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Investment risks and policy solutions for renewable electricity in Bangladesh

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ABSTRACT

Renewable energy project developers and financiers in Bangladesh face different risks in investing in renewable electricity projects. These barriers slow the progress towards attaining the renewable energy and climate goals of the country. This study presents the findings of a comprehensive survey of forty six key stakeholders in the renewable energy sector of Bangladesh, including thirty four project developers, six regulators and five financiers. Permits risk and power markets risk are considered the biggest challenges, whereas social acceptance risk, counterparty risk and macroeconomic risks are considered low. Foreign developers have the highest risk perceptions, whereas regulators have the lowest. Risk perceptions vary between debt and equity investors. Power Purchase Agreement guarantees, one stop licensing, financial product development and currency or interest rate hedging are considered top risk mitigation policy solutions, whereas awareness campaigns and community involvement are considered less effective. Public sector investors perceive risks to be lower than their private sector counterparts. The findings reveal that there is a gap between regulators and investors regarding the impact of the risks. A shared understanding of the challenges facing the sector must be attained for regulators to formulate policies that increase and facilitate investments in the sector.

Introduction

Bangladesh has had a policy to develop its renewable energy sector since 2008, in order to cut down greenhouse gas emissions, increase energy security of the country, and reduce dependence on local dwindling supplies of fossil fuels (Power Division, 2008). The Renewable Energy Policy, formulated in 2008, had set targets for developing renewable energy resources to meet 5 % of the total power demand of Bangladesh by 2015 and 10 % by 2020. However, those targets have not been met, and have been rescheduled to 2025 in the 8th five year plan (General Economics Division, 2020). Meanwhile, the latest updated Nationally Determined Contribution document of Bangladesh states that there is an unconditional target of 6.73 % of emission reduction in Bangladesh by 2030, and an emission reduction target of 15.12 % below the business as usual level, conditional on international support. Out of this emission reduction, 96.46 % is to come from the energy sector (Ministry of Environment, Forest and Climate Change, 2021). In 2016 Bangladesh ratified the Paris Agreement and registered its Nationally Determined Contribution at the UNFCCC, where it specified that increasing the share of renewable energy in the power generation mix would be a strategy to reduce greenhouse gas emissions (Ministry of Environment, Forest and Climate Change, 2018). In the power sector, the actions taken in the unconditional scenario of the Nationally Determined Contribution would include the implementation of renewable energy projects of 911.8 MW, out of which there would be 581 MW of grid-connected solar, 149 MW of wind, 20 MW of biomass, 5 MW of biogas, 56.8 MW of solar mini-grids and 100 MW of new hydro. In the conditional scenario, renewable energy projects of 4114.3 MW would be built including 2277 MW of grid-connected solar, 597 MW of wind, 50 MW of biomass, 5 MW of biogas, 1000 MW of new hydro, 56.8 MW of solar mini-grids, and 128.5 MW of waste-to-energy. At present, the installed capacity of renewable electricity in Bangladesh is 1200 MW, out of which the bulk comprises of solar photovoltaic electricity (SREDA, 2023). However, renewable energy accounts for around 3.57 %

Abbreviations: NDC, Nationally Determined Contribution; UNFCCC, United Nations Framework Convention on Climate Change; SHS, Solar Home System; LOI, Letter of Intent; PPA, Power Purchase Agreement; PV, Photovoltaic; IPP, Independent Power Producer.

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of the country's total power generation capacity as on May 2022 (SREDA, 2022) and electricity generation has become increasingly carbon intensive over the years, although becoming more energy efficient (Aziz & Chowdhury, 2020). Although policies in Bangladesh have promoted the expansion of renewable energy, the increasing electricity demands from a growing economy, and limited renewable energy resources has led to a growth in fossil fuel based electricity generation at a much faster rate than the growth of renewable electricity (Fig. 1.1) (Ember, 2023).

There have been periodic reviews of the prospects for renewable energy development in Bangladesh, describing natural resource potentials for different renewable technologies, existing government programs and policies, and challenges to development, (Halder et al., 2015; Hossain et al., 2017; Islam et al., 2014).

Traditionally identified barriers to the rapid proliferation of renewable energy technologies in Bangladesh have evolved over time, as the technologies improved, costs reduced and policies evolved. Challenges identified in the literature include financial, technical, institutional, informational, human capacity, policy and governance barriers (Mahmud & Roy, 2021). Mondal et al. (2010) have reviewed the institutional, technical and policy barriers to the proliferation of renewable energy projects in rural areas. However, as the technological and financial constraints evolve over time, the institutional, human capacity, and policy and governance impediments also change.

Mahmud and Roy (2021) have documented various barriers at this stage of the development of the sector. The institutional barriers have been identified to be uncoordinated function and procedure, and the lack of inclusiveness of various stakeholders in the decision-making process. The policy and governance barriers include placing a relatively low priority on renewable energy, and a top-down decision-making process. Economic and financial constraints include lack of a proper business model for renewables, and subsidies for fossil fuels, making renewables uncompetitive for grid connected electricity generation. Resource and environmental constraints include lack of adequate free land, and technical barriers include limited grid integration facilities for intermittent renewable energy (Mahmud & Roy, 2021). Solar PV electricity has proved to be the most promising renewable energy technology for Bangladesh, and the problems of land scarcity, information barriers and human resource barriers are particularly applicable to this technology (Rahman, 2012). A review by Karim et al. (2019) has identified some factors which can affect investors in the renewable electricity sector in Bangladesh. These include the complexity and risk of new technologies affecting commercialization of projects, unpredictable payback periods, difficulties in obtaining financing, large initial investments, competition from cheaper fossil fuels, and the relatively small size of renewable energy entrepreneurs compared to larger fossil fuel based independent power producers (IPPs). Steckel and Jakob (2018) show that in developing countries the initial upfront costs of renewable energy projects are a deterrent to investments, and if the cost of capital of renewable energy projects were lower below a given threshold, the bulk of energy would be supplied from wind and solar power, and the energy transformation would take place. Thus, they recommend policy and financial de-risking to reduce the investment risks, which would in turn reduce the cost of capital.

Although some broad industry level challenges to the development of renewable energy in the country have been identified in the literature, to the best of the authors' knowledge, there has been no in-depth exploration, using project level data, into the actual form and extent of how these challenges affect actual investors of renewable energy projects. This study aims to add to the literature by using primary data, obtained through in-depth interviews, to analyze the barriers faced by public and private sector investors to developing large scale grid connected renewable electricity projects. This study presents the results of semi structured interviews of almost all the existing and aspiring investors of such projects in Bangladesh, as well as key financiers, policy makers, and regulators. The study analyzes the factors that increase the risk of renewable energy investments in Bangladesh, and how some proposed policy measures can effectively mitigate these risks.

This study is original in that it is the first research study based on any country to measure the effects of risks identified specifically for renewable energy investments (Waissbein et al., 2013). Previous studies have explored the barriers to renewable energy investments in open ended investor surveys, without referring to professionally identified and standardized investment risks (Waissbein et al., 2013), and therefore the extant literature does not included a comprehensive investment risk inventory. The methods applied in this study can be generalized to other developing countries, and the findings provide an insight into renewable energy investment risks in developing economies overall.

Developing countries have an SDG 7 target of increasing the share of renewable electricity in the electricity mix, and obtaining an increased flow of development finance for clean energy. However, it is often perceived that these countries have endemic investment risks, which drive up the cost of capital of renewable energy projects, and show down project development and renewable energy expansion. The findings of

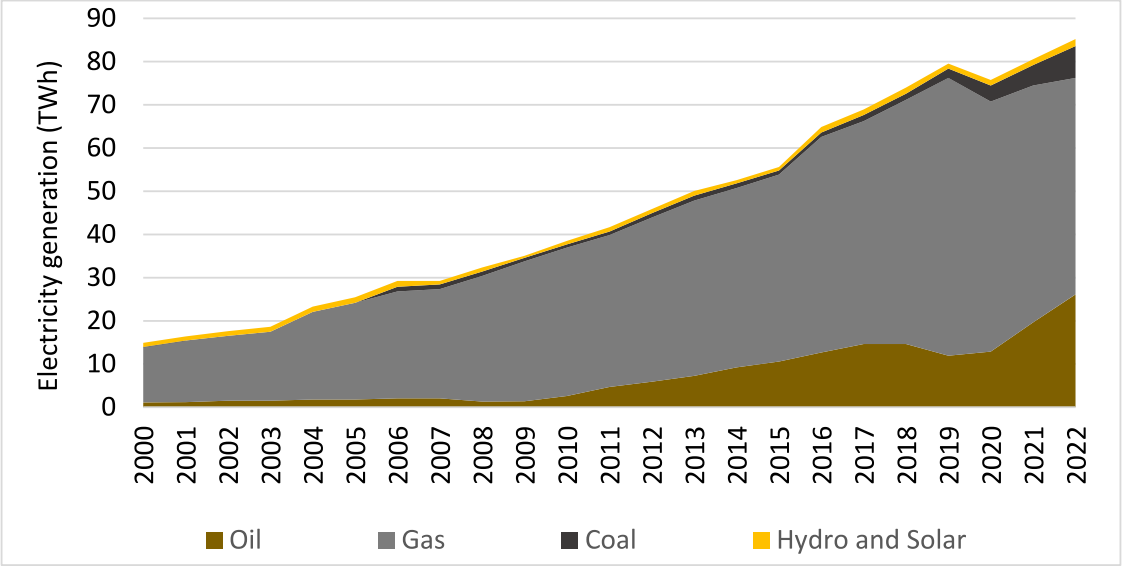

Fig. 1.1. Electricity generation trend in Bangladesh by source.

this study can help prioritize the main risks that hinder renewable energy investments, and identify appropriate policy solutions.

In the following sections of the study, the Investment process for grid connected renewable energy projects in Bangladesh describes the investment process for grid connected renewable energy projects and A review of the risks of renewable energy investments reviews the literature covering investment risks and policy measures. Materials and methods describes the methodology applied in this paper, Results and discussion provides an elaborate discussion of the results, and Conclusion and policy implications lays out the conclusion and suggests policy measures.

Investment process for grid connected renewable energy projects in Bangladesh

Fig. 2.1 shows the approval and implementation process for unsolicited renewable electricity projects, which is the most common form for projects (few projects follow the solicited process).

The project developer is usually a consortium, which is comprised of a lead partner and an operating partner. The lead partner has a majority share and must have experience of raising equity financing and debt financing for similar projects. The operating partner is supposed to have experience operating such projects. As large-scale solar power or renewable electricity projects are new in Bangladesh, it is difficult to find local entrepreneurs who have the necessary operating experience. This is why it is often necessary for local companies to form consortiums or joint ventures with more experienced foreign firms.

The site clearance committee is composed of five members representing the Power Division, the Bangladesh Power Development Board, the Power Grid Company, the Department of Agricultural Extension, and a representative of the concerned Deputy Commissioner's Office. The aspiring project developer enters tariff negotiations with a Proposal Processing Committee, which includes the Power Division, the Prime Minister's Office, the Bangladesh Power Development Board and the Power Grid Company of Bangladesh, the National Board of Revenue and any other relevant entity.

Within one week of LOI acceptance, the project developer must make a proposal security deposit (currently USD 5000 per MW of the project). Moreover, the developer must also make a performance security deposit (currently USD 18000 per MW of the project) before signing of PPA and the proposal security deposit is refunded. The developer should complete the procurement of land and all land related due diligence, which itself is a lengthy process. Developing one MW of solar PV requires around 3 acres of land. Sometimes, one acre of land has many different owners, and so that many land ownership documents have to be processed. After signing the PPA the sponsor needs to organize around forty permits and also achieve financial closure. After the signing of the PPA, the project must commence on the commercial operation date within a given time frame, which may range from twelve to thirty months, depending on the plant size. A penalty of USD 50 per MW/day will be imposed if the project does not commence operations on time.

Out of ten ground-mounted solar PV IPP projects currently running in Bangladesh, two are public-owned, and the rest are privately owned. Among the private projects, only one has a foreign lead partner. The lead partner has to organize debt financing and the operating partner has to have operating experience of a minimum of two years. The lead partner has to own at least 51 % of the project up to the commercial operation date, and after that must own at least 40 % of the project for the first six years of operation. The operating partner has to own at least 20 % of the project for the first six years after the commercial operation date COD. The locally available cost of debt for renewable energy projects is around 6 % in Bangladesh, and has a tenure of twelve to fifteen years, with a grace period of two years. The tariff trend of grid connected solar PV projects in Bangladesh is given in Fig. 2.2.

A review of the risks of renewable energy investments

The barriers to investments in renewable energy have been explored for a number of developing and developed countries alike, covering different categories of investors, and different policies and business

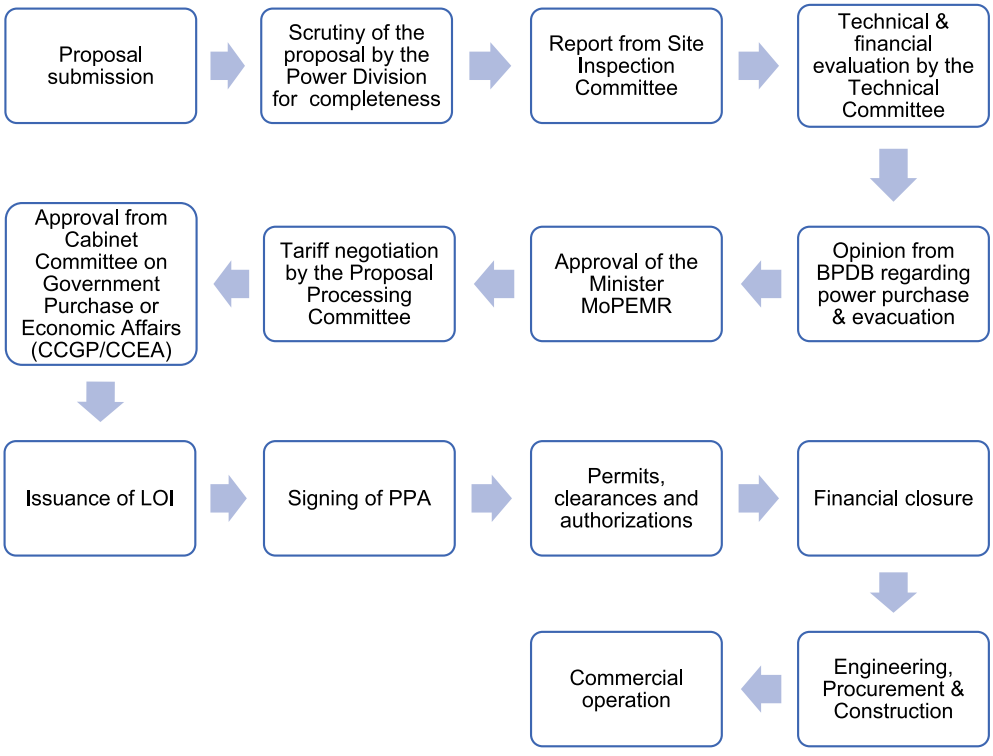

Fig. 2.1. Unsolicited renewable energy project approval process. Source: Quick Enhancement of Electricity and Energy Supply (Special Provisions) Act 2010 [Act No. LIV of 2010] & Guidelines approved on 27-10-2010 under the Act No. LIV of 2010.

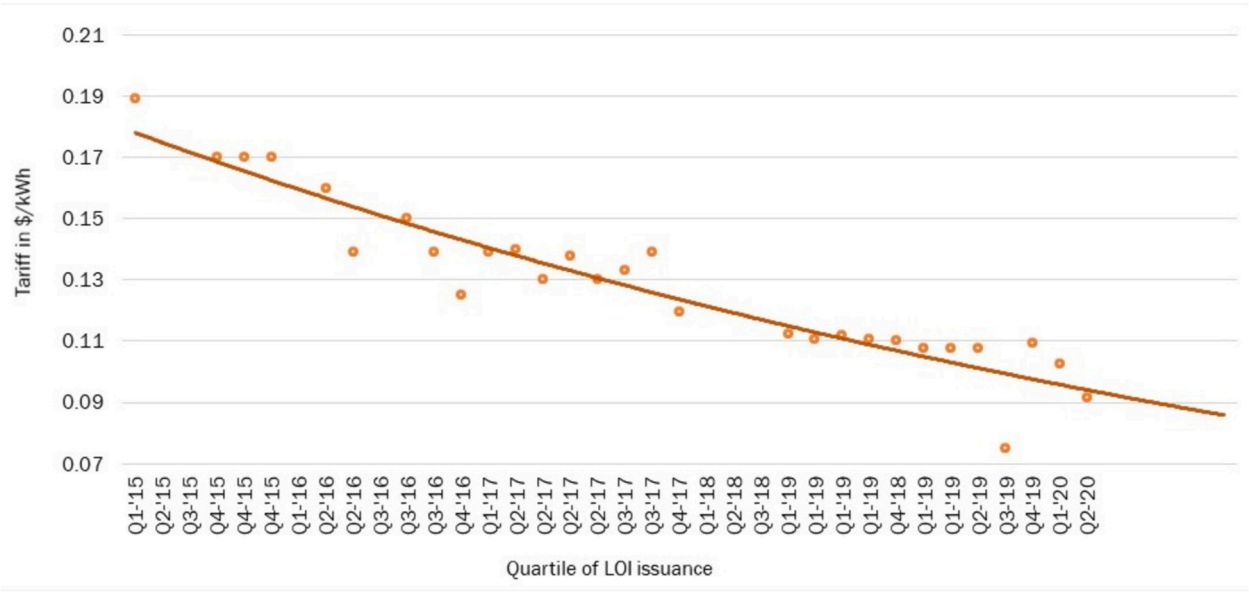

Fig. 2.2. Tariff trend of grid connected solar PV projects in Bangladesh.

models. One of the seminal studies on the de-risking of renewable energy investments in developing countries was done by Waissbein et al. (2013), who have identified a number of risk factors that increase the cost of capital of renewable energy projects in developing countries compared to developed countries. They have shortlisted a number of policy instruments that can be implemented in order to mitigate the risks and thereby reduce the cost of capital. In a review of the challenges facing renewable energy entrepreneurs in developing countries, Gabriel (2016) includes inadequate access to institutional finance, uncompetitive price of renewables compared to fossil fuels, lack of skilled labor, poor physical infrastructure and logistics, the power of fossil fuel incumbents, and inadequate government and policy support. In the case of the Philippines, the factors affecting the risks of project finance in renewable energy include the source of revenue in the form of revenue contracts, the project size and location, the core business of the investor, ownership type of the investor (public or private) and the nationality of the investor. It was found that an intermittent renewable energy project was more likely to use corporate finance or balance sheet financing, rather than project finance, whereas fossil fuel base load generation projects had an advantage in obtaining project finance. Preexisting revenue contracts like power purchase agreements (PPAs) facilitate project finance. Moreover, larger projects, where the investor is a power company and publicly listed, have an advantage in obtaining project finance (Barroco & Herrera, 2019). A survey of renewable energy investors, energy and power experts, and researchers and professionals in Iran revealed that concerns for investments were first technical feasibility, followed by business and government policies, and lastly environmental concerns (Aslani et al., 2012). A survey of Turkish investors revealed that the most common hurdles in investments were difficulties in the approval process and license process, and grid connection challenges, but few investors experienced difficulties in obtaining financing, or obtaining quality renewable resource data (Ozcan, 2014). A survey of renewable energy entrepreneurs in developing countries has revealed that facilities like government entrepreneurship programs, entrepreneurial finance, protection of investors, and availability of credit affect the business models of the entrepreneurs (Gabriel & Kirkwood, 2016). A study of investor perceptions of risks in renewable energy investments in North African countries revealed that the primary risk was regulatory risk, owing to the complexity and corruption of bureaucratic procedures, and instability of national regulations. This was followed by political risks like low political stability and low support from local governments, and force majeure incidents like natural disasters or terrorism (Komendantova et al., 2015). A survey of renewable energy project developers in Chile showed that the main barriers to renewable energy technology deployment were grid connection constraints, lack of grid capacity, longer processing time for a large number of permits, securing of land and water leases, and limited access to financing (Nasirov et al., 2015).

Jones (2015) conducted a study of the perceptions of barriers to renewable energy investments in developing countries, among developed country stakeholders representing asset management, pension funds, re-insurance, insurance, investment banking, banking, think tanks, brokers, credit rating agency, finance consultancy, finance development agency, international financial institutions and finance markets. The study revealed that main barriers include domestic policy and market barriers, financial barriers including exchange rate and inflation risk, reversal of policies supporting renewables, unproven technologies, and physical risk from climate disasters. A recent study of renewable energy risks in Belt and Road Initiative countries considered technical risk, political risk, economic risk, resource risk and social or environmental risk. It found that wind energy has the lowest investment risk, followed by hydropower (Hashemizadeh et al., 2021).

The findings of extant research represent the perceived risk levels of different types of risks affecting renewable energy projects, mainly from the point of view of entrepreneurs and investors. However, the previous studies do not distinguish between domestic and foreign investors, and between debt investors (financiers) and equity investors, and are based on surveys of equity investors only. Furthermore, to the best of the authors' knowledge, regulators are not included in the surveys, and their perceptions are not compared to those of investors. As the regulators play a key role is helping to mitigate investment risks through regulatory interventions (Waissbein et al., 2013), it is important to measure and compare the views of regulators, in order to assess the consistency in risk perception and discern any gap in understanding between investors and regulators. This study attempts to add to the literature by not only analyzing how different categories of investors perceive investment risks and the effectiveness of some policy solutions, but also to ascertaining the extent to which regulators and investors are on the same page. The existing literature highlights studies that have been conducted in different countries or groups of countries. One limitation of the literature is that none of the studies highlight how investment risks and challenges vary from developing to developed countries. There is no

justification in the studies for the choice of investment risks explored, and the investment factors are chosen from other literature without any selection guidelines. In this study, the investment risks are taken from the seminal report by Weissbein et al. (2013), where investment risks particularly relevant to developing countries have been chosen. These are risks that increase the risk premium in developing countries, which lead to a higher cost of capital than in developed countries. Another limitation of the literature is that the studies do not propose policy solutions linked to the chosen investment risks, which can serve to reduce the risk premiums of the cost of capital. The findings of the study can produce insights to policy makers regarding how to mitigate renewable energy investment risks in developing countries by applying appropriate policy solutions to major investment barriers.

Materials and methods

This section describes the methodology used in this research. The questionnaire for this study was developed in reference to similar studies done in other countries, namely Nasirov et al. (2015) for Chile, Ozcan (2014) for Turkey, Angelopoulos et al. (2017) for Greece and Egli (2020) for European countries. The sampling methods of similar studies was also followed, namely (Nasirov et al., 2015), Jones (2015) and Salm, 2018. Derisking policy variables selection was also guided by Steckel and Jakob (2018). The methodology can be summarized in the following Fig. 4.1.

Analytical framework

The analytical approach includes a simple quantitative analysis accompanied by a thematic qualitative analysis, according to the method adopted by Bürer and Wüstenhagen (2009). The questionnaires administered to the respondents were based on a preliminary interview of one respondent from each of the categories (developer, financier and regulator), and based on the risk factors highlighted in Waissbein et al. (2013) and the other literature covered. The stated preference approach is used for respondent opinions, rather than a revealed preference approach. This is considered appropriate in this situation because grid connected renewable energy projects are new in Bangladesh, and the sector can be considered at the inception stage, so not enough data of revealed preference from past investor activities is available. Therefore, the stated preference method is suitable at this introductory stage, in order to provide insights into how policy can effect investment outcomes in the long run. However, one limitation of this approach is that it is difficult to assess how the interaction among the policy instruments can effect investment decisions (Bürer and Wüstenhagen, 2009).

The method of the study is to obtain an estimate for the relative extent to which barriers to investments increase the investment risks and costs for potential investors in the renewable power sector. The study covers two aspects of renewable energy investment risk- the impact of risk drivers, and the potential for policy solutions to reduce the impact from the risks. In order to assess the impact from risks, the first step is to identify the drivers of risk in the investment environment (Table 4.1). Then the estimate of the probability of that risk occurring is conducted. Next, the effect of that risk on the financial performance of the project is assessed. Finally, the risk probability and risk impact are multiplied to obtain the total contribution of the risk driver to the cost of capital. In the order to identify the effectiveness of policy solutions, effectiveness of the policy solutions are also rated on a Likert scale. The expert opinions of different types of stakeholders are taken, because each stakeholder approaches the investment from a different angle. Local and foreign developers contribute equity capital, which can have different risk profiles from debt investors or lenders. Moreover, regulators are responsible for allocating public resources to the implementation of policy instruments which are designed to reduce the cost of capital to private sector debt and equity investors at the lowest cost to the public sector.

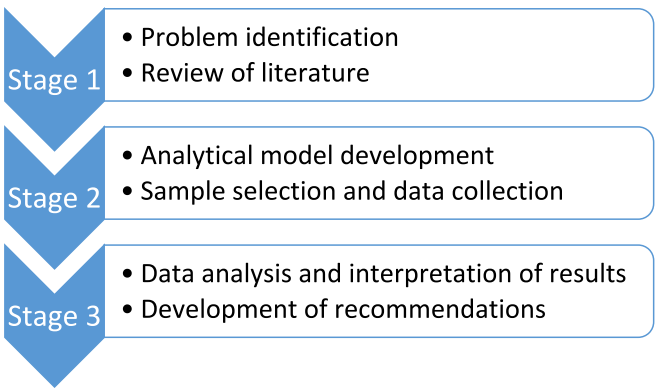

Fig. 4.1. Methodology of the research.

The theoretical expected return (loss) from each of these risks can be found from the contribution of risk to cost value, which is equal to the product of the probability of each risk and its score for financial impact. This method is adapted from Waissbein et al. (2013). The probability of each risk is represented by the score of the likelihood of that risk out of 5, which is the maximum score. Therefore, the contribution of each risk to the overall cost of capital can be represented by the following model:

$$Contribution\ of\ risk\ to\ cost = \frac{Risk\ likelihood\ score}{5} * (Risk\ impact\ score) \quad (1)$$

Where the term $\frac{Risk\ likelihood\ score}{5}$ represents the probability of occurrence of a risk, the Risk impact score represents the expected value of loss to the project in the event the risk occurs, and the contribution of risk to cost is the weighted value of the loss arising from the risk.

The questions were designed using a Likert scale of five points, where 1 represents the lowest score and 5 represents the highest. For the risks, the respondents were asked to rate the likelihood of each risk occurring in Bangladesh, and the risk impacts and policy effectiveness were to be rated from low to high. Table 4.1 shows the risks evaluated in the survey, and corresponding de-risking policy remedies. The answers received were then represented using box-whiskers plots, analyzed in SPSS 16.

Table 4.1
Investment risks and corresponding policy instruments.

Investment risks	Policy instruments
Power market risk	PPA
	Fossil fuel subsidy reform
	Long term RE targets
Permits risk	One stop licensing
	Contract enforcement mechanism
Social acceptance risk	Awareness raising campaign
	Community involvement
Resource and technology risk	Local resource assessment capacity building
	Local technical and O&M capacity building
	Technology standards and market information exchange
Grid and transmission risk	RE in grid code
	Policy for grid development
	Financing for transmission companies
Counterparty risk	Financial performance of utilities
	PPA guarantees
Financial sector risk	Financial products for project developers
	RE project assessment and financial restructuring training
	Favorable financial sector policy for long term payments
Political risk	Risk sharing and insurance
Currency and macroeconomic risk	Exchange rate and interest hedging

One source of error is that the answers are subjective according to the respondent. This has been addressed by interviewing multiple respondents in each group and averages taken. This research focuses only on renewable energy based large or grid connected power plant projects of different technologies. It does not cover any firms that are in another part of the supply chain, like the manufacturers or suppliers of component parts, or engineering firms that offer technical consulting services. It also does include small scale distributed generation, storage technologies, or applications of clean energy technology like solar heating and electric vehicles.

Sample selection and data collection

In this study, a survey was conducted on a sample of 46 respondents, representing 34 developers with running projects or prospective developers who have obtained letters of intent from the government, six regulators and five financiers. Among the developers, there are thirteen foreign and 21 local firms, out of which five are public sector generation utilities, and the remaining are from the private sector. Among private sector local developers, only one has its core business in the power sector, whereas the other firms have their core business in other industries. Among foreign developers, eight have their core business in renewable energy, one in the overall power sector, and the other three are multi sector conglomerates. Some of the developers operate under power purchase agreements with the government, whereas others operate rooftop solar plants primarily for self-consumption, while being connected to the grid under the Net Metering Guidelines. All the foreign developers operate under the PPA business model, and all the local public sector firms operate under the PPA model as well. Of the local private sector developers, seven operate under the PPA model, three under the net metering guidelines, and five are involved in both business models. All local developers except one are involved in solar PV electricity in Bangladesh, though some of the international developers have experience in other renewable technologies in other countries. In the survey, the respondents representing the developers are the chief executives, owners, or the heads of operations in the respective firms. In the case of the domestic developer organizations, the respondents were the chief executive officers, managing directors or general managers of the firms. In case of the international developers, the respondents were the country managers or country directors. These respondents are involved in all the steps of the project development process.

The financiers represent international development banks as well as local financial institutions. The regulators cover the government agency for renewable energy, a policy making wing of the power sector, the Ministry of Power Energy and Mineral Resources, the regulatory authority for determining tariffs, and the main public sector offtaker of electricity. The respondents representing the regulators are the key functionaries of their organizations.

Potential respondents were identified from the records of existing and prospective developers from the relevant government agency. As the renewable electricity sector is at the emerging stage in Bangladesh, there are only a few existing and aspiring developers so far, and all the developers with operational ground-mounted grid tied solar electricity projects have been contacted. All but one of the developers of industrial scale rooftop solar PV projects above 0.5 MW, and almost all the potential developers of this group, who have initiated the project application process, have also been contacted. The sole prospective developer of wind energy, which existed during the time of this study, was also surveyed. In this sense, the sample of developers covers almost the entire population.

Data collection included a questionnaire to be filled by email, and telephone interviews for in depth explanations. The respondents were first contacted by phone or email, and an appointment was set up to interview them. At the same time, the respondents were asked to fill in the questionnaire about the investment risks and policy solutions, and the questionnaires were sent by email. The answers thus received were examined for completeness, and if any missing answers were found, the questionnaires were resent in order to obtain complete answers. All respondents contacted agreed to fill out the questionnaires and donate their time for an interview. The interviews were conducted over the phone and lasted 30 to 60 min. The respondents were first briefed about the topic and objectives of the interview, and then were asked about their opinions of the risks of investments in the renewable energy sector in Bangladesh and potential policy remedies. In addition to the specified risks and policy instruments, the respondents were invited to share additional relevant insights. The answers were transcribed and then organized thematically.

Ethical measures were observed during the survey interviews in order to protect the rights and interests of the respondents. The identity of the respondents were not disclosed, and answers were recorded on a confidential basis. The respondents were briefed about the research topic and purpose before the interview to ensure transparency, and their consent was obtained.

Results and discussion

Risk likelihood scores

The responses of the stakeholders are first examined according to their distribution represented in box whiskers plots and then the average responses of the different stakeholder groups are analyzed using spider plots. The average values take into account the outlier scores.

The significant perceived risk in securing permits (Fig. 5.1) may be attributed to the lengthy processing by the authorities concerned, resulting in delayed implementation of the project, which leads to cost overrun. Furthermore, entrepreneurs have complained about harassment and making unlawful payments for acquiring needed permissions and authorizations in a number of cases. Bangladesh, as one of Asia's fastest developing economies with a world-class PPA, is able to give better investment returns because of increased aggregate demand and earnings growth, making it less vulnerable to macroeconomic risk.

On comparing the risk likelihood perceptions of different stakeholder groups (Fig. 5.2), it is observed that there is some variation in the perceptions among different stakeholders. The local developers have a moderately optimistic view about most of the risks, as most scores are within 2 and 4 for the risks, and for social acceptance risk, technology risk, counterparty risk, political risk and currency/macroeconomic risk, the risk likelihood scores are actually below the median score for most respondents. The sole exception is the risk of securing permits, which almost all local developers believe is quite likely. Foreign developers have a higher anticipation of risks than local developers, as the scores are concentrated towards higher values, especially for permits risk, but also for social acceptance risk, financial sector risk, political risk and currency and macroeconomic risk. The higher risk of foreign developers can be attributed to their lower levels of influence in the domestic market, and dependence on local partners, who are relatively new to the industry and do not have enough experience in the field. Financiers are more pessimistic about technology risk and grid transmission risk, but in case of other risks, they have a more optimistic view, as financial institutions in Bangladesh have less experience financing renewable energy projects, and are accustomed to financing fossil fuel projects. It is interesting to note that the financial institutions have the most optimistic view of counterparty risk and political risk. Regulators anticipate a higher likelihood of technology risk, but with respect to other risks have lower likelihood scores than other stakeholder groups. Regulators have lower expectations of counterparty risk, power market risk and currency/macroeconomic risks, and this is significant because regulators believe there is political will in support of RE investments, but do not see the point of view of other stakeholders who invest equity or debt capital.

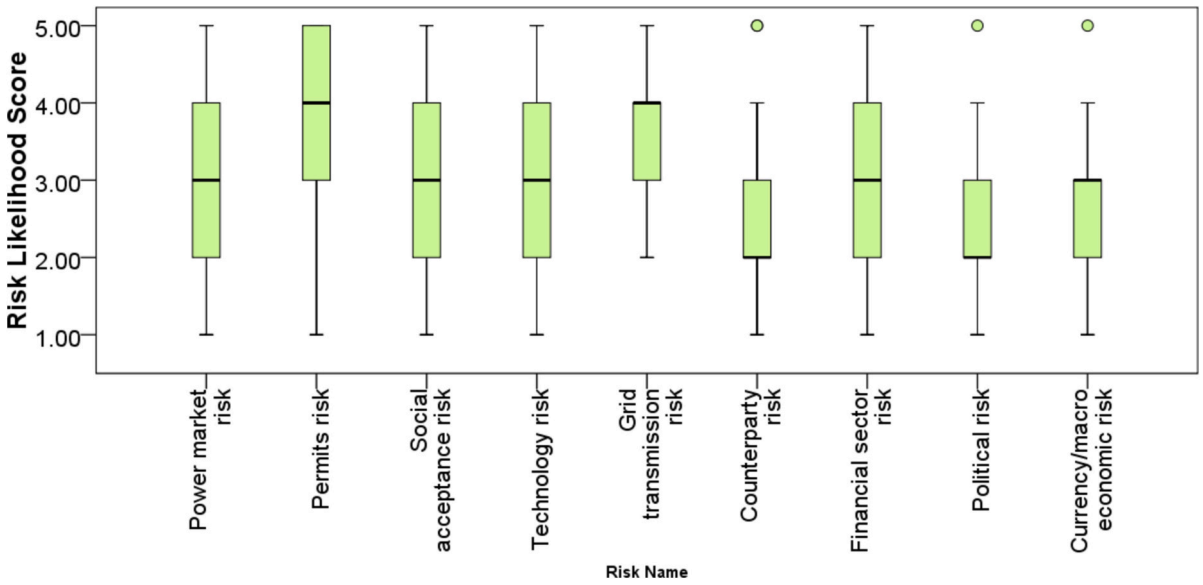

Fig. 5.1. Likelihoods of different risks affecting RE project investment in Bangladesh.

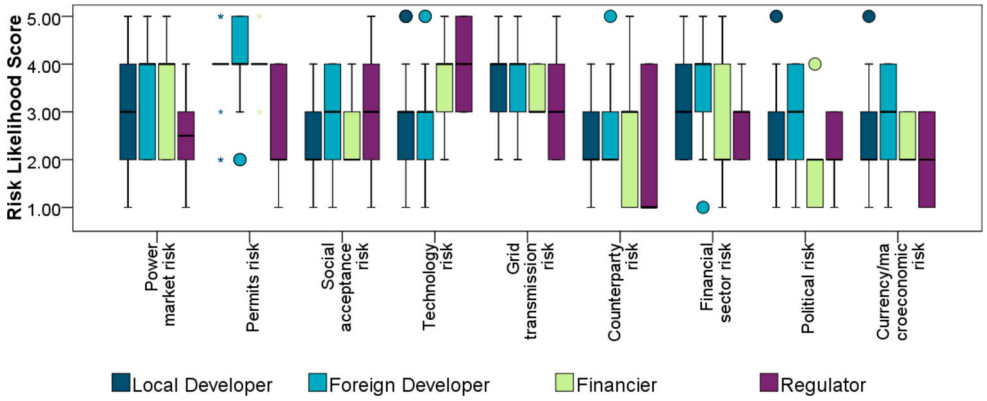

Fig. 5.2. Likelihoods of different risks perceived by different groups of stakeholders.

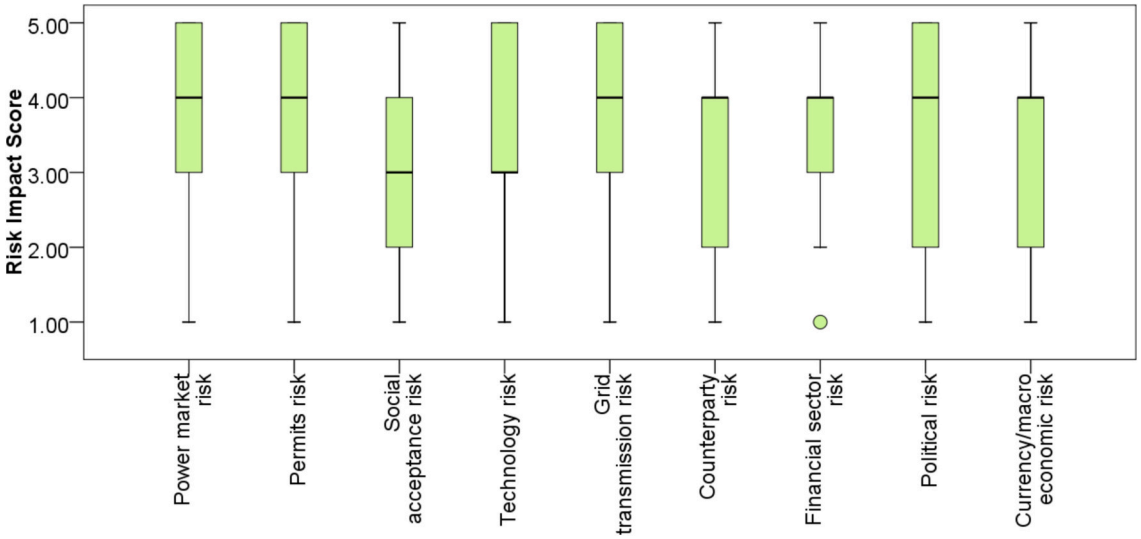

Fig. 5.3. Financial severity of different risks affecting RE project investment in Bangladesh.

Risk impact scores

The scores for financial impacts arising from the different risks are given in Fig. 5.3. Most risks seem to have a relatively high impact. Despite the fact that electricity is sold as a commodity, its price is more volatile than any other commodity. Many invisible and unpredictable market-driven elements, such as load-demand variation, market players' attitudes, resource availability, and so on, determine the price of electricity. Consequently, the power market risk appears to have the greatest influence. Legal/policy framework, as it exists today, protects the fulfilment of contractual obligations. The typical power purchasers in Bangladesh are the public-sector power utilities which historically never missed a payment. Power projects offer jobs for the local community in addition to providing electricity. Thus, impacts of counterparty and social acceptability risks are seen as minimal.

Broken down by stakeholder group (Fig. 5.4), it appears that the stakeholder bearing the greatest costs from any of these risks are the local and foreign developers and financiers, as they have a concentration of higher scores in all risks. Local developers appear to have lower risk impact than foreign ones, especially in social acceptance risk and counterparty risk. Foreign investors are more confident about being able to withstand the financial impact of technology risk, as foreign companies are usually more experienced with the RE technologies than local companies. However, foreign developers anticipate a higher impact from counterparty risk, permits risk, and political risk. This is particularly discouraging for foreign investors, as they apprehend that local partners will not fulfill the contractual obligations, the political climate may change to their disadvantage, and that the Bangladeshi Taka (BDT) may depreciate against international currencies. Financiers usually have the same financial impact from these risks as the developers, except in case of grid transmission risk, which affects developers more. Here, it is interesting to note that the regulators consistently assign lower scores to the financial impact of all the risks. This indicates a gap in the assessment between providers of capital (where developers provide equity capital and financiers provide debt capital), and the stakeholders who do not invest capital. It indicates that the regulators do not fully appreciate the extent of the financial concerns of debt and equity investors. This information or communication gap between regulators and investors must be addressed in order to carry out regulatory reform.

By multiplying the risk likelihood and impact, the overall contribution of the risk to the cost of the project is obtained (Fig. 5.5). In this case, it can be seen that the risks that contribute the most to increasing the cost are power markets risk and permits risk. Social acceptance risk, counterparty risk, and currency/macroeconomic risk contribute relatively less to increasing the cost of capital of projects.

An analysis of the responses by stakeholder groups as to the contribution of different risks to the cost of RE project development (Fig. 5.6) reveals that all the groups expect that the financial costs from power market risk and permits risk are relatively high, whereas the costs from social acceptance risk, counterparty risk, political risk and currency/macroeconomic risk are relatively low. Regulators significantly underestimate the expected loss from permits risk and counterparty risk, while somewhat underestimating the expected loss from other risks as well. Foreign developers have a greater expectation of adverse financial effects of the risks to the RE projects than local developers, especially with respect to power markets risk, permits risk, social acceptance risk, counterparty risk and currency/macroeconomic risks. The consequences of financial sector risk, and technological risk, according to financiers, have a worse financial impact on projects than is estimated by developers, while the opposite is true for grid transmission risk and political risk.

A comparison of average risk contribution to project costs according to different stakeholders (Fig. 5.7) shows significant variation in the responses among the groups. Regulators have the lowest estimates of all risks except social acceptance risk, and technology risk. Foreign developers expect a worse outcome from risks relative to local developers. Debt and equity investors consider power market risks, permits risk and grid transmission risks to have overall high effects on project costs. Financiers attribute the highest risk to technology risk.

Policy effectiveness scores

From the analysis of average policy effectiveness scores according to different stakeholders (Fig. 5.8) it is observed that most of the policy instruments are considered to be highly effective in reducing risks of investments. This shows that stakeholders have an optimistic expectation of policy instruments to support RE investments. This is also reflected in Fig. 5.10, which shows the effectiveness of different policy instruments in reducing risks affecting RE project investment in Bangladesh.

However, it can be seen that among developers, the average local developers have lower optimism about the effectiveness of some policies, notably, PPA, fossil fuel subsidy reforms, and risk sharing or insurance. The average foreign developer usually has greater expectations of the benefits of policies. Financiers have overall higher expectations of the benefits of policies. It can be seen that financiers tend to favor polices which address the shortcomings in the project development process from the financial sector's point of view. Regulators overall have average to low expectations of the benefits of policy interventions. This corresponds to their overall underestimations of the impacts of the risks themselves.

It is also interesting to note that among local developers, the public

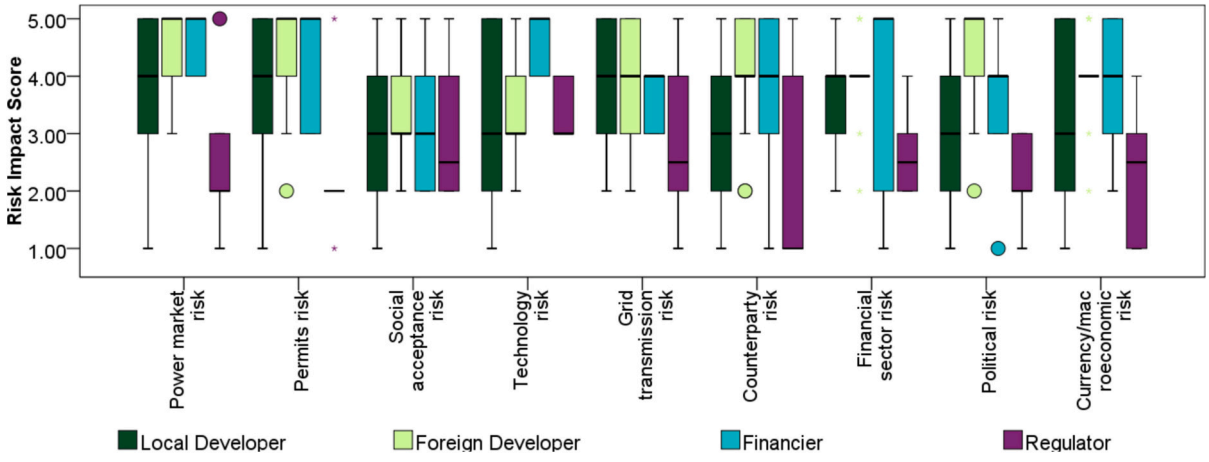

Fig. 5.4. Financial severity of different risks perceived by different groups of stakeholders.

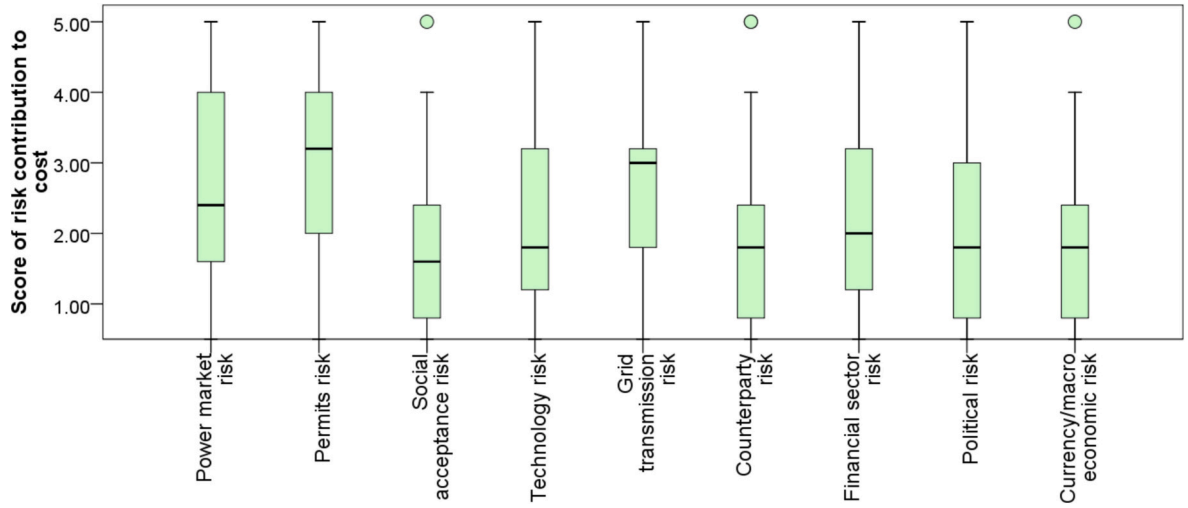

Fig. 5.5. Contribution of different risks to the cost of RE project investment in Bangladesh.

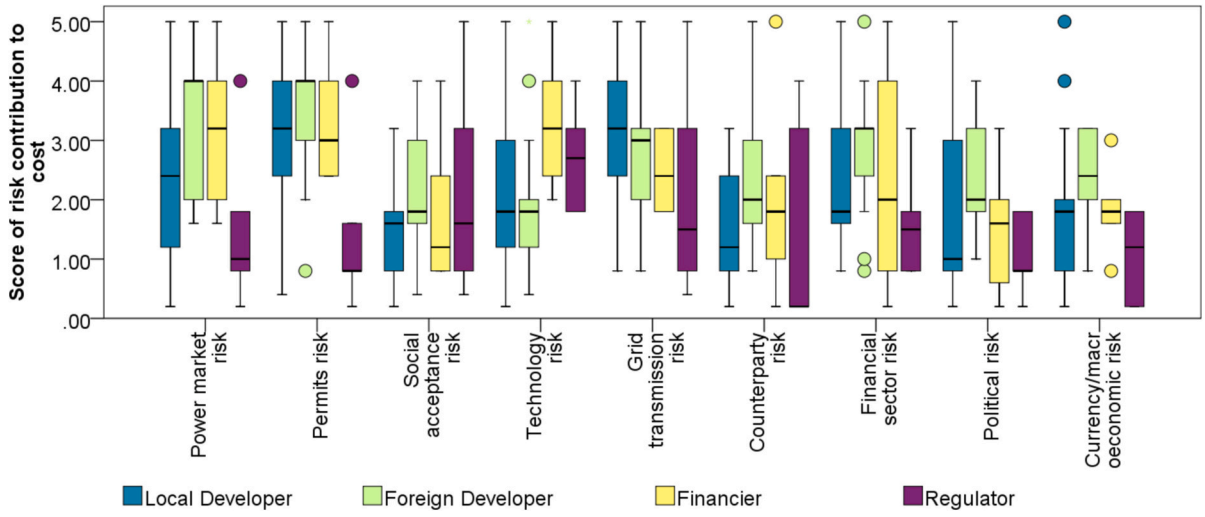

Fig. 5.6. Contribution of different risks to the cost of RE projects according to different stakeholder groups.

sector developers have a much more positive view of risks and their effects than their private sector counterparts, as shown in Fig. 5.9. Public sector project developers consider technology risks and power markets risk to be higher, but consider almost all other risks, especially permits risk and counterparty risk to be much less important. This indicates that they have the advantage of more support from regulators. Subsidy reform ensures a level playing field in tariff setting, allowing renewable energy project owners to compete with fossil fuels. Long-term renewable energy targets reassure investors by confirming the government's commitment to a specific proportion of renewable electricity output. Renewable energy is a site-specific energy, and so the cooperation of the local community is required for any renewable energy project to be successful. Most renewable projects require lenders to provide external financing. Renewable energy project risks can be transmitted through insurance, which is an important component in assuring lenders that their investment is safeguarded. Most of the renewable energy projects are financed with foreign loans (e.g., in USD) and projects earn revenues in local currency (i.e., BDT). The mismatch in the currency of debt obligations (i.e., USD) and currency of revenue (i.e., BDT) exposes the project to the risk of BDT depreciation over time resulting in reduced investments in the country. Hedging of exchange and interest rates with a third-party provider protects against these devaluations. All of these points have been given as reasons why these policy instruments are considered to be highly effective in reducing risks of investments. In fact, the effectiveness of an awareness campaign is determined by the target group's level of knowledge; for a learned community, the influence of awareness is little; but, when it comes to ordinary people, it is highly effective because it helps to establish trust among the audience.

A group wise analysis of stakeholder opinion of policy effectiveness, as shown in Fig. 5.11, reveals that most groups have an optimistic view of the potential effectiveness of policy instruments in addressing the corresponding risk. However, there are some variations among different types of developers. Foreign developers have a more positive view of many policy interventions, especially related to overseas investments like risk sharing or insurance, and exchange rate/interest rate hedging. These policy instruments reflect the greater risk exposure of foreign developers to long term political and macroeconomic risks. Local developers have a more positive view of fossil fuel subsidy reform, as they have to compete with local fossil fuel based power plants. Local developers recommend community involvement more, as they are responsible for the implementation of the project on the ground, and directly deal with the local inhabitants at the project site. Local developers also place greater importance on local resource assessment capacity building and local technical and O&M capacity building, compared to foreign developers. This is because the local developers have to obtain local data about project sites, and the EPC companies they

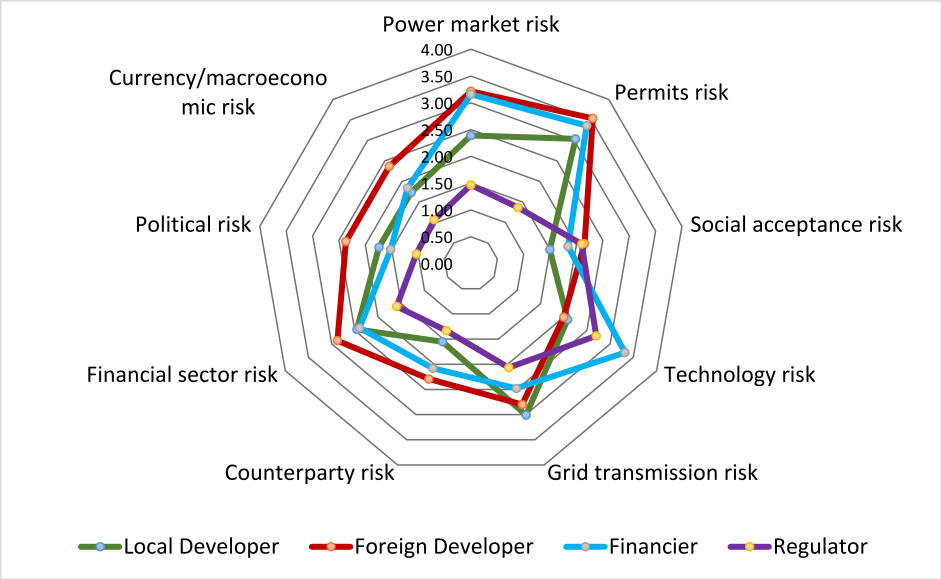

Fig. 5.7. Average risk contribution to project costs, perceived by different stakeholder groups.

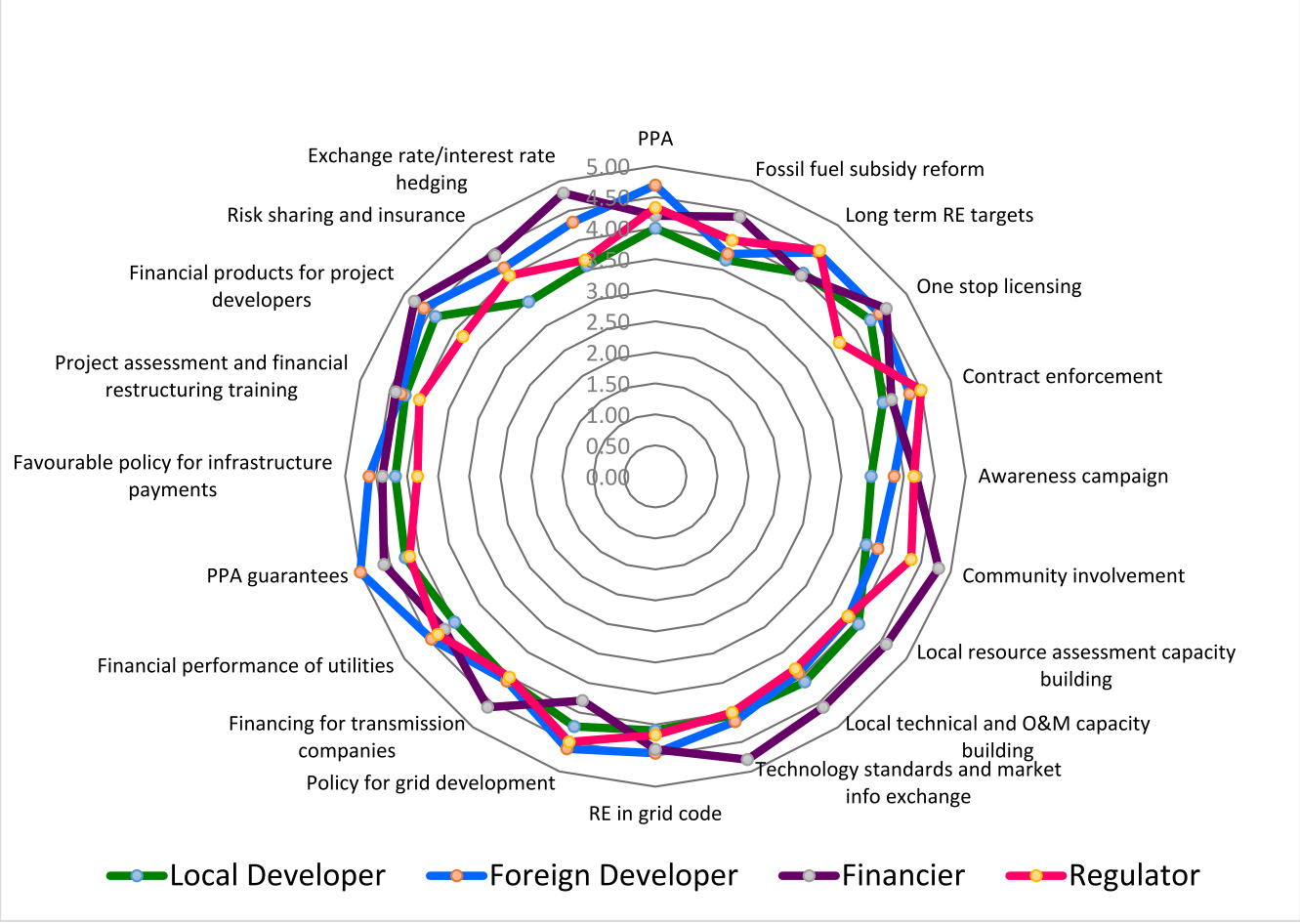

Fig. 5.8. Average policy effectiveness scores according to different stakeholders.

partner with are also local. Financiers have relatively higher expectations from most of the policy instruments. This is because the lender is involved at a stage after the PPA is awarded, and grid transmission matters are settled. Moreover, the financial performance of utilities is not that important as the utilities are not going to pay, but the contract is underwritten by the government. Regulators again show a significant difference in their rating of the importance of policy effectiveness, ranking the policies less effective overall. This again shows the

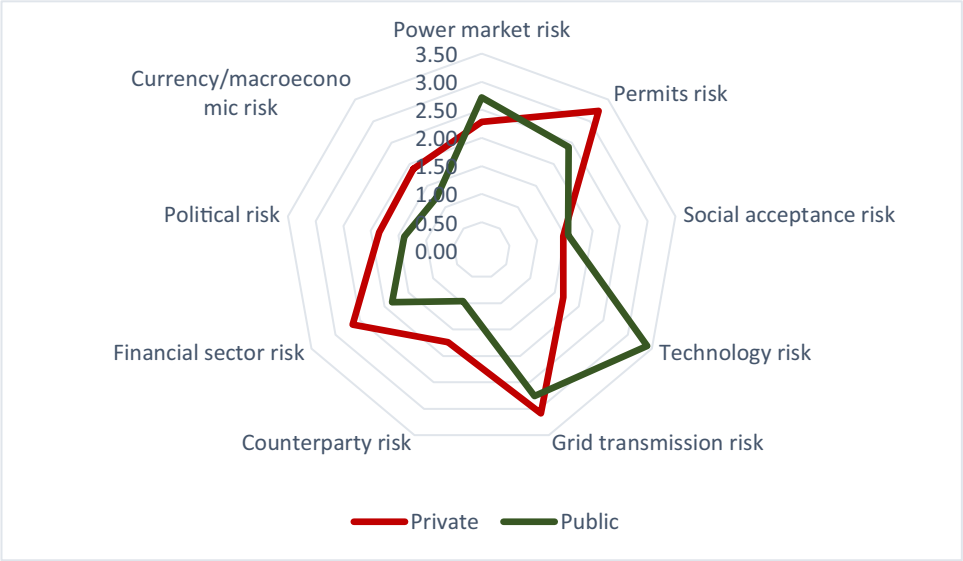

Fig. 5.9. Average risk perception scores according to public and private sector developers.

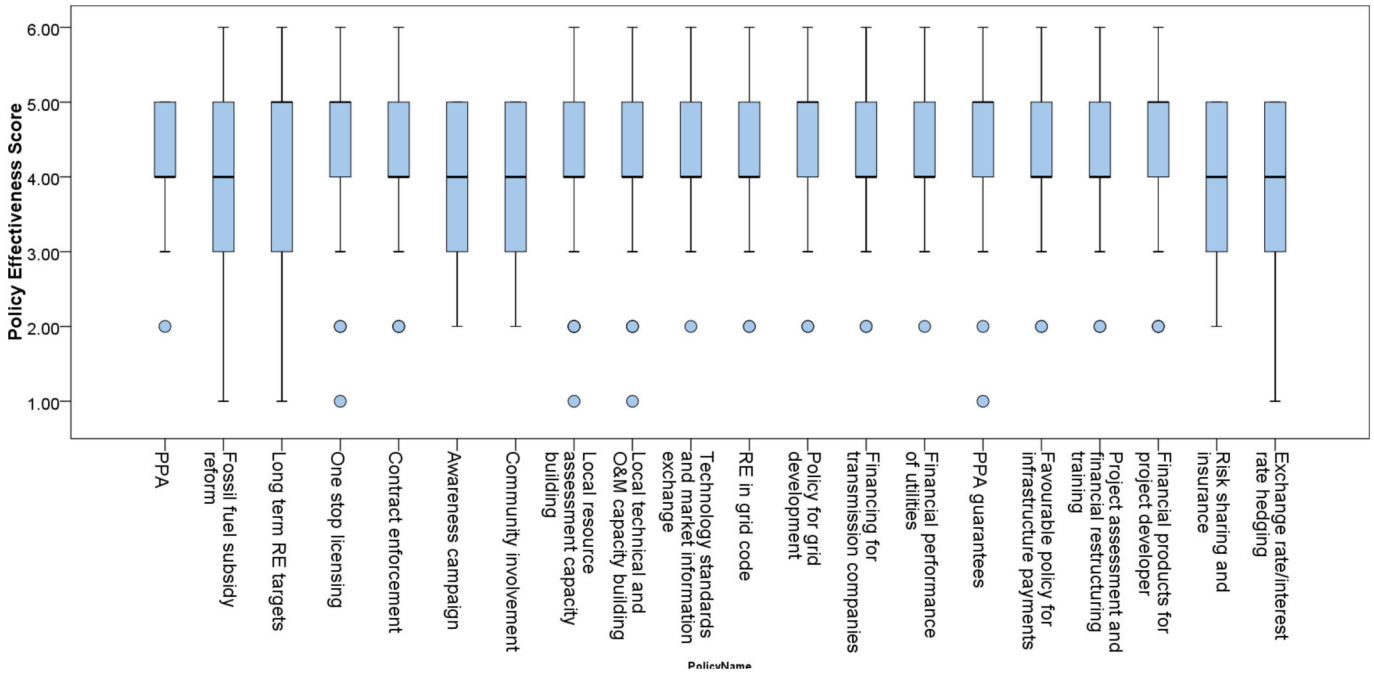

Fig. 5.10. Effectiveness of different policy instruments in reducing risks affecting RE project investment in Bangladesh.

divergence between regulators, and equity and debt investors, and highlights a gap in communication that needs to be bridged.

Stakeholder experience accounts

This section provides a qualitative description of how developers and financiers face different types of risk, from their experience of investment in projects. The section reports the findings from the in depth interviews to elaborate how risks affect the investment process, and how policy instruments can mitigate them. Developers and financiers have especially elaborated the detrimental effects of permits risk, as the approval process is time consuming and involves obtaining numerous levels of approval about land, grid connectivity and environmental clearance. This stage has the greatest uncertainty, as the approval process involves several steps, where progress can be delayed in any stage. There is also indirect competition from fossil fuel electricity generators, who promote their low cost advantages. Moreover, some stakeholders in the traditional power sector do not have optimistic expectations for renewable energy in Bangladesh in the short to medium term, and consider such projects experimental or ornamental.

Finding and organizing land is considered a great risk for project development, as Bangladesh is densely populated, and agriculture intensive. One financier stated that the policy instruments that are at present in force in Bangladesh would be good enough to promote much more investment in RE projects, if land scarcity was not an issue. Moreover, if a PV project developer expresses interest in purchasing land from one plot owner, other owners in the surroundings learn about it and raise the price of their land. This causes price uncertainty. However, developers point to the fact that the government often appropriates large tracts of land for large scale public infrastructure projects like highways,

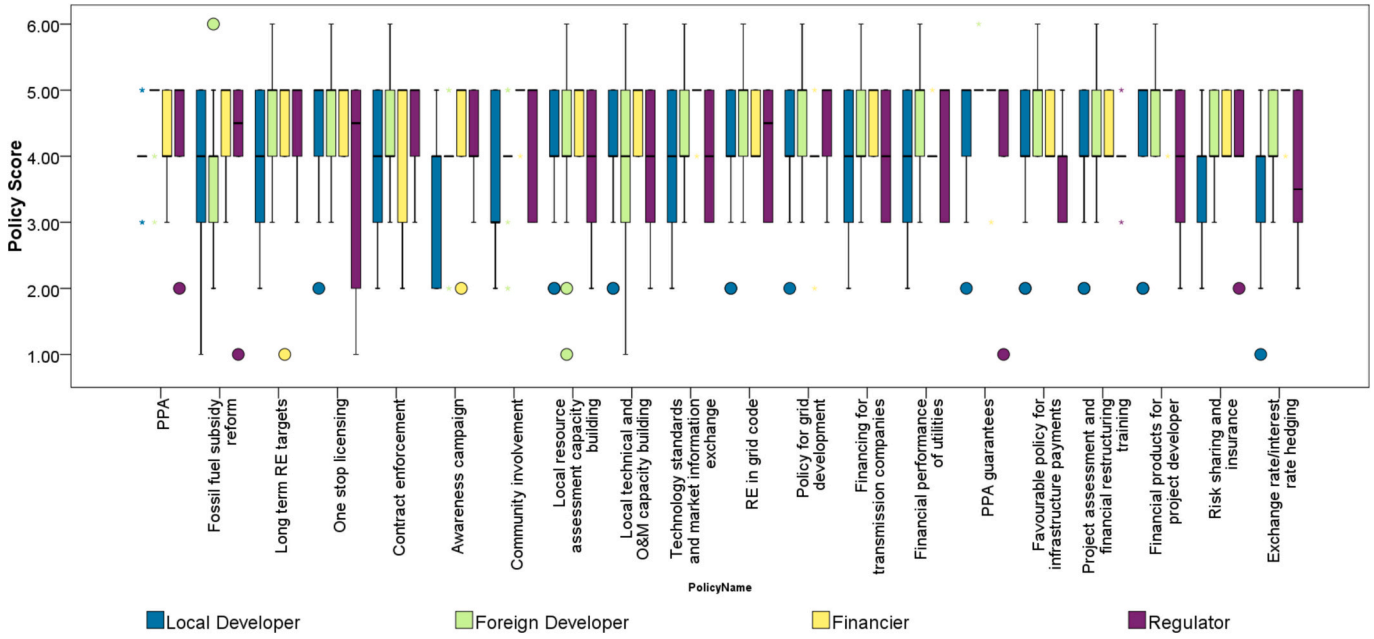

Fig. 5.11. Effectiveness of different policy instruments in reducing risks affecting RE project investment, subdivided by stakeholder group.

bridges, economic zones etc., where private owners of land have to sell their land to the government and receive compensation for it. This saves time and prevents uncertainty for private contractors to negotiate land sales from multiple owners. The government has made plans to allocate land reclaimed from river erosion prevention projects to solar PV projects, but this may take a decade to materialize, and may not be ready in time to meet climate or SDG targets.

Although social acceptance risk is not one of the top challenges, some land owners do not cooperate in allowing transmission lines to be built on their property in order to connect the power plant to the grid. Resource and technology risk arises when the forecasts for solar irradiance and electricity generation are actually significantly higher than the actual. This can arise because of inaccurate data about solar irradiance or overestimation of the efficiencies of PV panels generated from standard solar PV plant design software used at the design stage. The gap can be as high as 20 % in some cases, where the difference is amplified after taking into account PV panel soiling from dust, and irregular cleaning and maintenance. The lack of good civic infrastructure in remote areas suitable for PV projects makes the transportation and installation of plants more costly. In case of rooftop systems, the orientation of the buildings often make it impractical to obtain the best tilt angle of the solar panels for maximum electricity generation. Here, a lower tilt angle leads to higher deposits of dust and soiling loss. This also occurs in ground mounted plants in cyclone prone areas, where the PV panels are adjusted at suboptimal tilt angles to withstand wind loads from cyclones.

Not only is there an absence of a grid code for accommodating variable renewables, but existing grid infrastructure is poor in remote areas, which cause frequent interruptions. These occur especially in the monsoon/summer seasons, and can last up to several hours a day, several days a month. If they happen in the day time, it causes loss of productivity of PV plants, which cannot be made up later. Unfortunately, this interruption occurs during months when the demand for electricity is the highest in the country. In fact, grid outage due to faults in the lines, low voltage or scheduled and unscheduled load shedding, is by far the biggest cause of productivity loss, whereas unpredicted overcast conditions have a lesser effect. However, public sector project developers do not consider grid transmission risks to be as high as estimated by private sector developers, as these developers are usually government utilities, and can secure access to bigger substations over smaller distances.

Conclusion and policy implications

Bangladesh has been trying to increase its share of renewable energy in the electricity mix for more than a decade. However, the success of this drive has been impeded by numerous barriers to investments, which increase the risk to developers and financiers, and thereby increase project costs or cost of capital. This research aims to explore how different investment risks affect investments in renewable electricity projects in Bangladesh. The research is based on a survey and in-depth structured interviews of different categories of stakeholders, including public and private sector domestic developers, foreign developers, lenders and regulators.

Power markets risk and permits risks have been identified as the most salient and impactful risks overall. However, the risk perceptions varied among local and foreign developers and among equity investors and lenders. Foreign investors perceive risks to be more of a challenge than local ones. Financiers perceive some risks to be more significant than developers. Regulators overall consider these risks to have a lower effect on project development and profitability, indicating a gap in risk perception that needs to be bridged. All groups of stakeholders expect that de-risking policy interventions can mitigate the risks and lower project costs. Here again, regulators underestimate the beneficial effects of policy interventions than equity or debt investors. Local developers consider permits risk and grid transmission risk to be among the highest, whereas foreign developers consider power markets risk and permits risk to be the highest. Financiers have high risk perceptions of power markets risk, permits risk, technology risk and financial sector risk. Social acceptance risk and counterparty risk are considered high by regulators. Foreign developers attach the most importance to PPA guarantees, whereas local developers value financial products for project development. Long term renewables contracts, contract enforcement and policies for grid development are considered the most effective by regulators. Financiers rank many policy solutions hither than other stakeholders.

This research provides insights into the barriers to the development of renewable electricity projects in Bangladesh. One potential insight for mitigating challenges is that the greatest perceived risks are considered to be power markets and permits risk, which can be corrected by

regulatory reforms in the short term. Compared to these risks, grid transmission risk and technology risks are thought to be relatively low. This is a sign of optimism, as a large amount of investments would be needed to improve the transmission infrastructure, and this solution cannot be implemented in the short term. Counterparty risk, currency/macroeconomic risk, political risk and financial sector risk are thought to be higher among foreign developers. These risks can be mitigated by financial risk management instruments and contractual terms, which the foreign developers consider to be highly effective. In order to address power markets and permits risk, PPA contracts can be formulated to ensure the reliable return on investment, and there can be a centralized government agency for permits. Financial risks for foreign or local investors can be mitigated through the use of hedging instruments. There can be policies to require the grid to adapt to the proliferation of variable renewable energy plants, and provide the grid connection infrastructure.

An important theme revealed in the analysis is that regulators do not consider the risks to be as serious as the investors do, nor do they consider policy interventions to be as important. Moreover, public sector developers consider the importance of the risks to be lower than those of private sector investors. This indicates that those stakeholders who are in positions of advantage have a different view of risks and their solutions than the stakeholders who have less regulatory influence in the investment process, and have more private funds at stake. This is the gap in understanding that needs to be bridged. The public sector entities created limited amounts of renewable electricity capacity. The regulators have to understand the challenges faced by developers and financiers from their points of view. Here, the regulators have a key role to play in expanding renewables in the country, by using policy instruments and regulatory reforms to remove investment barriers. This constitutes reducing steps and duration in the administrative procedures, and streamlining the approval process. This can largely counteract some of the structural or systematic barriers to renewables expansion in the country, like land scarcity or renewable resource limitations.

The risks identified in this study can be mitigated through the corresponding policy solutions in the power sector to accelerate investment in renewable electricity, which can lead to the attainment of SDG targets and NDC commitments. It can lower the costs of domestic and international borrowing for project developers, encourage foreign direct investment, and promote technology transfer.

The government and regulators can implement the following policy changes to invite more potential investors to enter the renewable electricity market, while ensuring favorable electricity prices relative to fossil fuels, which will expand the share of renewables in the electricity mix.

1. The Bangladesh government now awards projects through an unsolicited process, where there is no competitiveness in the market. This prevents the revelation of the true competitive price of renewable electricity. Instead of this approach, a competitive bidding process should be implemented. This approach will encourage more developers to enter the market.
2. The cost of renewables is steadily decreasing, and it takes more than a year for a project get approval. In this time, the cost of equipment and component parts decrease. This approval time period should be decreased so that the real time costs of equipment are reflected in the project cost.
3. After receiving the LOI, some developers take years to sign the PPA. Even after signing the PPA, some developers take years to complete the project. To correct this, the LOI should be awarded with the condition that the developer must sign the PPA within a given time period and commence commercial operation within a given timeline. If a developer fails to maintain these deadlines, the tariff should be renegotiated.
4. The government should give training to the potential investors and developers to enable them to apply for international financing for renewable energy from sources like Clean Development Mechanism (CDM) funds and the Green Climate Fund (GCF). The government should also tailor financing instruments and loan terms, in collaboration with financial organizations, to match the tenure of renewable energy projects.

The study of investment risks in renewable energy could be further explored in future studies by covering renewable energy based heating and cooling, and transport applications.

CRediT authorship contribution statement

S. Aziz: Writing – original draft, Project administration, Methodology, Formal analysis, Conceptualization. **S.A. Chowdhury:** Writing – review & editing, Writing – original draft, Validation, Conceptualization. **M. Alauddin:** Writing – review & editing, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A Supplementary data

The survey data of this study has been included in supplementary materials. Supplementary data to this article can be found online at https://doi.org/10.1016/j.esd.2024.101605.

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