institute for Sustainability Leadership

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Authors

Judith Plummer Braeckman

Sanna Markkanen

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Abstract

More renewable electricity generation capacity will be needed to support progress towards the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement on climate change including in low- and lower-middle income countries (LICs and L-MICs). Given the limited availability of public sector finance for energy generation, some of the new generation capacity may need to be financed entirely by the private sector or through public–private partnerships (PPPs). Sustainably developed large hydropower could play a vital role in a future electricity mix dominated by intermittent renewables. In addition to generating low-cost, low-carbon electricity at a large scale, hydropower is capable of delivering ancillary services that are needed to facilitate greater penetration of intermittent renewable electricity. However, concerns over social and environmental outcomes, uncertain financial returns – and thus a widespread perception of large hydropower as a 'high risk' – have so far made it difficult to attract private sector investment and finance for such projects, especially in many LICs and L-MICs. To reduce the perceived riskiness of these projects, it is necessary to understand how various partners in a hydropower PPP conceptualise risk, including what types of risks are regarded as unacceptable or un-mitigatable and what new risk mitigation mechanisms are available and deemed effective by the relevant parties. The analysis presented in this paper integrates original qualitative and quantitative data on financiers' perceptions of risk with an existing analytical framework for risk and risk mitigation. The findings suggest that many of the greatest risks associated with large PPP hydropower projects in LICs and L-MICs are those that may cause reputational damage to the parties involved, such as social and environmental risks. Other major risks include some financial risks, such as non-repayment, and factors that may cause excessive delays or project cancellation. The results presented in this paper will enable governments and developers to take targeted action to reduce risk and thus facilitate more effective use of the PPP financing model for large renewable energy infrastructure projects in LICs and L-MICs, where additional large-scale sustainable electricity generation capacity is most needed.

Keywords

Hydropower, sustainable development goals, finance, risk, public–private partnerships

JEL codes

G32, O16, O19

Contents

1 Introduction

In an earlier output from our ongoing research, we presented a conceptual framework for the analysis of risks in relation to large hydropower projects in low- and lower-middle income countries (LICs and L-MICs) to facilitate discussion about how financiers perceive risk, how these perceptions influence their financing decisions, and how the various risks can be mitigated (Plummer Braeckman et al, 2020b). The framework included information on risks that may present a considerable barrier to involvement, as well as on the currently available risk mitigation mechanisms. It also raised important questions as to why, considering the available risk mitigation mechanisms, so little private sector finance is directed at large hydropower projects in LICs and L-MICs, despite the huge amount of untapped hydropower potential in many of these countries.

In this paper, we set out to understand why and how specific risks may lead to a decision not to finance a project. Through this understanding we aim to validate the risk analysis framework. We collected qualitative and quantitative data through focus groups and an online survey, asking the participants and respondents what they thought the greatest risks are and why, and to what extent the currently available risk mitigation mechanisms are deemed sufficient to reduce these risks to acceptable levels.

Many of the risks described in the framework, and further detailed in the current paper, are well known within the global hydropower community. However, much of the conversation about the best ways to mitigate these risks and their shortcomings tends to be highly 'siloed' and restricted to those currently involved in projects. In practice, this means that the environmental and social risks are discussed by specialists and stakeholders, while technical risks are discussed by engineers and developers. There is thus a need to broaden the range of understanding of different risk categories and foster an interdisciplinary debate.

Our analysis will show that reputational risks are viewed just as seriously as financial risks by potential investors and financiers. This is an important finding for those preparing sustainable hydropower projects for financing. It emphasises the importance of attention to the sustainability aspects, such as mitigation of environmental and social impacts, which may create both financial and reputational risks.

The next section provides background and is followed by an overview of the research methodology in section 3; this includes the qualitative and quantitate data generation processes. The results are described and discussed in section 4, while section 5 outlines some of the implications for financiers, developers and LIC and L-MIC governments that may be drawn from the results. Section 6 offers conclusions for policymakers.

2 Background

Hydropower constitutes an important and reliable source of renewable electricity worldwide (Berga, 2016; IEA, 2018; IRENA, 2019; Gernaat et al, 2017). It accounts for over 50 per cent of renewable electricity globally (IRENA, 2019) and over 95 per cent of the world's grid-scale electricity storage, making it an important enabler for large-scale deployment of intermittent renewable electricity systems (World Energy Council, 2015). In every country where renewable electricity accounts for over 95 per cent of total electricity output, over 50 per cent of total electricity is generated from hydropower (World Bank, 2018). To decarbonise the global energy sector in line with the Paris Agreement, IRENA's 2050 Energy Transformation Roadmap (Transforming Energy scenario) indicates that a total of 1,822 GW of hydropower capacity would need to be installed worldwide by 2050, increasing the current installed capacity by some 60 per cent (IRENA, 2020b).

The vast majority of the world's technically feasible but currently untapped hydropower potential is located in LICs and L-MICs, many of which have low electrification rates and/or experience frequent disruptions to their electricity supply (Alam et al, 2017; Corfee-Morlot et al, 2019; IHA, 2020; IEA-ETSAP & IRENA, 2015; World Bank Group, 2014; World Bank, 2017a).

During the latter half of the 20th century, many hydropower projects, especially in developing countries, were implemented with limited regard for their adverse social and environmental impacts, such as population displacement, loss of livelihoods and damage to local ecosystems. Since then, the global hydropower community has worked hard to develop protocols and best-practice guidelines, such as the Hydropower Sustainability Assessment Protocol (HSAP), and to ensure that these are implemented when new dams are constructed (for more detail, see Markkanen & Plummer Braeckman, 2019). Sustainably developed large hydropower could foster electrification and environmentally sustainable economic growth in these countries (Cheng et al, 2020; World Energy Council, 2015). While small-scale, off-grid solutions are invaluable in improving energy access in rural areas, large hydropower projects could supply cost-effective, low-carbon electricity to densely populated urban areas and industries and also provide storage to balance intermittent renewable electricity supply.

Changes to the availability of development finance and concessionary loans for energy infrastructure projects over the past two decades mean that much more private sector finance is needed to develop energy generation capacity and distribution infrastructure in the least developed countries (AfDB, 2019; Eberhard et al, 2017 IRENA, 2020a; World Bank, 2017b). Reduced availability of public sector finance presents a challenge, especially to projects such as large hydropower, which are capital-intensive, site-specific and require large-scale, up-front investment. So far, limited access to private sector finance has largely prevented the effective use of public–private partnerships (PPPs) to finance such projects and, consequently, relatively few large hydropower PPPs have been developed in LICs and L-MICs (Markkanen et al, 2020; Plummer Braeckman et al, 2020a). Various authors argue that the lack of private finance in LICs and LMICs is to the result of poor governance (Zaman & Brudermann, 2017) or of other factors (Gregory & Sovacool, 2019), or that the problem is largely one of financial constraints (CEPA, 2015). Meanwhile, concern has also been expressed over the use of the PPP model and the implications for domestic electricity tariffs (Foster & Rana, 2019). At the same time, a growing proportion of new large hydropower projects in these countries is being financed with debt from export credit agencies,

predominantly from China (Eberhard et al, 2017; Gallagher, 2018; Le, 2017). This 'new' bilateral finance offers a more straightforward financing proposition than the PPP approach for cash strapped LIC and L-MIC governments. However, it comes with conditions and constraints that may have long-term implications for the host countries' debt burden and for project sustainability (Plummer Braeckman et al, 2020a).

These issues led to the development of the risk framework, in order to enhance the understanding of both financiers and governments of the wide taxonomy of risk factors at play in large hydropower projects and to endeavour to assess the relative importance of these risks in decision making.

3 Methodology

3.1 Approach

This paper presents and discusses the results from a mixed-methods study to validate and test an analytical framework for understanding and conceptualising risk and risk mitigation in the context of financing large hydropower projects in LICs and L-MICs (Plummer Braeckman et al, 2020b).[1] This framework (presented in Figure 1) was developed during an earlier stage of our ongoing research project to help governments, developers and financiers identify, manage and mitigate risk and thus enhance the likelihood of successfully financing projects. Focusing on risk as seen from the perspective of the financiers, it classifies it into four segments: government, environmental and social, technical, and financial.

In the paper, we use the analytical risk framework to explore which risks are perceived to be the most significant or least mitigatable in LICs and L-MICs, influencing the availability of finance and hindering the ability of these countries to raise finance for large hydropower projects. To this end, we have integrated the analytical framework with additional data collected through a mixture of qualitative (focus groups) and quantitative (online survey) methods. In both data generation processes participation was restricted to representatives from organisations and private sector companies with experience of large hydropower PPPs.

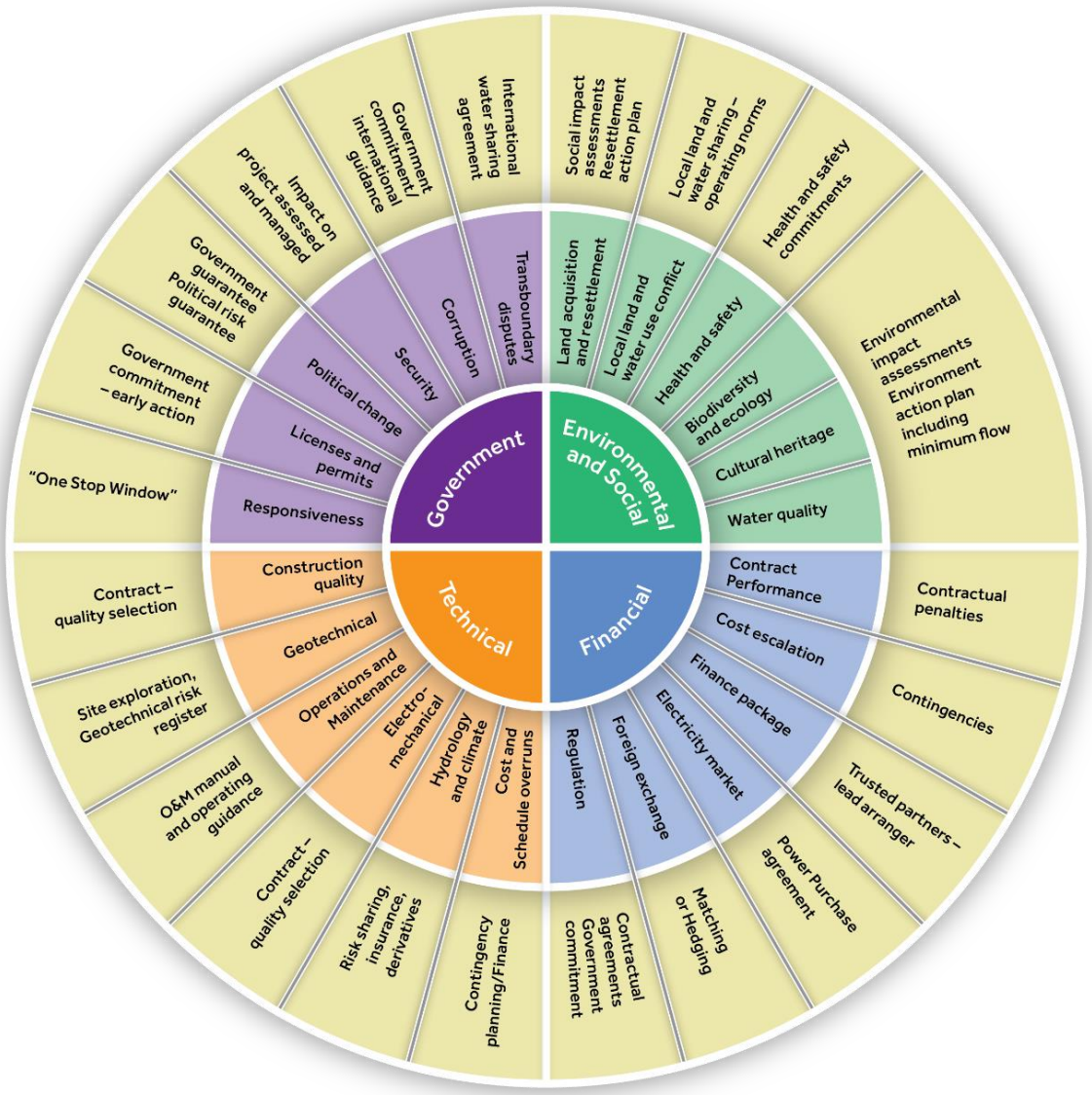
These additional qualitative and quantitative data allow us to explore how experience influences perceptions of risk and what other approaches the parties involved in PPPs found available to them in addition to the conventional risk mitigation mechanisms. Reflecting on these experiences will help to prepare new actors to consider large hydropower in LICs and L-MICs, while also enabling various country governments and quasi-governmental organisations to address the issues that currently pose the greatest challenges to effective utilisation of PPPs in the hydropower sector. More detailed description of the data generation and analysis is provided below.

3.2 Qualitative research

The qualitative research component consisted of three focus group discussions that took place in London, Windhoek and Singapore between November 2018 and November 2019. In these discussions, the analytical framework for conceptualising risk was presented to the participants, who were then invited to discuss the content and structure of the framework and to suggest edits based on their perceptions, experiences and expectations of future developments that might affect the hydropower sector. Initial plans involved a total of four focus groups with a global coverage. However, these plans had to be revised as a result of the relocation of the COP25 from Santiago (Chile) to Madrid and, later, a postponement of an event in Europe as a result of the Covid-19 pandemic, during which a further focus group would have taken place.

[1] Plummer Braeckman et al (2020b) note that "The way in which risks are addressed can be variously described as measures to avoid, manage or mitigate adverse impacts (Irwin et al. 1998). For convenience all these terms are considered part of 'mitigation' for the purpose of this paper. Similarly, the common parlance of risk is used to describe all risks and uncertainties rather than the strict academic interpretation of the differences between risk and uncertainty (Knight, 1921)." This parlance continues into this paper.

Figure 1: Analytical framework for conceptualising risk, including mitigation mechanisms



Source: Plummer-Braeckman et al (2020b).

The focus group participants were drawn from various professional groups, including lawyers, insurers, lenders, equity investors, development banks and lenders' engineers. Each focus group discussion involved 10–15 participants from various backgrounds, all of whom had direct experience of large PPP-financed hydropower projects in LICs and L-MICs. Each session lasted for 2.5 hours and involved presentations on different types of financing options for large hydropower in LICs and L-MICs, analysis of risk, and risk mitigation mechanisms. After each presentation, the participants discussed their views in small groups of 3–4 people, followed by a shared discussion.

To encourage honesty and openness, and to create a safe space for direct conversation, the focus group discussions were carried out under Chatham House rules (i.e. with no attribution of views) and not recorded. Instead, detailed notes were taken by two members of the research team at each meeting. During the small-group discussions, these two researchers each monitored the conversation. Immediately after the event, the detailed notes were compared and conflated to create a final record of the discussion, which both the researchers agreed accurately reflected the content and coverage of the conversation without allowing any individual participants to be identified based on the comments they made. This record was then subjected to thematic analysis following the approach detailed by Nowell et al (2017) to ensure the trustworthiness of the data collection and analysis. Thematic analysis was regarded as the most appropriate method of analysis given the flexibility it provides in identifying, describing, and reporting and comparing the perspectives of different research participants, and generating unanticipated insights. The analysis was carried out by the same researchers responsible for the qualitative data collection and who thus attended all three focus group sessions.

In addition to the focus groups, the conceptual framework was presented at two major international industry conferences to audiences with considerable experience of the development, finance and operation of large hydropower projects. The feedback from the question and answer sessions after each presentation has also informed the thinking presented in this paper, although it was not subjected to the same degree of scrutiny and analysis as the focus group transcripts.

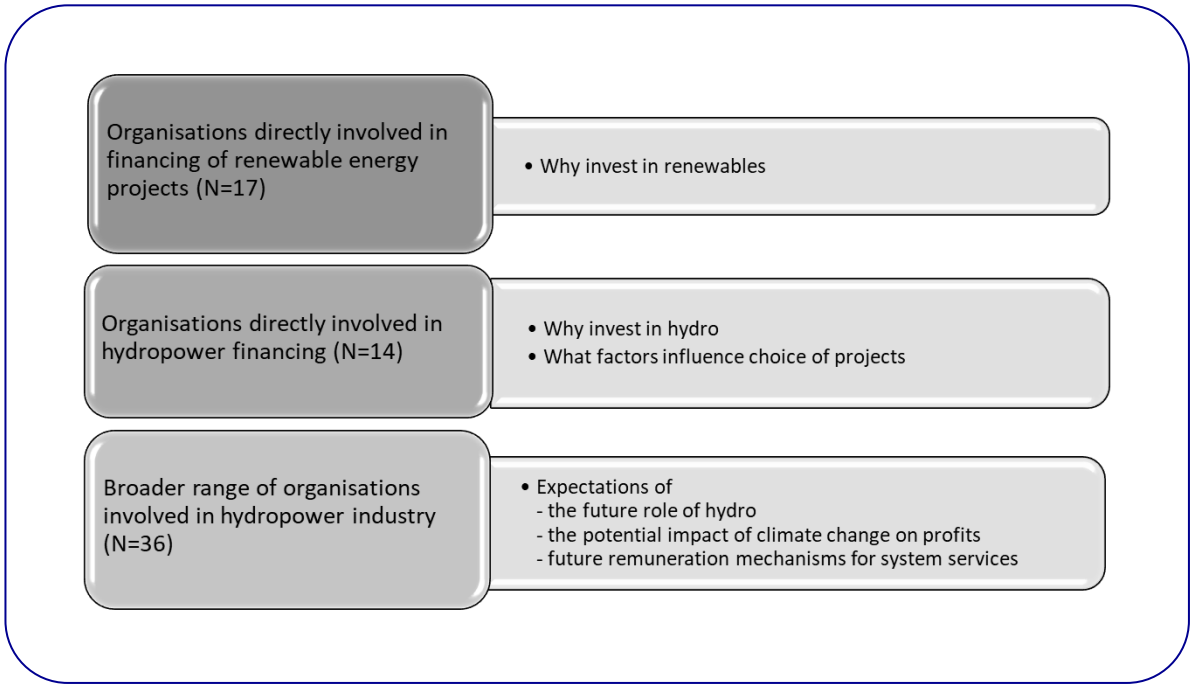
3.3 Quantitative research

Following the first two focus groups, and in the light of the preliminary findings, a survey was designed to enable remote participation in the research and to allow individuals to share their views anonymously. The survey, entitled 'Financing renewable energy infrastructure – focus on hydropower', was publicly accessible online in Qualtrics from 25 August 2019 to 15 April 2020. During this time, it was promoted at various events at which the researchers were speaking. After the Covid-related postponement of the final two focus groups planned for March and May 2020, that survey was closed ahead of schedule on 15 April 2020. The inability of the research team to attend the events planned for the first half of 2020 because of the pandemic may have had a negative impact on the number of responses.

The main objective of the survey was to help us understand how financiers make decisions on renewable energy infrastructure projects, with a particular focus on hydropower. It contained six main question blocks, with skip logic being used to ensure that questions only appeared to those respondents to whom they were relevant. Figure 2 summarises the survey coverage, indicating which sets of questions where targeted at which respondent categories.

The survey attracted 36 full responses, 14 of which came from companies or organisations directly involved in financing hydropower projects.

Figure 2: Survey structure and respondent categories



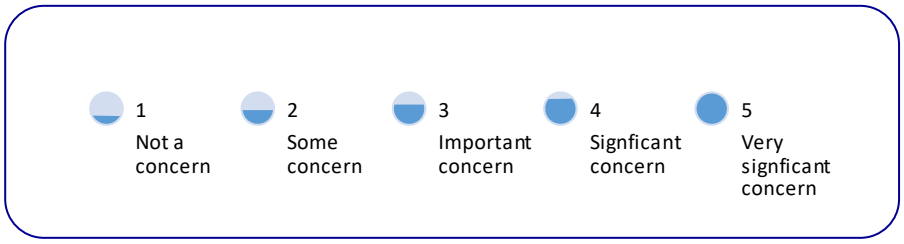
As the purpose of this paper is to validate and test the appropriateness and usefulness of the analytical risk framework for financiers, we focus here exclusively on the survey results from the 14 respondents from organisations directly involved in financing projects.[2] Thirteen out of these 14 respondents represent companies or organisations involved in financing hydropower projects in LICs or L-MICs, although not necessarily exclusively so. One of the respondents represents a private sector company that currently finances hydropower projects only in high-income countries. All but one of the 14 finance medium (10–100 MW) and/or large (>100 MW) projects, while one finances predominantly small/small–medium projects. The respondents represent various different types of organisations, including multilateral development banks (MDBs) public and private windows, bilateral development banks and agencies (public and private windows), national development banks and agencies, private equity and venture capital firms, investment banks, commercial banks, private sector project developers, and public and private sector power generation companies.

The respondents were asked a range of questions focusing on how important certain project characteristics were to them when deciding on whether to finance a hydropower project (using a Likert scale): how significant a concern they considered each of the risks in the risk framework presented to them (using a Likert scale); and how concerned they were about reputational risk when deciding on financing a hydropower project (on a sliding scale from 1 to 100).

The risk questions were framed around the analytical framework and respondents were invited to respond using a Likert scale, as shown in Figure 3, thus drawing on the strength of combining qualitative and quantitative methods under the mixed-methods research design. The response to the question on perceived level of reputational risk was used to calculate average (mean) and median values.

[2] The remaining responses have a wider focus than just risk and will be analysed in a separate paper at a later date.

Figure 3 – Likert scale for survey questions on risk



The results were downloaded from Qualtrics to SPSS for analysis; this was carried out using numerical values to allow the calculation of average, standard deviation and number of the highest risk scores of 5 (very significant concern). The large number of types of organisation and limited number of responses from each type, meant that our analysis was limited to counting frequencies and mean/median values across the responses, rather than analysing differences in perception based on the type of organisation. While the number of responses is low, it is in line with similar surveys (Plummer, 2012) and reflects the relatively small pool of companies and other institutions currently involved in financing large hydropower projects in LICs and L-MICs.

4 Understanding risks – results from focus groups and survey

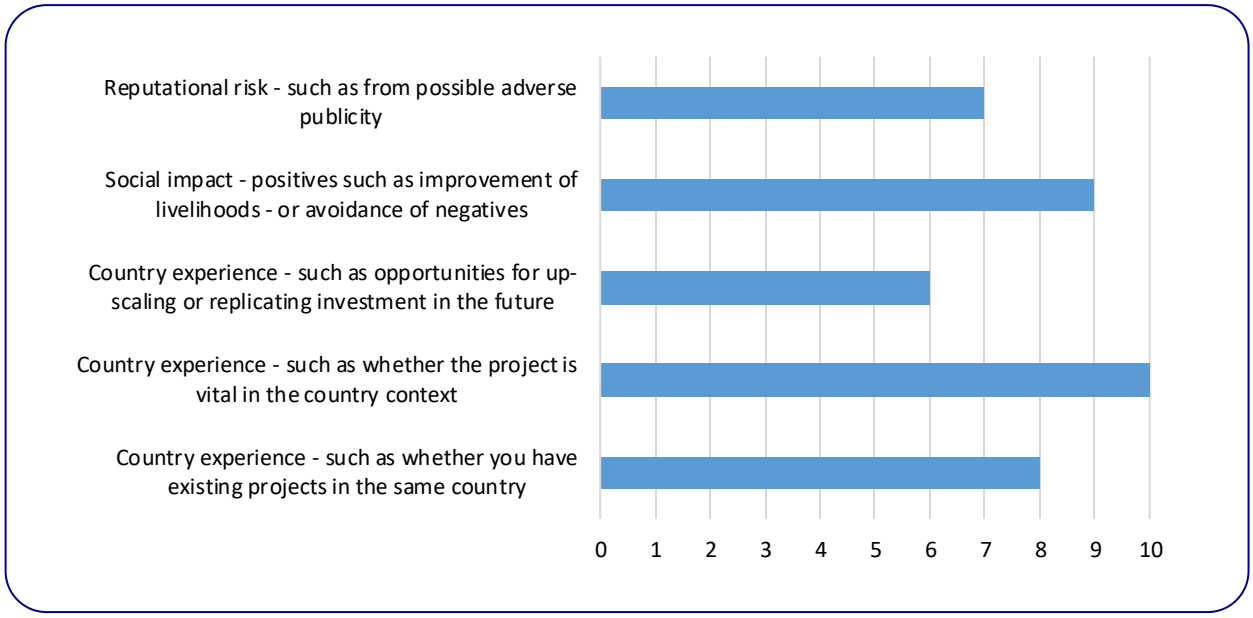
All participants in the three focus groups had experience of large hydropower PPPs in LICs and L-MICs. However, the diversity among the participants showed the extent to which perception of risk varies between the stakeholders and depends on the nature and type of actor: while some are more prepared to take on construction-stage risks, others are more willing to accept operations and maintenance risks.

For all participants, risk constituted an important project selection criterion. The focus group discussions revealed that most financial stakeholders consider each new project using a *staged approach*. The first stage considers factors such as governance-related risks, country credit rating, and the size and location of the proposed project and degree of alignment with the company's own strategic priorities. Both the focus group participants and the survey respondents noted the high likelihood of problems with security, lack of experience or knowledge of the country context, corruption and transboundary disputes as factors that would be likely to prompt a 'no' decision at this early stage. Only if the project were to pass this initial screening would the risks be analysed in more detail.

The survey included a question seeking to identify what project-related factors, beyond their company's financing and investment strategies, the respondents' organisations considered when deciding whether to finance a project. In response to this question, the country context emerged as a particularly important factor. Interestingly, the survey results indicate that, for the ten financiers who responded to this question, reasons *to* invest were slightly more prominent than reasons *not to* invest: the project being vital in the country context constituted an import consideration for all the respondents, with nine also mentioning positive social impacts or the avoidance of negative impacts as an important factor. Having existing projects

in the same country was important to eight out of these ten respondents, closely followed by reputational risk, which was flagged up as an important consideration by seven respondents. These results are presented in Figure 4.

Figure 4: Important factors influencing financing considerations beyond financing and investment strategies (frequency count, sample size = 10)



Source: 'Financing renewable energy infrastructure – focus on hydropower' survey.

These results indicate that development objectives and perceptions of unmet demand for electricity are strong motivating factors for those who finance hydropower projects in LICs and L-MICs, but these parties are more likely to engage in hydropower projects in contexts that they are familiar with. Better understanding among financiers of the socioeconomic development benefits of large hydropower projects in countries with low electricity access rates or supply shortages could therefore attract more funding for such projects. However, this information may be most effective when targeted at financiers already familiar with the country contexts, such as those involved in solar or wind projects.

The results of the focus groups for each risk quadrant are detailed in Appendix 1 and summarised here along with the survey results analysis.

4.1 Government risk

Without the support of the host country government, a project can grind to a halt or face severe delays. The focus group participants were in strong agreement that government support constitutes an essential prerequisite for all large hydropower projects. For many, this was regarded as essential for a proposed project to be given a green light at the earliest review stage. However, it was also suggested that foreign actors entering a new market do not always fully appreciate just how much government support (both capital and in kind) hydropower projects need. This comment is particularly interesting in the light of the

results presented above, highlighting the risk of promoting hydropower projects as 'just like' any other investment, resulting in negative experiences among first timers and reluctance to engage in such projects again.

Government risks remain relevant from the pre-construction stage to the operational stage of a project, and are unlikely to decline over time, although their nature may change. The focus groups' discussions on government risk focused primarily on three out of the six categories in the risk framework: lack of responsiveness of government, corruption and the risk of political change.

As shown in Figure 5, government risks were a substantial concern in the survey results, although overall slightly lower than other categories of risk, with an average score of 3.5 (on a scale of 1 to 5) compared with the overall average of 3.9 across all four quadrants of the risk framework. However, higher standard deviation for government risks (compared with other risk quadrants) indicates a greater degree of diversity among the respondents' perceptions across the various risks. Apart from 'external political pressures', all risks fell within the same general level of concern (between 3 and 4, an 'important' or 'significant' risk). This result could be indicative of a general perception among the respondents, as well as among focus group participants, that, apart from 'transboundary disputes', government risks are the most difficult to mitigate effectively and impossible to eliminate through the risk mitigation mechanisms that are currently widely available

The question on 'external political pressures' was included in the survey after this topic was brought up by one focus group participant and was then subjected to a substantial amount of attention and discussion. In the survey results, this question received the lowest score of all – 2.5 (between 'some concern' and an 'important concern') – which was not considered sufficiently high to warrant its inclusion in the final iteration of the framework.

In line with the focus group conversations, 'problems acquiring licences and permits' received the highest score in the government risk quadrant (4.0), closely followed by 'security in the host country' (3.9) and 'corruption' (3.8). 'Corruption' was regarded as a 'very significant concern' by five out of the 12 respondents, while 'security in the host country' was regarded as very significant by four respondents. The survey respondents were marginally in favour of governments taking an equity stake in a project to ensure that they had a strong incentive towards project timeliness and success, but were more strongly in favour of some level of MDB involvement.

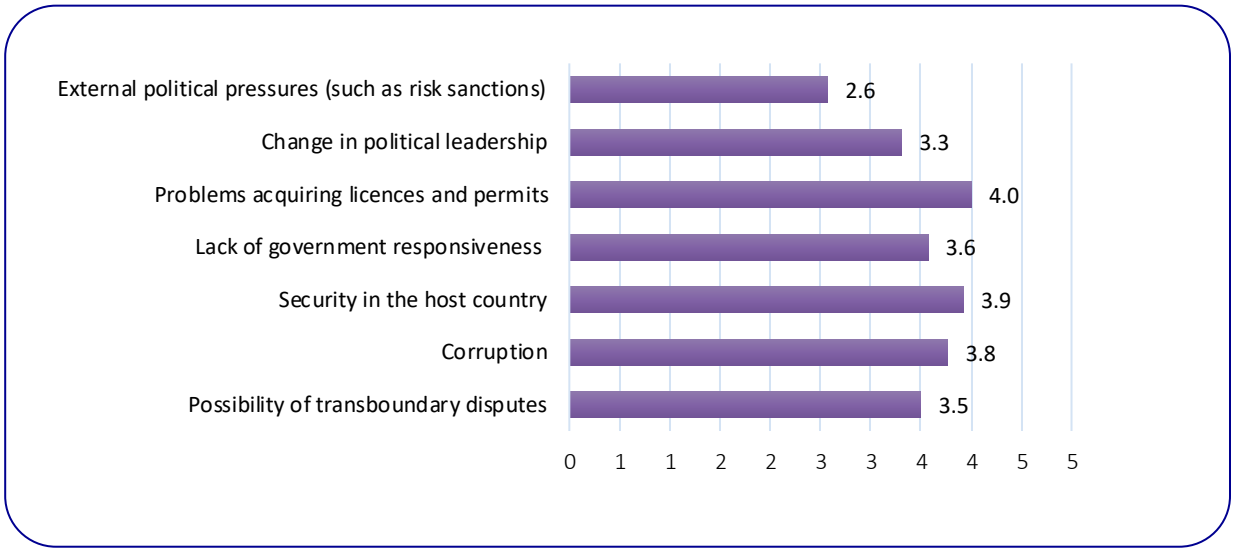
As well as dealing with the central government, the focus group participants highlighted a growing awareness among hydropower developers of the need to find ways to engage with affected and local communities to secure their support. It was noted that, in addition to the communities in the immediate vicinity of a project, more distant communities might also be affected by the project, for example through its impact on fisheries or water flows. Benefit-sharing agreements – and following through with promises made to local stakeholders – were deemed essential to acquiring and retaining the support of the affected populations. However, it was also acknowledged that effective community engagement, which involves developing positive relationships with the local and regional stakeholders and decision makers, can be challenging or even impossible in fractured societies with high levels of inequality or internal conflict.

Substantial government risks were seen to lead to a decision not to finance a project. For some, this was not an issue of seeking risk mitigation, as the project was simply 'too difficult' and they had easier options

for investing their money. In particular, an inability to secure the support of local stakeholders might also result in a 'no' decision at this stage, especially if the lack of support could be expected to present a security risk, a health and safety risk, or a reputational risk as a result of vocal objection to the project attracting negative publicity. For equity investors, the opportunity to sell their investment in the project was also important, and this consideration influences their approach to longer-term political risk.

In the focus groups, it was suggested that more could be done to investigate how bilateral treaties survive changes in government to reduce the risk of transboundary disputes and the renegotiation of export Power Purchase Agreements (PPAs) following political change in neighbouring countries.

Figure 5: Government risks - average significance of risks



Source: 'Financing renewable energy infrastructure – focus on hydropower' survey.

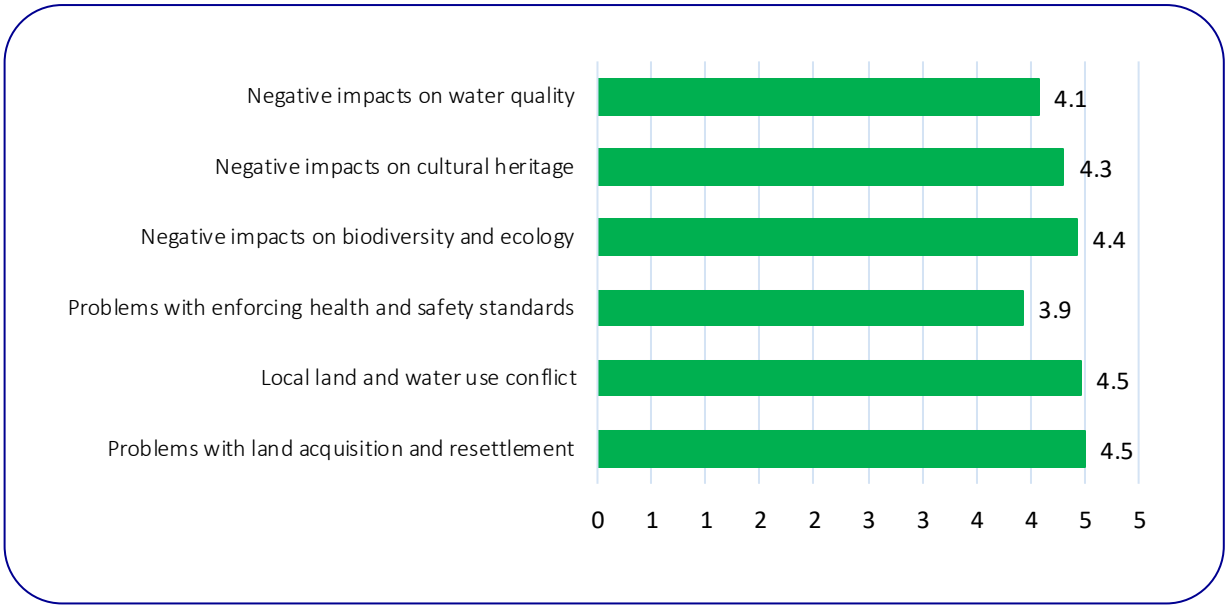
4.2 Environmental and social risks

Since the 1990s, the environmental and social impacts of large hydropower projects have attracted growing attention worldwide. Some of these risks – such as those associated with land acquisition, resettlement, biodiversity and ecology – may cause delays and slow down the process of securing the required permits to proceed with the project.

The focus group participants were clear on their intention only to finance sustainable projects, but also concerned about the inadequate attention paid to environmental and social impacts for two reasons: (1) insufficient social and environmental impact assessment or mitigating action can cause delays, which are costly; (2) negative environmental and social impacts reflect badly on the project and thus present a considerable reputational risk. If the risk of negative social or environmental impacts is perceived to be high, or there is a high risk that these will not be appropriately managed (such as evidence from a previous project in the country), a proposed project tends to receive a 'no' decision at the earliest stage.

The survey results (presented in Figure 6) also demonstrate that environmental and social risks present a significant concern to financiers. At 4.3, the average concern score for environmental and social risks was the highest of all four risk quadrants, and significantly above the overall average score of 3.9. The standard deviation of the results was only 0.2, showing a high level of agreement. 'Problems with land acquisition and resettlement' and 'negative impacts on biodiversity and ecology' were both regarded as a 'very significant concern' by seven out of the 14 respondents.

Figure 6: Environmental and social risks – average significance of risk



Source: 'Financing renewable energy infrastructure – focus on hydropower' survey.

Reputational risk was discussed in the focus groups extensively as an important underlying cause of high-level of concern over some government risks, such as corruption and many of the social and environmental risks. To explore this further, we included in the survey an additional question asking the respondents to rate, on a scale of 0 to 100, how concerned they were about reputational risk when deciding whether to finance a hydropower project. This question was answered by all 14 of the survey respondents whose organisations were directly involved in project financing. The results, an average score of 70.7 (and a median value of 76), support the perception we derived from the focus group discussions of the high relevance of reputational risk to all financiers. The discussion in the focus groups suggested that reputational risk presents a great concern largely because the damage from negative publicity cannot be undone, and the only effective mitigation strategy is to ensure that projects are well prepared to avoid any potentially damaging incidents. For financiers, this entails placing a high level of confidence in the developer.

The mitigation of social and environmental risks is best done via high-quality and thorough environmental and social impact assessments (ESIAs) and impact management plans. However, the focus group

participants also welcomed the emphasis on project-specific stakeholder consultations, on benefit sharing and on community-engagement strategies as potentially valuable approaches to improving relationships with the local stakeholders and working together to mitigate any negative impacts and draft benefit-sharing plans. The consensus was, nevertheless, that reaching agreement was often far from easy and often time-consuming.

An overall agreement across all focus groups was that the host country governments, particularly those officials involved in overall energy systems planning and water resource management, could make better use of some of the emerging performance standards and sustainability protocols (such as the HSAP) when preparing projects for private sector development. These protocols are designed to assess various potential projects to ensure that new hydropower plants are built in locations where any potentially adverse social and environmental impacts can be minimised. However, the participants also agreed that these tools are only useful when compliance and quality standards are properly monitored and enforced – a factor over which the financiers do not have much control. For this reason, many focus group participants indicated that their company was likely to consider a project in a LIC or an L-MIC only if it had some MDB involvement, which was generally regarded as an assurance that the analysis and management of the social and environmental impacts would be held to international standards and subject to some degree of external oversight.

4.3 Technical risks

For developers, technical risks are more easily managed than government and social or environmental risks, partly because most technical risks (with the possible exception of geotechnical risk) can be mitigated, and partly because developers have more control over the decisions that can substantially reduce many of these risks.

Financiers who have several large hydropower projects in their portfolios tend to employ engineers (known as lenders' engineers) with extensive technical expertise and experience in hydropower. They can help the financiers to understand the specific technical risks that are relevant for each project and the action that has been taken to mitigate them. During the focus groups some equity investors who were also developers even went so far as to say that they made their money by taking technical risks, because they had the experience to manage this.

Although technical risks concentrated in the very early stages of a project cannot be completely mitigated, some de-risking can be done through high-quality feasibility and geotechnical studies. However, these risks tend to be of greater concern to the developer than to financiers, as most financiers do not typically commit to a project before the design stage is either completed or near completion.

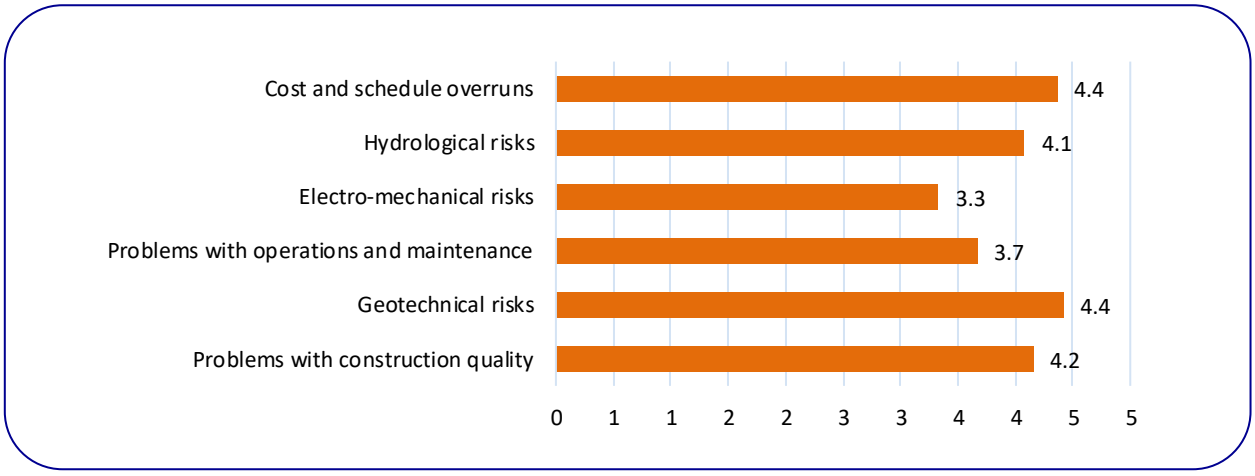
Risks that may occur during the construction and operational phases, on the other hand, are highly relevant for financiers because of potential delays or cost overruns, which can affect investors' returns or the project's ability to service its debt. However, as the focus group participants pointed out, the risks associated with electro-mechanical issues and construction quality can be reduced substantially through strategic selection of the contractor, the supervising engineer and the equipment – with smart decisions during the construction phase effectively also reducing the operations and maintenance risk later on. In fact, the ability to make decisions regarding issues such as supervision was deemed an essential risk-

mitigation mechanism by many focus group participants, while an inability to influence these decisions was seen to increase the perceived level of risk. Thus, projects where the host country government refuses the use of a supervising engineer, or is determined to carry out the supervision itself, may be considered riskier by potential financiers.

In addition to general operations and maintenance risks, hydropower projects are susceptible to changes in hydrology, ie the availability of water. This is a growing concern because the impact of climate change on weather patterns is increasing the unpredictability of precipitation, rendering historical data increasingly inadequate as a means of predicting future hydrology. Consequently, there is a growing need to develop new mechanisms to estimate future hydrology and to mitigate hydrological risk through approaches such as greater utilisation of capacity-based tariffs, or building more flexibility into the operating conditions.

The survey results demonstrated a detailed understanding of technical risk with an average level of concern of 4.0, slightly above the overall average of 3.9 across all quadrants. The standard deviation of the quadrant average was 0.39, indicating larger variation in the scores than was the case with environmental and social risks. As shown in Figure 7, the average risk scores ranged from 3.3. ('electro-mechanical risk') to 4.4 ('geotechnical risk' and 'cost and schedule overruns'). The low concern score for the electro-mechanical risk quite possibly reflects the extensive experience in hydropower among the survey respondents and their familiarity with the 'informal' approaches to mitigating the technical risks discussed in the focus groups, such as selecting projects that utilise familiar and trusted technologies and partners. With an average score of 4.4, concern over geotechnical risk was among the highest in the entire survey and surpassed only by two of the social and environmental concerns. Geotechnical risk was also rated a 'very significant concern' by more respondents than any other risk in the questionnaire (eight out of 14 respondents). This high score could be indicative of the limited options currently available for mitigating geotechnical risk and influenced by high representation among the survey respondents of organisations (such as MDBs and power sector companies) that commit to projects at an early stage or provide finance for feasibility studies.

Figure 7: Technical risks – average significance of risks



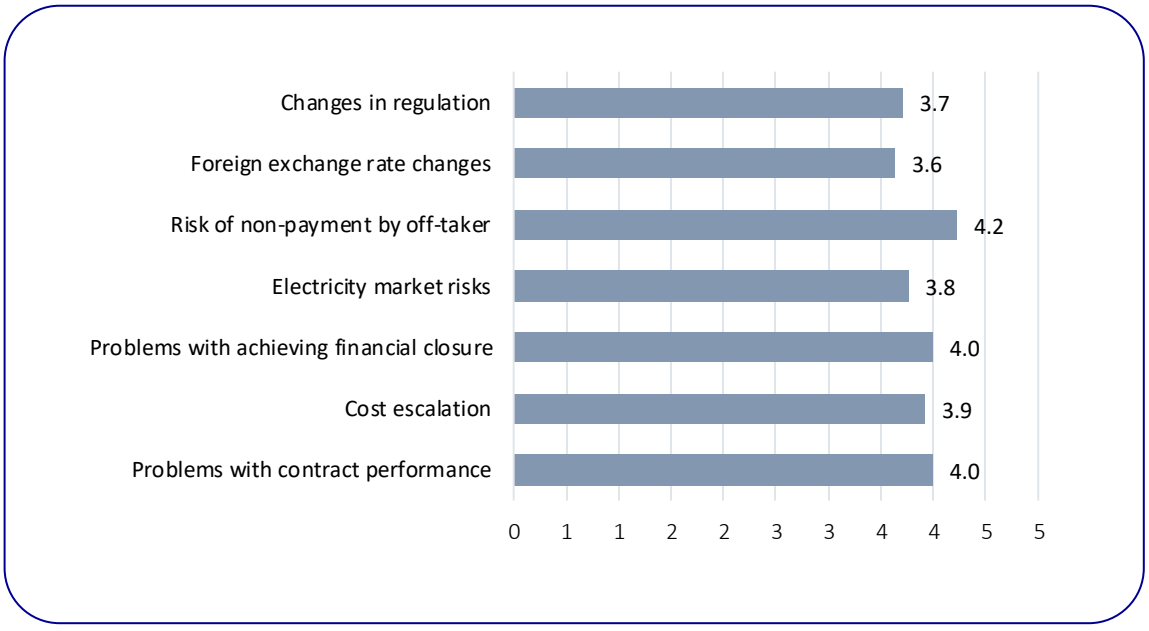
Source: 'Financing renewable energy infrastructure – focus on hydropower' survey.

4.4 Financial risks

The focus group participants were in general agreement that the two most important financial risks associated with large hydropower projects in LICs and L-MICs are foreign currency exchange risk (linked to less developed local commercial banking sectors and volatility of the local currency), and electricity market risk (linked to the potential need for grid upgrades to distribute electricity generated by the new hydropower plant and difficulties in setting a user tariff which ensures cost recovery).

While hedging can mitigate the currency exchange risk, most focus group participants agreed that this is difficult, and often too expensive to constitute a feasible risk mitigation strategy. Alternative methods, such as revolving credit in a foreign currency, denominating a part of the PPA in foreign currency and paying domestic shareholders their dividends in the domestic currency, were generally regarded as more feasible approaches to reducing the currency exchange risk and attracting more international investors into hydropower. The survey results on financial risks (see Figure 8) supported the findings from the focus groups in showing this as a significant but well understood area. The average score was 3.9, in line with the overall average score across all four quadrants. The standard deviation was only 0.2, showing a close alignment across all risks. The financial risks section in the survey included another risk, 'risk of non-payment by off-taker', in addition to the ones initially shown in the framework. This was partly because the focus group members were concerned that the term 'electricity market risk' did not explicitly include the risk of non-payment. In the survey responses the risk of non-payment scored highest, at 4.2, showing this as a significant concern and warranting its inclusion in the risk framework as a separate category. However, 'market risk' was also regarded as an important concern (average score 3.8), resulting in a decision to revise the risk framework to include both these risks individually. The survey respondents were also keen that climate finance be made available to hydropower projects and noted that this might reduce the financial risk of a project by diversifying the range of sources of finance available.

Figure 8: Financial risks – average significance of risks



Source: 'Financing renewable energy infrastructure – focus on hydropower' survey.

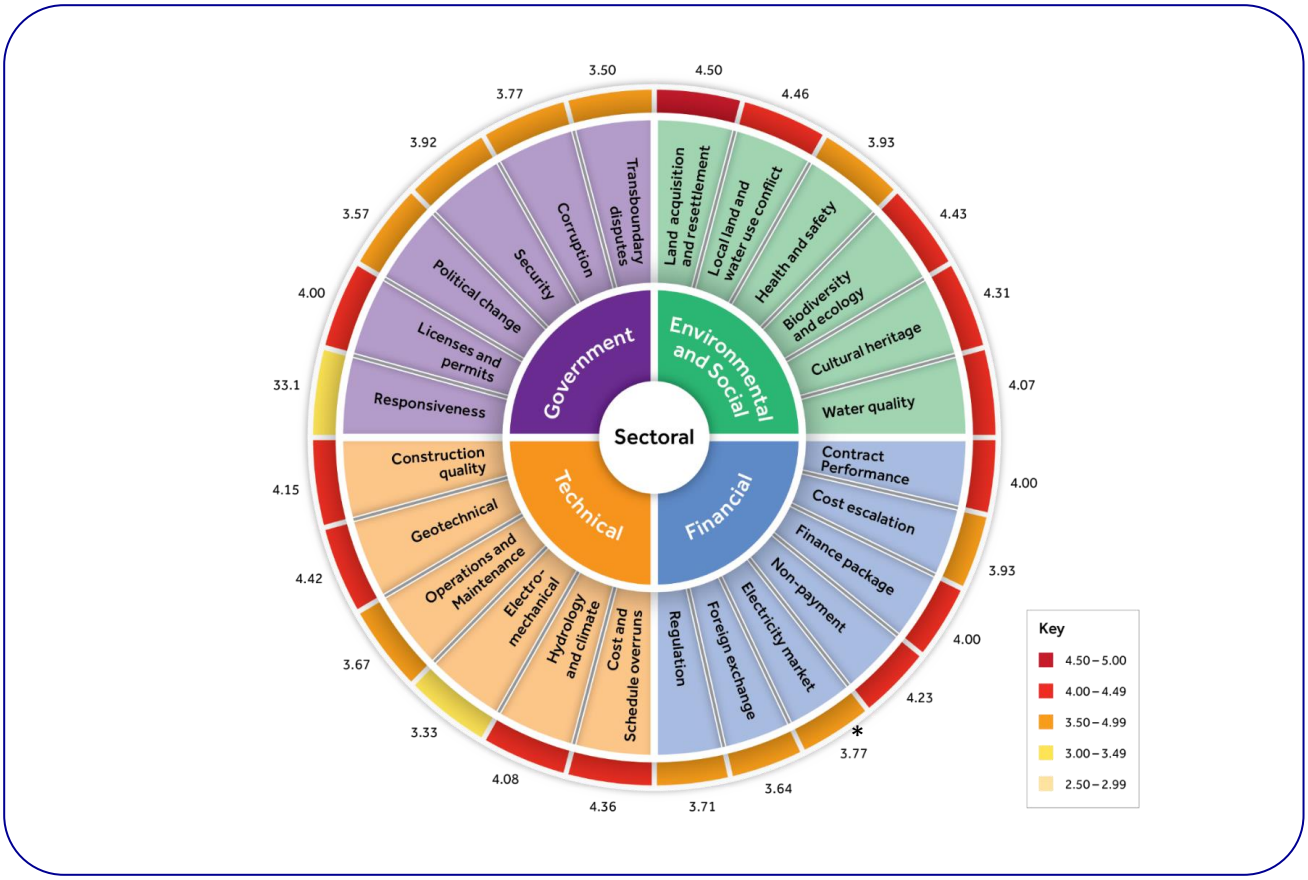
In summary, the results of the survey on risk were generally in line with the issues raised in the focus group discussions, with concerns over land acquisition and resettlement gaining the highest score. Very few of the risks included in the survey questionnaire were regarded as unimportant by the respondents. Given the uncertain political environments in many low-income countries, the low score for political change risk was perhaps unexpected. However, this can be at least partially explained by the widespread propensity of hydropower specialists to avoid getting involved in projects that are not supported by the government. Further, withdrawal of a concession, once agreed, is rare, even in the event of a change in political leadership. While political change may result in some contracts needing to be renegotiated by an incoming government, guarantees are available for this area. The low score for electro-mechanical risk shows the strength of the contractors and maturity of the technology.

5 Implications for developers, financiers and governments

5.1 How fit for purpose is the risk framework?

Most risks included in the framework were considered important by the financiers, as demonstrated by the overall average score of 3.9 across all four quadrants. The survey results validated the original perception from the focus groups, where all the risks included in the framework were regarded as relevant by the participants. While some minor changes to the risk framework were required in response to the survey results and the focus group discussions, overall the process provided reassurance that the content of the framework is appropriate and sufficiently comprehensive. A revised risk framework, including the relative risk scoring from survey results, is shown in Figure 9. Amendments to the previous version of the framework are the inclusion of the sectoral perspective in the centre and the additional financial risk category of 'non-payment' separated from other market risks (as indicated on the diagram by asterisks).

Figure 9: Revised risk framework with relative risk scoring from survey results



*Note: * denotes additions to the original framework.*

Source: Authors' amendments to original framework (Plummer Braeckman et al, 2020b).

The visual presentation of risks in the framework was regarded by the focus group participants as a useful tool to facilitate the discussion of risks and risk mitigation mechanisms in terms of individual risks as well as 'categories' of risk, represented by the four quadrants in the diagram. The framework was complimented for accurately reflecting the various risks in LICs and L-MICs, and drawing attention to risks that may constitute less of a concern in more developed markets. For example, the 'Government' quadrant of the framework may fade in importance in more developed countries, which tend to be more politically stable and arguably less prone to corruption. The presence of market mechanisms, strong institutions, reliable regulation and appropriate law enforcement mechanisms in more developed countries will also reduce many of the financial risks and social and environmental risks.

The framework was thought to be a particularly helpful instrument for sharing information with new entrants to the hydropower sector, as it enables financiers to see how the risks associated with large hydropower may differ from what they expected based on their previous experience of solar PV or wind projects. Comments from the focus group participants, on, for example, the essential requirement for new entrants to the hydropower sector to understand the importance of government support, validate the need for this type of sector-specific risk framework.

The combination of qualitative data from the focus groups and quantitative survey data allowed us to understand which risks are important to financiers and other actors, as well as how the various risks in the risk framework are interlinked – for example, a government risk causing a non-payment risk. Understanding these interlinkages and how they arise is almost as important as descriptive detail of each risk and how it may be mitigated. The focus group discussions also revealed that the underlying reason *why* risks such as 'corruption' and various environmental and social risks are regarded as major concerns is because of the reputational risk that they present to the parties involved. The high level of concern over reputational risk was confirmed in the survey results, where respondents estimated their level of concern about it at an average of 71 out of 100 (median 76/100). Also, 85 per cent of the financial respondents agreed that hydropower presented a greater reputational risk than other renewable energy projects.

In addition to discussing the risks identified in the first iteration of the analytical risk framework (see Figure 1), the focus group participants identified some additional risks that are emerging or gaining more prominence in the context of climate change. These include both climate change itself and the impacts of climate change mitigation policies, in particular growing financial and political support for intermittent renewables.

However, climate change and greater inclusion of intermittent renewables are issues likely to affect the entire energy landscape of a country, and the hydropower sector as a part of it, instead of targeting a specific project. While issues to do with climate change are certainly important at the project scale, they primarily concern hydrology, which is already included in the risk framework. To highlight the potential impacts that climate change mitigation policies may have on the broader hydropower sector (including regulation and new financing instruments to support and incentivise investment in intermittent renewable energy technologies), we considered adjusting the risk framework to include these broader contextual and sectoral factors. We also noted a reference to the importance of climate change adaptation, which the focus group participants felt could boost new interest in dam development. The various ways in which climate change, climate change mitigation policy and the need for climate change adaptation might affect

the hydropower sector is a complex topic deserving of more detailed assessment than space here allows, and will thus be discussed in more detail in a forthcoming paper.

A new iteration of the risk framework is shown in Figure 10[3]. To avoid over-complicating the diagram, the need to consider sectoral risks (such as the wider impacts of climate change or competition from other renewables) is noted as an area in the centre of the diagram.

Figure 10: The risk framework placed in a sectoral context

[3] An interactive version of Figure 10 is available at http://www.futuredams.org/risk-framework/

5.2 Policy implications

Overall, the findings presented in this paper support a previous conclusion by the World Energy Council (2015) that markets and policy will need to evolve further to appropriately incentivise investors, particularly where the private sector is expected to engage. The risks identified in the survey and by the focus groups as of greatest concern to financiers tend to be those for which formal mitigation strategies are not widely available or are regarded as ineffective or extremely expensive. For example, the available risk mitigation mechanisms against non-payment still fail to prevent off-takers, or an incoming government, from wanting to renegotiate PPAs before the concession period comes to an end. Mitigating this issue may require a guarantee but financiers consider this a last resort option as it affects their standing with the government concerned; they are thus more likely to agree to negotiate if future projects opportunities are available.

Many of the risks regarded by the focus group participants and survey respondents as most concerning or least mitigatable are linked to the nature of large hydropower projects and thus specific to this sector. For example, a long construction period means that the electricity market situation may change during construction. The size of such projects means that *some* environmental and social impacts will always occur (although many of these can be minimised through high-quality impact assessment and mitigating action). The scale of the output capacity in terms of GWh means that finding a new off-taker for the electricity is difficult in many LICs and L-MICs, or even impossible in contexts where there is a single grid operator and no electricity market.

The results presented in this paper provide LIC and L-MIC country governments with some insights into what private sector actors and financiers consider to be the main barriers to greater private sector involvement in large hydropower projects in these types of country contexts. Although the specific contextual factors may vary, the results from our research enable us to draw some conclusions on this. Many of the risks are overlapping and may reinforce each other: corruption, and environmental and social risks, are important because they increase reputational risk. These need to be addressed though good preparation and implementation following international good practice and strong government action to reduce corruption. The risk of non-payment by the off-taker is currently regarded as the most significant financial risk associated with large hydropower projects in LICs and L-MICs. However, this will become less of a concern as economies grow and prosper. Economic growth will also help to reduce some of the other financial risks, such as the foreign exchange rate risk, eventually easing access to finance and reducing the likelihood of a project having difficulties in achieving financial closure. This process is, to some extent, circular: as more projects are developed and additional electricity generation capacity enables economic growth, the government capacity develops and the economies grow, leading to improved breadth of financial options, more projects and thus more development. More prosperous societies also tend to be more politically stable, a factor which may reduce many of the government risks and the risk of non-payment by the off-taker. Some approaches that are currently detailed as a mechanism to mitigate government risk are self-reinforcing, such as the 'single window' approach to reducing red tape and reducing the risk of delays in acquiring licences and permits, which may also lead to improvements that mitigate some of the risks in other quadrants, such as better financial regulation.

For the private sector, all risks that affect a project's costs or its ability to service its debts and generate revenue are relevant. As our previous research shows, technical risks, social and environmental risks and

government risks may all become credit or market risks because of the impact they can have on a project's ability to generate income on schedule for profit distribution (including dividend payments) or debt service (Plummer Braeckman et al, 2020). However, some of the risks may be more difficult to mitigate or eliminate than others, presenting an insurmountable barrier to involvement in a project. Risks that present a reputational risk fall into this category; thus, where there is a concern that these risks cannot be adequately mitigated, a project is likely to be dismissed by financiers. For LIC and L-MIC governments in countries with abundant untapped hydropower resources, addressing and mitigating these risks will be essential to create the conditions that enable greater utilisation of PPPs in large hydropower development.

6 Conclusions

Most financiers have a wide range of business opportunities. If hydropower is perceived as excessively risky in comparison to the returns available from other infrastructure finance transactions, they are likely to seek simpler, more remunerative opportunities elsewhere. However, an ability to attract private sector finance for large hydropower projects will be necessary to enable LICs and L-MICs to increase their renewable electricity generation capacity and facilitate meaningful progress towards the SDGs and the Paris Agreement objective. To this end, better understanding of the factors that deter private sector involvement in such projects is required.

The aim of this paper has been to explore how perceptions of risk influence the prospects of obtaining finance for large hydropower projects in LICs and L-MICs. Tools such as our analytical framework, which facilitates a comprehensive understanding of risk and of available risk mitigation mechanisms, are essential to support environmentally, socially and economically sustainable hydropower project development in countries with below-investment-grade credit ratings. Together with the analysis presented in this paper, the risk framework will enable financiers, private sector companies and host country governments to develop a thorough understanding of the risks associated with large hydropower projects and how they may be mitigated, either through formal risk mitigation mechanisms or through practices utilised by those already active in this sector to reduce uncertainties. The framework and analysis can also enable financiers less familiar with large hydropower to improve their understanding of the nature and extent of these risks and how they may be mitigated or managed, and to see the opportunities that the hydropower sector may be able to offer to them, for example through refinancing.

Capital-intensive projects such as hydropower remain contentious and carry considerable business and credit risks. Although most of these can be mitigated, many such measures are expensive, or ineffective against risks such as loss or damage to reputation, and it is impossible to eradicate all risks completely. For LIC and L-MIC country governments, it is important to acknowledge that the risks associated with large hydropower projects cannot be effectively addressed by ignoring them or hoping that other parties will not notice them. This approach will lead to bad projects, which will reinforce prevailing perceptions of large hydropower projects as 'risky' or likely to result in negative publicity, leaving financiers with an impression that the sector as a whole, or the country in question, is best avoided. Rather than trying to divert risks on to other stakeholders without considering the cost implications, governments would benefit from being more transparent in their project risk assessments, discussing the relevant risks with potential financiers, and agreeing risk-sharing mechanisms so that no stakeholder is over-exposed to risks they cannot manage. Greater financial support from MDBs to carry out thorough environmental and social impact assessments and pre-construction studies in their role of broker between the financing entities and the project could help reduce many of the risks currently regarded as most concerning and least mitigatable by the private sector.

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Appendix 1 - Focus group discussions reportage

Government risks

Host country governments are responsible for issuing various concessions, permits and licences to large hydropower projects. Without the support of the host country government, a project can grind to a halt or face severe delays. The focus group participants were in strong agreement that government support constitutes an essential prerequisite for all large hydropower projects. For many, this was regarded as essential for a proposed project to be given a green light at the earliest stage. However, it was also suggested that foreign actors entering a new market do not always fully appreciate just how much government support (both capital and in kind) hydropower projects need. This comment is particularly interesting in the light of the results presented above, as it emphasises the risk of promoting hydropower projects as 'just like' any other investment, resulting in negative experiences among first timers and reluctance to engage in such projects again.

Government risks remain relevant from the pre-construction stages to the operational stages of the project, and are unlikely to decline over time, although their nature may change. In the focus groups, the discussions on government risk focused primarily on three out of the six categories in the risk framework: lack of responsiveness of government, corruption and the risk of political change.

Lack of responsiveness was seen to constitute a major risk for a project. However, there was strong consensus that the reasons for lacking or slow responsiveness could vary, and in some contexts a slow response might genuinely be caused by a lack of capacity or knowledge. This is the case especially in countries where the government does not have previous experience of large hydropower projects. In other instances, lack of responsiveness was linked to unwillingness or cultural factors, and possibly corruption. Lack of responsiveness presents a risk particularly during the early stages, when the necessary permits and certificates need to be acquired. However, a 'single window' approach was widely regarded as a highly efficient mechanism to mitigate this risk, and several focus group participants suggested that more widespread use of the single window approach could improve the ease of doing business in contexts where lack of government responsiveness was currently seen as a high risk.

Corruption may result in a challenging business environment wrought with uncertainty, but the risk to reputation may be even greater. The reputational risk associated with corruption allegations, even if later shown to be unfounded, acts as a disincentive to involvement in projects in countries where corruption is known to be a problem. Some focus group participants revealed that companies often base their guidelines on broad generalisations – for example, one London participant stated that their current employer does not even consider projects in Africa because of the perceived risk of corruption in the continent.

The risk of political change is heightened by the long gestation period of large hydropower projects. Even after a project is operational, political change may prompt a tariff renegotiation, increasing the risk of changes to the expected rate of return for equity investors and reduced debt repayment capacity for creditors. However, some participants indicated that there was a worrying trend, especially among African governments, of requests for tariff renegotiations even in stable political contexts.

As electricity markets become increasingly integrated at sub-regional level, the risk of a hydropower project being negatively affected by political change in nearby countries has grown. Regime changes in neighbouring countries may result in trade wars or may reignite transboundary disputes, which may affect the financial feasibility of a project through the broader impacts of political upheaval and civil unrest. Examples are the (intended) purchasers defaulting on PPAs, changes in demand or changes in payment capacity, which are classified as financial risks in the analytical framework. Political change in neighbouring countries, or in countries to which electricity is being exported, was seen as a growing risk, especially by the Singapore focus group participants, many of whom noted that this concern was increasingly prevalent in Southeast Asia, where projects in countries such as Lao PDR have been developed specifically for export purposes (although this risk had not as yet transpired).

As well as dealing with the central government, the focus group participants highlighted a growing awareness among hydropower developers of the need to find ways to engage with affected and local communities to secure their support. It was noted that, in addition to the communities in the immediate vicinity of a project, more distant communities might also be affected by it, for example through its impact on fisheries or water flows. Benefit-sharing agreements – and following through with promises made to local stakeholders – were deemed essential to acquiring and retaining the support of the affected populations. However, it was also acknowledged that effective community engagement, which involves developing positive relationships with the local and regional stakeholders and decision makers, can be challenging or even impossible in fractured societies with high levels of inequality or internal conflict, or where a given project is a part of a larger river basin development.

Proposed projects that are not supported by the host country government, projects in countries where the risk of political change is perceived to be very high, and projects that are perceived to be at high risk of being affected by transboundary disputes or by the intended foreign purchaser defaulting on the PPA typically receive a 'no' decision from developers and financiers at the earliest stage. Thus, for some, this is not an issue of seeking risk mitigation, as the project is simply 'too difficult' and they have easier options for investing their money. Inability to secure the support of the local stakeholders may also result in a 'no' decision at this stage, especially if the lack of support can be expected to present a security, health and safety or reputational risk as a result of vocal objections to the project attracting negative publicity. For equity investors, the opportunity to sell their investment in the project is also important, and this consideration influences their approach to longer-term political risk.

In the focus groups, it was suggested that more could be done to investigate how bilateral treaties survive changes in government to reduce the risk of transboundary disputes and export PPA renegotiations following political change in neighbouring countries.

Environmental and social risks

Since the 1990s, the environmental and social impacts of large hydropower projects have attracted growing attention worldwide. Some of these risks – such as those associated with land acquisition, resettlement, biodiversity and ecology – can cause delays and slow down the process of securing the required permits to proceed with the project.

The focus group participants were clear on their intention only to finance sustainable projects, but also concerned about the inadequate attention paid to environmental and social impacts for two reasons: (1) insufficient social and environmental impact assessment or mitigating action can cause delays, which are costly for developers and are of concern to financiers because they may affect repayments; and (2) negative environmental and social impacts reflect badly on the project and thus present a considerable reputational risk. If the risk of negative social or environmental impacts is perceived to be high, or there is a high risk that they will not be appropriately managed (such as evidence from a previous project in the country), a proposed project tends to receive a 'no' decision early on.

The focus group discussion suggested that, for private sector financiers, environmental and social risks are slightly less important than they are for developers, as an ESIA is typically completed before private investors need to confirm their commitment to a project. However, unforeseen environmental and social impacts may emerge during the construction period, especially if: (1) the ESIA has not been thoroughly conducted; (2) the associated mitigation plans are not followed through; or (3) a project has been pushed through by the government in spite of strong opposition from local communities. In some instances, negative social and environmental impacts may attract high-profile celebrity campaigns against the project, causing severe delays and negative media coverage. If such campaigns start after the project has achieved financial closure, they present a considerable reputational risk to the financiers as well as the developer. If financial closure has not yet been reached, these campaigns may incentivise financiers to pull out of a project after indicating approval in principle.

The mitigation of social and environmental risks is best done via high-quality and thorough ESIAs and impact management plans. However, the focus group participants also welcomed the recently emerging emphasis on project-specific stakeholder consultations, benefit sharing, and community-engagement strategies as potentially valuable approaches to improving relationships with local stakeholders and working together to mitigate any negative impacts and to draft benefit-sharing plans. However, there was a consensus that reaching agreement was often far from easy and sometimes outright impossible.

An overall agreement across all focus groups was that the host country governments, particularly those officials involved in overall energy systems planning and water resource management, could make better use of some of the emerging performance standards and sustainability protocols (such as the HSAP) when preparing projects for private sector development. These protocols are designed to compare various potential projects, in order to ensure that new hydropower plants are built in locations where any potentially adverse social and environmental impacts can be minimised. However, the participants also agreed that these tools are only useful when compliance and quality standards are properly monitored and enforced – a factor over which the financiers do not have much control. For this reason, many focus group participants indicated that their company was likely to consider a project in a LIC or an L-MIC only if it had some MDB involvement, which was generally regarded as an assurance that the analysis and management of the social and environmental impacts would be held to international standards and subject to some degree of external oversight.

Technical risks

For developers, technical risks are more easily manageable than government and social/environmental risks, partly because most technical risks (with the possible exception of geotechnical risk) can be mitigated, and partly because developers have more control over decisions that can substantially reduce

many of these risks. Financiers who have several large hydropower projects in their portfolios tend to employ engineers (known as lenders' engineers) with extensive technical expertise and experience in hydropower and who can help the financiers to understand the specific technical risks that are relevant to each project and the action that has been taken to mitigate them. Some focus group participants even went so far as to say that they made their money by taking technical risks because they had the experience to manage them.

Technical risks that are concentrated in the very early stages of the project (planning and design phases), such as some of the geotechnical risks, are of greater concern to developers than to private sector financiers, as most financiers do not typically commit to a project before the design stage is either completed or near completion. Although these risks cannot be completely mitigated, some de-risking at the early stages can be done through high-quality feasibility and geotechnical studies. However, these are often very expensive, especially in less developed countries, where high-quality data on geological conditions are not readily available. Moreover, the up-front costs associated with the surveys need to be met largely by the developer, who may lose all this investment if the survey results indicate that the project is unviable.

The focus group participants suggested some approaches that would reduce the impact of geotechnical risks to private sector investors. For example, greater availability of grants from MDBs to LIC and L-MIC governments would enable them to commission high-quality pre-construction studies, meaning that sites would be recommended for development and put to tender only after the geotechnical and other conditions had been appropriately surveyed. Alternatively, cost-sharing mechanisms, such as approaches that enable the costs to be split between the developer and the host country government or the off-taker (such as geotechnical risk registers), could be used to reduce the risks associated with conditions that render the site unsuitable for the proposed project. These approaches would have two benefits: (1) high-quality feasibility and geotechnical studies would reduce the risk of unexpected problems and delays during the construction stage; and (2) the lower risk of delays would reduce the total project costs, as the private sector would not need to be paid a high premium for taking on an unquantifiable *potential* risk.

The focus group participants then discussed some of the risks that occur during the construction and operational phases. Such risks are highly relevant for financiers as well as developers, because unexpected issues that cause delays, cost overruns or difficulties in operation can affect investors' returns or the project's ability to service its debt.

There was strong agreement among the participants that the risks associated with electro-mechanical issues and construction quality can be reduced substantially through strategic selection of the contractor, the supervising engineer and the equipment – with smart decisions during the construction phase effectively also reducing the operations and maintenance risk later on. Most foreign companies that get involved in the development of large hydropower projects in LICs and L-MICs have extensive experience in hydropower project development, which is typically acquired initially in the context of highly developed countries, where many of the risks associated with such projects are perceived to be lower. Over time, these companies have acquired a wealth of knowledge regarding different technologies, and many have also established strong relationships with each other through collaboration. These networks make it possible for a developer to source equipment, labour, expertise and materials from companies regarded as a 'known quantity', reducing the risk that is always associated with 'unfamiliar' entities and untested

technologies. Many of the focus group participants felt that procuring technology and labour from 'known quantities' could reduce overall projects costs, even if the goods and services were more expensive than the less familiar alternatives.

Some of the well-established collaborative arrangements extend to including financiers, who are more inclined to finance a project where they consider the lead arranger and the developer to be a 'known quantity' they can trust. For example, the French energy company EDF has been involved in several large hydropower projects in French-speaking Africa and Southeast Asia, often sourcing part of the project financing through grants and debt from Agence Francaise de Developpement and Proparco. There are also companies in the hydropower sector that are widely regarded as 'trustworthy and knowledgeable' among financiers. Participants gave the example, SN Power (owned by the Norwegian private equity firm Norfund) concentrates on acquiring, developing, constructing and operating hydropower assets in developing countries, and has a wealth of experience built up over the years. Projects that involve a 'known quantity' as a shareholder are likely to be regarded as less risky by financiers.

For new financiers interested in entering the hydropower sector, as well as countries that do not have existing recently constructed hydropower assets, acquiring knowledge of the experienced and trusted partners in the hydropower sector would considerably reduce the risks of new ventures and ease the process of securing finance. There may also be possibilities for developing and improving the host country capacity through collaboration with well known and highly reputable international partners, especially in countries where much of the existing hydropower potential remains untapped.

In two of the focus groups, the participants drew attention to the importance of appointing a good on-site supervising engineer for each project, as active construction management is essential to mitigate technical risks. Again, a supervising engineer who is a 'known quantity' improves confidence among the developer, investors and lenders. The ability to make decisions regarding issues such as supervision was deemed an essential risk mitigation mechanism by many participants, while an inability to influence such decisions was seen to increase the perceived level of risk. Thus projects where the host country government refuses the use of a supervising engineer, or is determined to carry out the supervision itself, may be considered riskier by potential financiers.

In addition to general operations and maintenance risks, hydropower projects are susceptible to changes in hydrology, ie the availability of water. This issue was subject to extensive discussion in all three focus groups, partly because it has substantial financial implications for large projects, and partly because of participants' growing concern over the impact of climate change on hydropower. Under the currently prevalent remuneration mechanisms, hydrological risk is closely linked to financial returns: long periods of insufficient hydrology reduce the amount of electricity that a plant can generate. On the flip side, abundant hydrology will make it possible for the project to operate at full or near full capacity, which can create additional revenues. Capacity-based tariffs which remunerate hydropower plants based on their availability rather than on production can protect the projects from the downside risk of low hydrology. However, this approach also limits the potential for any upside gains when more water is available.

Hydrological risk is a growing concern because the impact of climate change on weather patterns is increasing the unpredictability of precipitation. As one participant in the Singapore focus group remarked, historical data provide an increasingly inadequate indication of future hydrology, a concern which is exacerbated by the long construction period, during which further changes in hydrology may emerge.

Consequently, there is a growing need to develop new mechanisms to estimate future hydrology that rely less heavily on historical hydrological data, in order to minimise the financial impacts of unexpected hydrological changes. Although some risk mitigation mechanisms such as derivatives and new types of insurance have recently become available, these tend to be expensive and relatively rare. The focus group participants expressed a preference for mitigating hydrological risk through approaches such as greater utilisation of capacity-based tariffs, or assuming below-maximum capacity for the project when conducting the feasibility studies. Alternatively, tools such as 'staged' insurance to partially cover the impact of hydrological changes on the project's generation capacity, as has been done in Uruguay, may present a solution for other countries.

Financial risks

The focus group participants were in general agreement that the two most important financial risks associated with large hydropower projects in LICs and L-MICs are foreign currency exchange risk and electricity market risk. These are linked to a less developed local commercial banking sector, volatility of the local currency, and the potential need for grid upgrades to distribute electricity generated by the new hydropower plant.

Currency exchange risk can be mitigated by hedging, but most focus group participants agreed that this is difficult and often too expensive to constitute a feasible mitigation strategy. Instead, it was suggested that some portion of the PPA be denominated in foreign currency or that MDBs be requested to provide a US dollar revolving credit to ensure a dollar cash flow – an approach that has reportedly been used on one occasion by the World Bank. In addition, investors could be split into offshore and domestic shareholder groups, paying domestic shareholders their dividends in the domestic currency. This approach would reduce the amount of US dollars required for dividends, while investing in the local currency could appeal to domestic pension funds. A 70/30 split (70 per cent in US$ and 30 per cent in the local currency) was suggested as a working hypothesis.

The last approach could potentially also be used to bring down the cost of debt financing for smaller hydropower projects of 1–30 MW. These projects are lower cost and thus do not necessarily require international financing, as local financiers often have sufficient capital available. However, a lack of sufficient expertise, high default rates and a low understanding of risk among local financiers may make this capital prohibitively expensive. Approaches to reduce the currency exchange risk could make such projects more appealing to international investors, improving the availability of financing for small and medium-sized hydropower projects, as well as reducing the cost of finance. For large projects, local currency finance was thought to be constrained by strict limits on the length of tenor in local capital markets; however, a recent example from Nachtigal in Cameroon provides some ideas for how this challenge can be overcome by building in refinancing options to the financing package from the start.

Electricity market risk encompasses risks associated with energy prices, problems with the PPA and the inability of the off-taker to purchase and distribute the electricity as agreed. Government responsibilities and guarantees can be used to mitigate the electricity market risk but, as the focus group participants emphasised, are useful only if they are enforceable. In practice, a government guarantee in LICs and L-MICs typically needs to be backed up by an MDB guarantee. One of the participants offered an example of a project where partial risk guarantee (PRG) from an MDB helped to improve the bankability of a project by reducing the cost of debt from Libor + 12 per cent to Libor + 4 per cent. Another participant suggested

using a system whereby the client pays for both power and system services, rather than cost per kWh alone, to mitigate the electricity market risks associated with an off-taker. Some countries with highly sophisticated electricity markets are already moving towards methods that incorporate payment for system services, to facilitate greater penetration of intermittent renewables into the grid. In the future such approaches may also gain traction in LICs and L-MICs as well.

It was also suggested that a greater host government involvement or share in the project might help alleviate the electricity market risk, as well as other financial risks not related to currency exchange. For example, offering free equity to government (or equity in exchange for resource rights) could increase the government's interest and stake in the project, but only require pay-out when the project generates returns. This could provide a less risky alternative for a PPP project than royalties or a guarantee of free energy to the host country government.

Some participants, particularly in Namibia, noted the role that refinancing could play in hydropower finance. Although hydropower may be seen as a high-risk project before construction is complete, the level of risk is dramatically reduced once the project becomes operational. Furthermore, as hydropower plants are not subject to a fuel price risk, they may actually have lower operational risks than thermal power plants (although there may be some hydrological risk depending on the PPA structure). Thus, refinancing a hydropower project after construction can enable it to release high cost 'risk' finance and replace it with lower-cost long-term finance, such as from institutional investors. The focus group participants felt that it was important to build options for refinancing into the financing plan from the beginning.

The survey results on financial risks supported the findings from the focus groups in showing this as a significant but well understood area. The average point score was 3.9, in line with the overall average score across all four quadrants. The standard deviation was only 0.2, demonstrating a close alignment across all risks. The financial risks section in the survey included another risk, 'risk of non-payment by off-taker', in addition to the ones initially shown in the framework. This was partly because the focus group members were concerned that the term 'electricity market risk' did not explicitly include the risk of non-payment. In the survey responses the risk of non-payment scored highest, at 4.2, showing this as a significant concern and warranting its inclusion in the risk framework as a separate category. However, 'market risk' was also regarded as an important concern (average score 3.8), resulting in a decision to revise the risk framework to include both these risks individually. The survey respondents were also keen that climate finance be made available to hydropower projects and noted that this might reduce the financial risk of a project by diversifying the range of sources of finance available.