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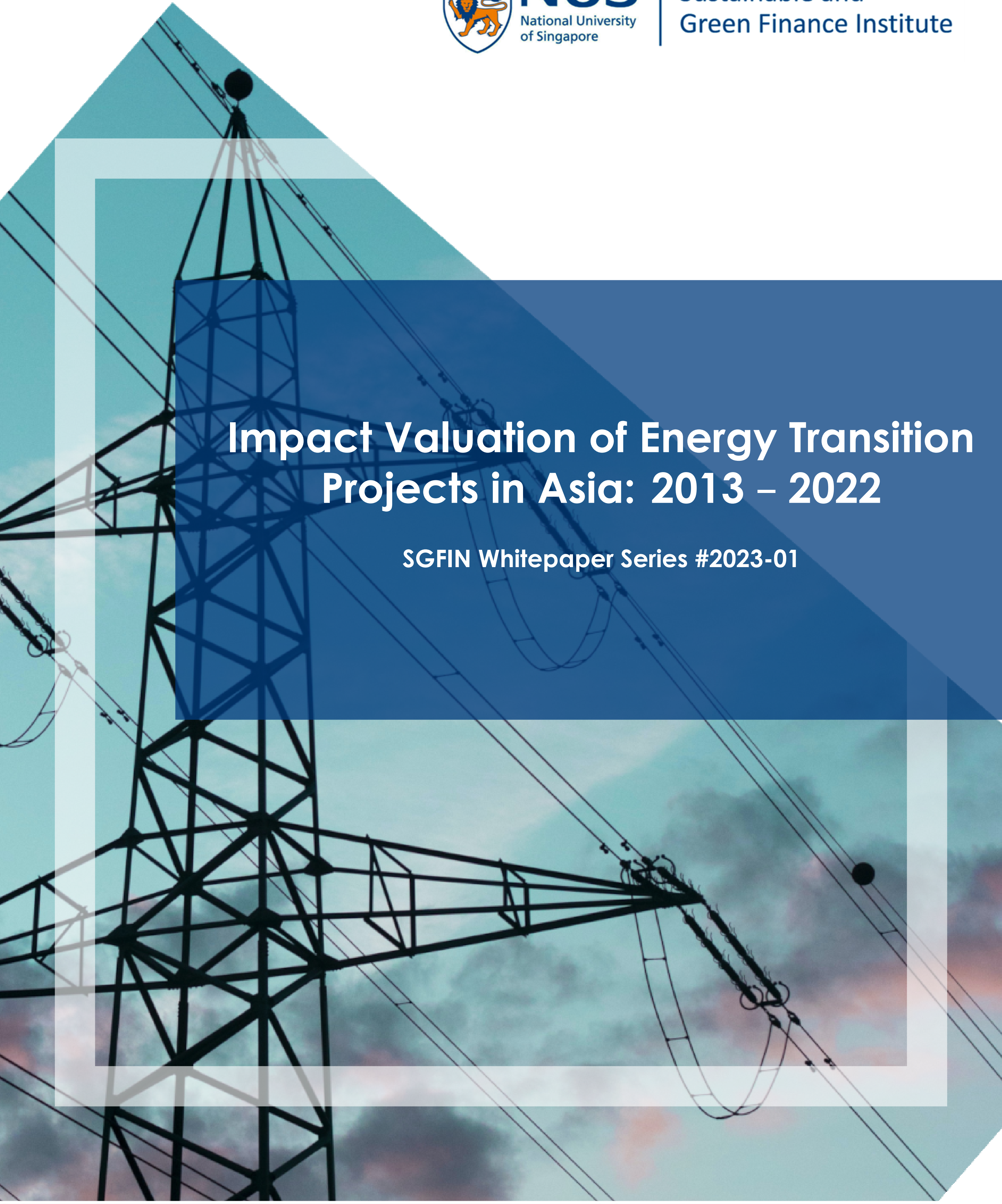

Impact Valuation of Energy Transition Projects in Asia: 2013 – 2022

SGFIN Whitepaper Series #2023-01

Vigilia Ang Sher Wen | Desmond Tay Zhi Yuan | Weina Zhang

The Sustainable and Green Finance Institute:

The Sustainable and Green Finance Institute (SGFIN) is a research institute established by the National University of Singapore (NUS). SGFIN aims to develop deep research capabilities in sustainable and green finance with a focal point on Asia, and to provide thought leadership and shape sustainability outcomes in policymaking across the financial sector and the economy at large. Supported by exceptional domain experts across NUS, SGFIN will equip businesses with critical cross-disciplinary knowledge, training, and toolkits to integrate sustainability dynamics into their business strategies and investment decisions to better quantify the environmental and social impacts of their business developments, operations, products, and services. In essence, SGFIN aims to help companies embed sustainability as a key pillar in their business decisions.

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Foreword

Making the transition to a net-zero economy is more than an objective, it is a requirement. Economic systems, and the financial markets and mechanisms that support them, have built themselves around measures of value that were not trained to take into consideration the full range of economic, environmental and social (EES) impacts that we know today to be of critical importance.

There are reasons why this is so. Two which are critical to appreciate are that despite centuries of modern industrial and economic development, it is only recently that we have become aware of the depths of impacts to our environment. The second point to appreciate, follows from the 'epiphany of hindsight' - we have learned what to monitor and appraise, and have become increasingly adept at valuing a more comprehensive suite of EES impacts.

Driven by the belief that there is value being left on the table, which if realized could help scale-up and accelerate clean energy investments, SGFIN has developed a framework for integrated return on investment (IROI) analysis which recognizes complementing attributes of different investors appraisal frameworks, and assigns dollar-values to EES impacts that were previously not captured. We apply this framework to green bond backed investments into energy transition projects in Asia.

The main results verify that with careful consolidation and re-calibration of valuation paradigms, we can uncover the material importance of a wide range of EES impact metrics using a systematic yet easy-to-adopt framework. The framework has been developed to align with multilateral development banks (MDBs) while also being relevant to corporates, where there remains a need for more consistent monitoring, reporting and evaluation of energy transition project impacts financed using green bonds.

This is SGFIN's first Whitepaper, and we are proud to launch this just a few months after our official launch in April 2023. We hope that you see as much value in the results and the insights as we do!

Prof. Sumit Agarwal
Managing Director, SGFIN
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November 9, 2023

Executive Summary

Energy transition in Asia is a critical step in the global trend of decarbonization for various stakeholders including governments, corporates, financial intermediaries, and individuals. Asian countries contribute to more than 50% of the global greenhouse gas (GHG) emissions and five of them are in the top ten most polluting countries in the world. More than 35% of energy-related carbon emissions came from developing Asia in 2022 according to Asian Development Bank (ADB), up from 19% in 1990.

To date, we have a very limited understanding of the challenges faced in energy transition projects in different parts of Asian countries due to little disclosure by the corporate sector (about 36% in our sample). On the other hand, multilateral development banks (MDBs) such as the World Bank (WB), ADB, and International Finance Corporation (IFC) have been very active capital deployers to invest in many energy transition projects in Asia. Moreover, they also produced very detailed project-level reports that can shed light on the value creation of the projects funded. In this paper, we aim to draw valuable insights from these project reports.

Our research effort started with an industry survey on the definitions of energy transition projects in Asia due to the lack of clear framework and definitions. Based on the responses from the industry experts, we filtered the initial projects financed by green bonds and sustainable bonds in Asia (a total of 2,615) by the defined "transition projects" and were left with 359 projects from 35 Asian countries, comprising of 228 projects from corporates and 131 projects from MDBs. The total amount of capital commitment through the bonds was US$123 billion.

After hand-collecting detailed project financing information and project impact metrics, we consolidated a common set of metrics for four industry sectors: 1) Energy, Extractives, Renewable Energy, Energy Efficiency; 2) Transportation; 3) Green Buildings; and 4) Green Banking. We monetized the financially material impact achieved and evaluated the integrated return on investment (IROI) that incorporates economic, environmental, and social (EES) value created relative to the size of investment.

The median IROI from 359 projects is US$3.54 for each $1 investment. The majority of this value comes from the environmental pillar (94%), followed by the social pillar (4%) and economic pillar (2%). The top three environmental value drivers include GHG emission reduction, renewable energy generation, and reduction in coal usage.

Cross-sectionally, the EES value creation from the MDBs is higher at $5.36 than that from the corporates at $2.85. As we do not see economic or social indicators reported by the corporates in their impact reports, we attributed the lack of indicators to the possibility that such reporting is not required under the current green bond principles.

Pertaining to the cost of debt, the MDBs (except IFC) were charging similar interest rates comparable to the 10-year government bond yields with credit spreads ranging from -1.5% to 3.8%. Corporates had more variations in their credit spreads ranging from -7.1% to 5.7%. These results suggest that there is room for the blended financing model with different tiers of interest rates from the public and private sectors respectively to contribute to the much-needed energy transition projects in Asia.

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Contents

List of Figures

List of Tables

List of Appendix Tables

Part 1

Introduction

With abrupt climate change looming, transition financing has been a central topic of discussion among many industries and financial institutions.

The aim of transition finance is to progressively decarbonize energy intensive sectors such as power generation, buildings, and transportation.

Key takeaways:

- The Monetary Authority of Singapore (MAS) launched the Finance for Net Zero Action Plan to include transition finance in April 2023.
- In order for green finance to play its core function and role in tackling climate change issues, the quality of information surrounding green bonds and the underlying projects has to be significantly improved.
- It would be useful if this progress could be simplified for corporates, allowing more private capital to flow into such projects.

Introduction

The term energy transition was coined in the 1970s after the Arab oil embargo sent energy prices soaring. It was then popularized by US President Jimmy Carter in his 1977 Address to the National on Energy where he stated *"We must look back into history to understand our energy problem"* (Woolley & Peters, 1977). Now, energy transition is largely referred to as the global shift from fossil-based systems of energy production and consumption to renewable energy sources (S&P, 2020).

With abrupt climate change looming, transition financing has been a central topic among many industries and financial institutions. The importance of transition finance has been increasingly emphasized by various international organizations and governments. Taking Singapore as an example, the Monetary Authority of Singapore (MAS) launched the Finance for Net Zero Action Plan to include transition finance in April 2023, which aimed to progressively decarbonize areas such as power generation, buildings, and transportation (MAS, 2023).

The Organization for Economic Cooperation and Development (OECD) identified five highest carbon-emitting sectors, namely Energy, Buildings and Industry, Transport, Land Use, and Information and Communications Technology (ICT). It is estimated that US$ 5 to 7 trillion of investment is required annually in order to deliver on the Paris Agreement (CBI, 2020a). Indeed, the size of the green bond market has been expanding exponentially in the past five years and is expected by Climate Bonds Initiative (CBI) to reach a market size of US$5 trillion by 2025 (CBI, 2022). According to CBI, 80% of use-of-proceeds green bonds went to the Energy, Transport, and Buildings sectors, reflecting investors' strong interest in financing energy transition projects (CBI, 2020b). This type of green financing has become a key and growing capital source for green technological transition and the establishment of greener infrastructure.

In response to the increased popularity of green bonds as a financing instrument, green bond principles have been published to guide the issuance. A few examples include the European Green Bond Standard (EU GBS), UN Sustainable Development Goals (UN SDGs), International Capital Market Association (ICMA) green bond principles, and CBI green bond principles. However, to date, there is no universal standardization of the definition and certification of green bonds issued. The validation of green bond capital commitment and allocations, as well as their performance and impact reports are usually done by a third-party assurance entity. However, this process does not guarantee to track and reflect the complete results and impact that the bond can generate. In addition, as impact reporting of green bonds is not mandatory, there is a significant gap in reporting, especially among corporate-issued green bonds. Indeed, an extensive effort is required to publish impact reports, and not all corporates have the luxury of time and money to embark on this journey. According to the World Bank, the team would spend five to six months on data collection, validation and analysis, research consultation, and drafting content, in order to publish their annual impact reports (Keenan & Russo, 2022). Hence, it would be useful if this progress could be simplified for corporates, allowing more private capital to flow into such projects.

In order for green finance to play its core function and role in tackling climate change issues, the quality of information surrounding green bonds and the underlying projects has to be significantly improved. For starters, proper impact reporting should be done to improve transparency around these financing instruments.

Our paper makes five contributions to address the challenges identified above. First, we bridged the gap in the definition of energy transition projects in Asia given the lack of standardized concepts. This was done through the survey we conducted with the industry experts. Second, we hand-collected the specific impact indicators from all the identified energy transition projects in Asia in the past ten years from 2013 to 2022. As far as we know, this is the first time such detailed project-level data has been collected and built into a database. Third, to provide a more holistic understanding of the effectiveness of GBs and SDBs, we proposed a comprehensive process to convert the impact indicators into financial values. This translation is critical as the monetary measures are more easily communicated and understood by all stakeholders, facilitating a better comparison of different types of green projects. Moreover, we scaled the impact value by the amount of investment to reach the comparable return measure named integrated return on investment (IROI). The project-level IROI can be compared across time and geographical locations, facilitating a more efficient investment decision process in energy transition in Asia. This IROI concept is similar to return on investment (ROI) in finance. Lastly, our research also established a comprehensive dictionary of financial proxies used in the valuation of impact metrics from the energy transition projects.

The rest of this paper is organized as follows. Section (2) presents the survey results from industry experts on the definition of energy transition projects. Section (3) describes how we collected and cleaned the project information including impact metrics. Section (4) explains the process of computing the integrated return on investment and the key financial proxies used in our calculation. Section (5) presents the main empirical findings based on computed IROI and case studies, and section (6) concludes the paper.

Part 2

Defining Energy Transition Projects

In practice, there are mixed perspectives on the types of projects that qualify as energy transition projects.

While industry-recognized standards provided a list of principles and guidance for issuers to adhere to, these standards did not explicitly identify the activities that contributed to the energy transition.

Key takeaways:

- We surveyed industry experts including asset managers, commercial banks, carbon exchanges, non-profit organizations, central banks, sovereign wealth funds, and renewable energy firms.
- From this we established a list of qualifying energy transition projects.
- This list is used to screen all green bond projects and identify the subset of projects which can be classified as energy transition projects based on our industry expert survey results.

Defining Energy Transition Projects

In this section, we explain how we reached the definition of energy transition projects in Asia through the industry survey we had constructed.

2.1 *Industry Recognized Standards*

With the increasing popularity of Green, Social, Sustainability (GSS) bonds, there is a need for industry-recognized standards to ensure the credibility of these financial instruments. The activities that are being financed by issuers have a direct impact on its climate transition strategy. We outline a few commonly referenced industry standards.

2.1.1 ICMA Climate Transition Finance Handbook

ICMA's Climate Transition Finance Handbook sought to provide clear guidance and common expectations on the practices, actions, and disclosures to be made available by issuers when raising funds for their climate transition strategy (ICMA, 2023). However, ICMA's framework did not provide specific definitions of transition projects. Instead, ICMA identified four key elements to the disclosure recommendation (ICMA, 2023).

1. Issuer's climate transition strategy and governance – the financing should be emphasized on the issuer's strategy to reduce greenhouse gas (GHG) emissions, aligning with the goals of the Paris Agreement.
2. Business model environmental materially – the strategy has to be relevant to the environmental aspect of the issuer business model.
3. Climate transition strategy and targets to be science-based – the strategy should reference science-based targets and transition pathways (GHG emission reduction trajectory).
4. Implementation transparency – there should be sufficient and clear market communication regarding the offer of a GSS financing instrument.

2.1.2 Climate Bond Initiative (CBI)

CBI developed a framework for identifying credible transition aligned with the Paris Agreement with two core purposes. Firstly, the framework defined transition as a concept by presenting a credible transition as ambitious, inclusive, and aligned with the Paris Agreement. Secondly, CBI put forward a framework for the use of the transition label in practice and proposed clearly demarcated roles for green and transition labels (CBI, 2020b).

CBI introduced five principles to prevent the transition project from greenwashing.

1. In line with 1.5 Celsius Degree trajectory

2. Established by science
3. Offsets do not count
4. Technological viability trumps economic competitiveness
5. Actions, not pledges

CBI also proposed the distinction between green and transition labels. The green label was suggested to be used for investments that had a long-term role to play and were either already near-zero-emission or following decarbonization pathways in line with the trajectory. A transition label was suggested to be used for investments that had a substantial contribution but did not have a long-term role to play or investments that had a long-term role to play but at present were uncertain (CBI, 2020b).

2.1.3 European Green Bond Standard

In October 2023, the Council of EU adopted a regulation creating a European green bond standard (Council of the EU, 2023). This standard set out consistent criteria for bond issuers who seek to label their environmentally sustainable bonds as "European green bonds". The adoption of such a standard represented a significant step towards enhancing transparency and trust in the green bond market, as it provided clear guidelines for assessing the environmental sustainability of these financial instruments, ultimately contributing to the EU's broader goals of promoting sustainable finance and green investments.

As an integral part of the European Green Bond Standard, the requirement for impact disclosure stood as a cornerstone of transparency. Under this framework, bond issuers were required to publish an impact report at least once during the bond's lifetime after the full allocation of its proceeds (European Green Bonds and Optional Disclosures for Bonds Marketed as Environmentally Sustainable and for Sustainability-Linked Bond, 2023). This report served as a critical tool for stakeholders, offering a comprehensive and transparent account of the bond's environmental impact. It mandated the clear specification of metrics, methodologies, and assumptions used in assessing the environmental effects of the bond. In addition, an independent external reviewer would play a pivotal role in validating the impact report, serving as a safeguard against deceptive green claims and greenwashing practices. This commitment to transparency and third-party verification ensured that green bonds genuinely supported environmentally sustainable initiatives and fostered trust in the broader sustainable finance ecosystem.

2.1.4 Monetary Authority of Singapore (MAS) Finance for Net Zero Action Plan (FiNZ)

MAS unveiled the Finance for Net Zero Action Plan in April 2023, outlining its approach to stimulate financial support for driving the shift toward a net-zero economy in Asia and advancing decarbonization endeavors in Singapore and the surrounding regions. The plan aimed to progressively reduce carbon emissions in sectors including power generation, construction, and transportation, aligning with the broader goals of sustainability and environmental responsibility (MAS, 2023).

Four strategic outcomes of FiNZ include:

- Data, Definitions, Disclosure
- Climate Resilient Financial Sector
- Credible Transition Plans
- Green and Transition Solutions and Markets

In October 2023, MAS issued a set of consultation papers proposing guidelines on transition planning by banks, insurers, and asset managers to enable the global transition to a net zero economy. These proposals encompassed various key expectations, including the requirement for financial institutions to provide transparent and pertinent information. The information aimed to aid stakeholders in comprehending significant climate-related risks, as well as the strategies and costs associated with mitigating these risks.

2.1.5 Importance of Reporting

Transparency and accountability are common and fundamental themes found across various frameworks and guidelines globally. In the context of financing the transition pathways to a more sustainable and environmentally responsible economy, these principles are essential. When financial institutions and corporates seek to mobilize funds for initiatives that promote decarbonization and the shift toward a net-zero economy, they must ensure transparency in the underlying projects. This transparency includes disclosing meaningful information about how these funds are being used, the impact they are achieving, and the potential risks involved. In addition, accountability comes into play when these entities take ownership of their commitments to address climate-related challenges.

In the realm of transition financing, the public and private sectors rely on transparent reporting to build trust with investors and the public, while accountability mechanisms are critical for ensuring that these financial resources are allocated efficiently and that the intended sustainability goals are met. In this way, transparency and accountability serve as the foundation upon which successful transition financing initiatives can be built, driving the necessary changes to achieve a more sustainable and resilient future.

2.2 Defining Energy Transition Projects from Industry Lenses

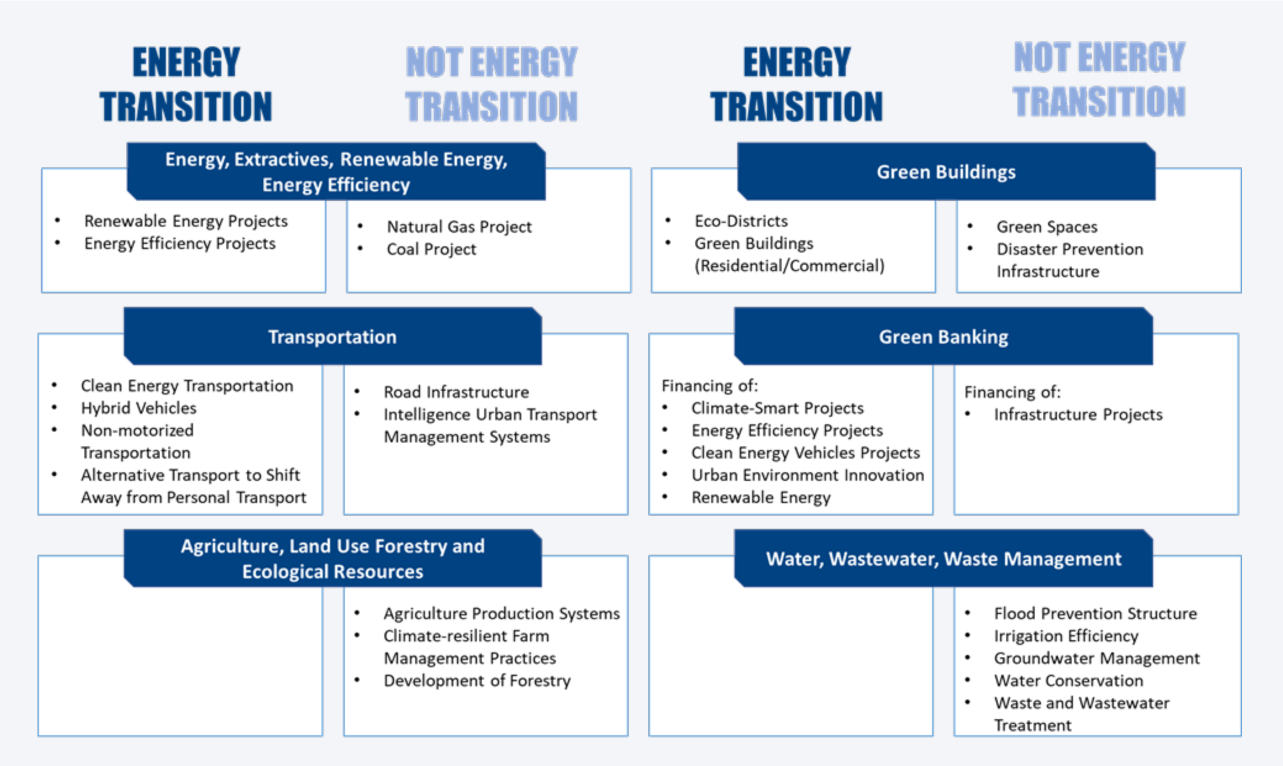
While industry-recognized standards provided a list of principles and guidance for issuers to adhere to, these standards did not explicitly identify the activities that contributed to the energy transition. For many people, taxonomies and guidelines were considered too complicated and required much effort to comprehend. It would be useful if we could simplify these definitions and provide specific examples of projects that contributed to energy transition. This paper aimed to establish a clear set of energy transition projects that were widely financed by GSS bonds in the market.

Using a bottom-up approach, we started with a database of projects financed by Multilateral Development Banks – the World Bank, Asian Development Bank (ADB), and International Finance Corporation (IFC) through their green bonds and sustainable bonds. In total, we identified a total of six broad sectors financed by these MDBs. They included 1) Energy, Extractives, Renewable Energy, Energy Efficiency; 2) Transportation; 3) Green Buildings; 4) Green Banking; 5) Agriculture, Land Use, Forestry, and Ecological Resources; and 6) Water, Wastewater, and Waste Management.

We then constructed the survey questions based on six sectors. Under each sector, we categorized the projects according to the nature of the activities and implementation. The survey was designed to describe the specific activity, allowing survey participants to decide if it contributed to the energy transition agenda in Asia.

This survey aimed to gather practical insights from industry experts. The survey was sent out to 90 industry experts across various institutions and firms including asset managers, commercial banks, carbon exchanges, non-profit organizations, central banks, sovereign wealth funds, and renewable energy firms, etc. A total of 20 responses had been received and the results were given in Figure (1).

Figure 1:
Overview of Energy Transition Projects.



Specifically, Figure (1) showed that the survey respondents did not consider two sectors that contributed to energy transition: Agriculture, Land Use, Forestry, and Ecological Resources; and Water, Wastewater, and Waste Management.

Within each of the remaining four sectors, some types of projects were not considered as energy transition projects. For example, natural gas projects or coal projects were not considered as energy transition projects under the sector of "Energy, Extractives, Renewable Energy, Energy Efficiency". Under the "Transportation" sector, road infrastructure, intelligence urban transport management systems were not considered as the energy transition projects. Under "Green Buildings", the creation of green space and disaster prevention infrastructure were not considered as energy transition projects. Lastly, under the sector of "Green Banking", infrastructure projects were not considered as energy transition projects.

In the following section, we will explain how we have collected the specific projects' financial and impact information from the published reports.

Part 3

Building the Database of Energy Transition Projects in Asia

We obtained information on all green bond projects undertaken within Asia between 2013-2022.

The sample included projects supported by local and national governments, multilateral development banks, as well as private corporations/listed companies.

Key takeaways:

- Out of a total of 2,615 issuances, we found 1,033 bonds that have their performance outcome indicators published.
- We manually collected the project data from all publicly available sources such as project bond impact reports, assurance reports, use of proceeds reports, pre-issuance reports, and press releases.
- Without taking the quality of data into consideration, this means that only 36% of corporate green bonds issued have some form of transparency and accountability.

Building the Database of Energy Transition Projects in Asia

In this section, we explain how we have constructed the database of energy transition projects from various sources.

3.1 Projects from the Multilateral Development Banks

We started the data collection process by hand-collecting each energy transition project that had been identified from the previous step. MDBs such as the World Bank (International Bank of Reconstruction and Development, IBRD), ADB, and IFC are financial institutions that provide financial assistance to developing countries to foster sustainable growth and have vast experience in project financing. Impact reports of green and sustainable bonds issued by MDBs were particularly important as these institutions have played a crucial role in financing projects that have significant global impacts, contributing to international development and finance. As a result, MDBs published impact reports consistently over time to highlight the progress of the projects financed.

3.1.1 The World Bank

The World Bank started full-fledged impact reporting for its Green Bond issuance program in 2015. The World Bank used the Harmonized Framework for Impact Reporting to guide its reporting process. The World Bank eligible projects portfolio is divided into the following sectors – Renewable energy and energy efficiency, Clean transportation, Water and wastewater management, Solid waste management, Biodiversity, Agriculture, land use, forests and ecological resources, and Resilient infrastructure, build environment, and other. We identified a total of 67 projects financed by the World Bank green bond issuance program in Asia. Among these projects, 33 projects fit the criteria of energy transition that were outlined previously. They were located in five countries including China, India, Indonesia, Pakistan, and Iraq with a total size of US$ 12.6 billion.

The hand collection of impact metrics was done concurrently. The impact indicators of these projects were reported in the section of "project development objectives", whereby both target value and actual value achieved were recorded.

3.1.2 Asian Development Bank (ADB)

ADB's green bond program was officially launched in 2015 and has been proven to be an effective tool to promote ADB's strategic priorities, including climate change, climate and disaster resilience, and environmental sustainability (Asian Development Bank, 2022). In general, ADB categorized its eligible projects into the following sectors – Renewable energy and energy efficiency, Sustainable Transport, Water, and other urban infrastructure. Between 2010 to 2021, ADB financed a total of 133 projects through green bonds. We filtered them by the definition of the energy transition projects established from the survey and ended up with 57 projects from 20 Asian countries with a total capital amount of US$ 7.2 billion.

We also hand-collected the bond information and the outcome metrics in their impact reports. For each project financed by ADB, a design and monitoring framework is published as part of the "Report and Recommendation of the President to the Board of Directors" document (if the project is still in progress) or "Completion Report" (if the project has been completed). The Design and Monitoring Framework usually reports the output, outcome, and impact of the projects. Output refers to the tangible or concrete products or services that result from the project. Outcome refers to the intended benefit or changes that occur as a direct result of the output. Impacts refer to the long-term and broader effect on the sector's landscape. In our context, we focused on the outcome of the projects since we aimed to measure the effects that the projects have on the target audience and beneficiaries.

Table 1:
Impact Reporting Statistics by Country.

		Quantified impacts available = YES		Quantified impacts available = NO	
Country	Number of Bonds	Count	Percentage	Count	Percentage
Australia	98	35	35.70%	63	64.30%
China	1,097	431	39.30%	666	60.70%
Fiji	5	5	100.00%	0	0.00%
Hong Kong	66	25	37.90%	41	62.10%
India	94	20	21.30%	74	78.70%
Indonesia	13	0	0.00%	13	100.00%
Israel	1	1	100.00%	0	0.00%
Japan	361	117	32.40%	244	67.60%
Kazakhstan	1	1	100.00%	0	0.00%
Lebanon	1	1	100.00%	0	0.00%
Malaysia	200	78	39.00%	122	61.00%
New Zealand	40	6	15.00%	34	85.00%
Pakistan	1	0	0.00%	1	100.00%
Philippines	17	5	29.40%	12	70.60%
Qatar	2	1	50.00%	1	50.00%
Saudi Arabia	6	2	33.30%	4	66.70%
Singapore	82	16	19.50%	66	80.50%
South Korea	115	37	32.20%	78	67.80%
Taiwan	57	12	21.10%	45	78.90%
Thailand	33	17	51.50%	16	48.50%
Turkey	7	4	57.10%	3	42.90%
UAE	18	14	77.80%	4	22.20%
Vietnam	18	5	27.80%	13	72.20%
Grand Total	2,333	833	35.70%	1500	64.30%

3.1.3 International Finance Corporation

International Finance Corporation (IFC) is one of the largest MDBs exclusively focused on the private sector in developing countries (International Finance Corporation, 2022). IFC investments were often directed towards companies to attract more private investment to achieve the goal of the Paris Agreement. As governments recognize that the majority of funding required to finance climate change initiatives must come from the private sector, IFC must continue to provide emerging economies with direct capital support from the private sector. The IFC's Green Bond Program was launched in 2010, aiming to catalyse and unlock private sector capital for climate-related projects. The projects financed were categorized into four broad areas – Renewable energy, Energy Efficiency, Other mitigation, and Adaption. IFC issued a cumulative of 178 bonds as of FY21, 82 of which were issued in Asia. A total of 41 energy transition projects have been identified after our filter. These projects were located in 8 Asian countries such as China, Philippines, Vietnam, and Pakistan with a total capital of US$960 million, which is less than 25% of the total project investment of US$4.4 billion.

Unlike the World Bank and ADB, IFC did not publish individual impact reports for their projects due to the issue of confidentiality. The impacts of the projects were published in IFC's Green Bond Impact Report annually. Four impact metrics were reported: 1) Annual Energy Produced; 2) Annual Energy Savings; 3) Renewable energy capacity constructed/rehabilitated; and 4) Expected annual reduction in GHG Emission.

3.2 *Projects Financed by Corporates*

Using the CBI Green Bond Database, we first identified all energy transition bonds that were issued by corporates between 2013 to 2022 in Asia Pacific. Next, we manually collected the impact data from all publicly available sources such as bond impact reports, assurance reports, use of proceeds reports, pre-issuance reports, and press releases.

> Out of a total of 2,333 corporate issuances, we found 833 bonds that have their expected impacts published. Without taking the quality of data into consideration, this means that **only 36% of corporate green bonds issued have some form of transparency and accountability** for their financing actions.

To have a better understanding of the impact reporting landscape for green bonds in Asia, we reported the number of green bonds issued and the percentage of impact reporting for each country in Table (1). Among countries with a significant number of bond issuances (greater than 10 bonds), only the UAE and Thailand have reported expected impacts for more than 50% of the green bonds issued.

Part 4

Methodology of Impact Valuation

Using a bottom-up approach, we collected commonly used outcome metrics used to create a list of commonly defined metrics relevant to energy transition projects.

Outcome metrics are then mapped into value drivers classified under three broad pillars – Economic, Environmental, and Social (EES).

Key takeaways:

- We were able to identify a total of 47 commonly used metrics that were used to evaluate the energy transition projects.
- The 47 common outcome metrics were further mapped into 22 value drivers under the three EES pillars.
- A large number of research papers were then used to build a financial proxy dictionary, used to attach a dollar-value to the identified value drivers.

Methodology of Impact Valuation

We present the entire impact valuation process in this section. In total, we took a total of five steps. First, we coded all the impact indicators from the MDBs and corporates (~1,000 raw indicators). In the second step, we standardized the list of 47 common indicators and categorized them under three broad categories – economic, environmental, and social proxies (EES). In the third step, we then assigned the common indicators with financial value based on the literature review that linked the indicators with a direct financial value. In the fourth step, we computed the present value of all the yearly EES values by converting the values into the present value in US dollars. Lastly, we computed the integrated return on investment (IROI) by dividing the integrated value computed by the total investment of each project.

4.1 Harmonized Outcome Metrics

Using a bottom-up approach, we collected commonly used outcome metrics used by the World Bank and ADB, complementing with ICMA Harmonized Framework for Impact Reporting to create a list of commonly defined metrics relevant to energy transition projects.

ICMA published the first Harmonized Framework for Impact Reporting in 2015 to complement the Green Bond Principles, enhancing the integrity and transparency of environmental finance through recommended impact reporting. Although there was no mandate on impact reporting for the issuance of bonds, green bonds issuers were encouraged to report on both the use of proceeds and the environmental impact (minimally) on an annual basis.

The handbook provided sector-specific guidance and reporting metrics for various sectors. Two types of metrics were suggested. The core indicators were metrics that were usually applicable to the projects implemented in the sector. In case the core indicators were either not applicable or data was not available, issuers were then encouraged to use other metrics when appropriate.

Example of ICMA Harmonized Framework for Impact Reporting Core Indicators:

Renewable Energy:

#1: Annual GHG emissions reduced/ avoided in tonnes of CO2 equivalent

#2: Annual renewable energy generation in MWh/GWh (electricity) and GJ/TJ (other energy)

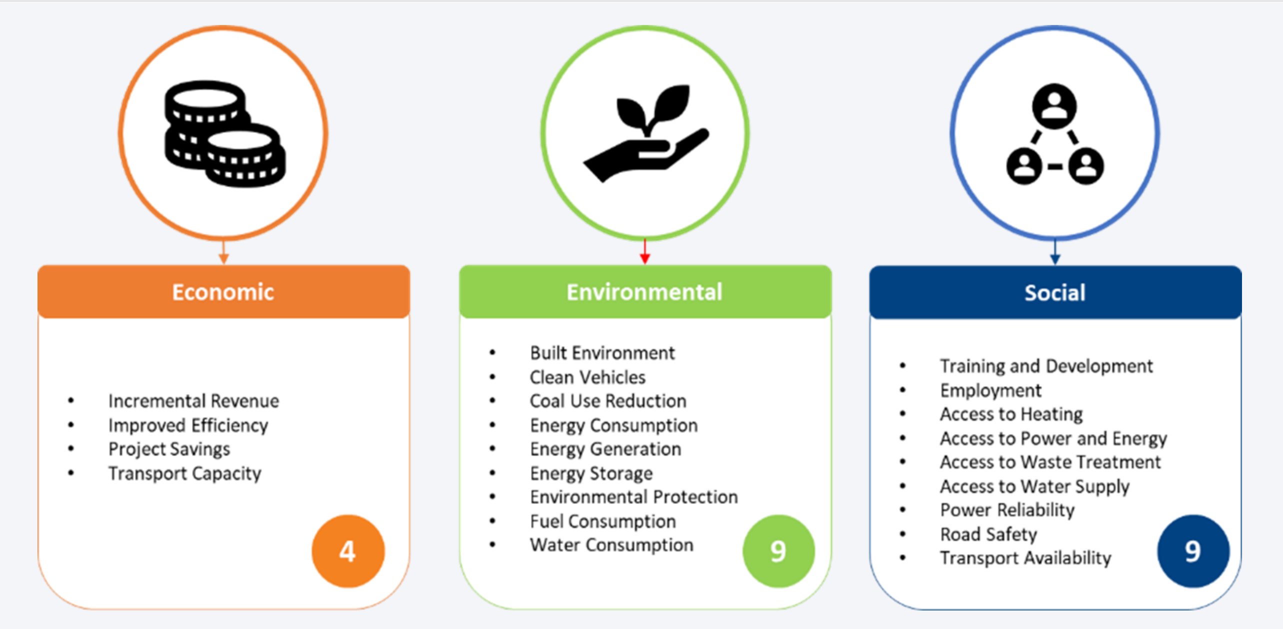
#3: Capacity of renewable energy plant(s) constructed and rehabilitated in MW

When evaluating the outcome generated by various projects, it was imperative for us to conduct a comprehensive analysis by looking through all metrics reported by the existing projects. We then consolidated different metrics into a commonly used set of metrics. This list would subsequently play a pivotal role in the valuation assessment as it provided a standardized way to understand different project outcomes. Through this exercise, we were able to identify a total of 47 commonly used metrics that were used to evaluate the energy transition projects (See Appendix for the list of 47 metrics).

4.2 Mapping from Common Metrics to Value Drivers

The 47 common outcome metrics were further mapped into 22 value drivers under three broad pillars – Economic, Environmental, and Social (EES). These three pillars were used to assess the overall impact value creation of various actions and projects, collectively reflecting the broader goals of sustainability and responsible development. Figure (2) presents the details of the value drivers under each of the three pillars. We provide the detailed definitions of the value drivers below.

Figure 2:
Summary of Value Drivers under ESS Pillars.



4.2.1 Economic Value Drivers

Economic value drivers captured the financial and economic effects of the projects and were often reported in monetary terms. Under the economic pillar, we have identified four value drivers to be monetized later.

1) **Incremental revenue** refers to the additional or extra revenue generated by the projects as a result of project-related spending and its contribution to government revenue.

2) **Improved efficiency** refers to the cost savings and time reduction achieved through more effective practices. This allows for a reduction in expenses and reallocation of time to other more productive activities. This emphasizes resource optimization and productivity enhancement in achieving economic well-being.

3) **Project savings** refers to the reduction in cost due to a project. These savings can occur in various forms such as cost savings and time savings.

4) **Transport capacity** refers to the increase in revenue of logistics transportation due to the increase in transport capacity.

4.2.2 Environmental Value Drivers

Environmental value drivers reflected the effect of projects on the natural environment and the ecosystem. Under the environmental pillar, we have identified nine value drivers to be monetized later.

5) **Built Environment** refers to the value of the built areas within the urban or targeted areas that are intentionally designed to contain greenery, such as parks.

6) **Clean Vehicles** refer to the cost savings that are realized due to a lower cost of ownership when a low-emission vehicle is procured in replacement of internal combustion engine (ICE) vehicles.

7) **Coal Use Reduction** refers to the actual savings resulting from the reduction in coal usage due to the project activities.

8) **Energy Consumption** refers to the actual savings resulting from the reduction of energy usage due to the project activities.

9) **Energy Generation** refers to the cost savings realized when energy is generated from renewable sources in replacement of energy generated from coal.

10) **Energy Storage** refers to the value generated by energy storage technology.

11) **Environmental Protection** refers to the value generated by activities of safe-guarding and preserving the natural environment.

12) **Fuel Consumption** refers to the actual savings resulting from the reduction in fuel usage due to the project activities.

13) **Water Consumption** refers to the actual savings resulting from the reduction in water usage due to the project activities.

4.2.3 Social Value Drivers

Social value drivers capture the impact value from human well-being, communities, and societies at large. This is vital for evaluating the social implications of activities and promoting social welfare and equity. Under the social pillar, we have constructed nine value drivers to be monetized.

14) **Training and development** refer to the perceived benefits gained by beneficiaries through improving and enhancing knowledge, skills, and capabilities.

15) **Employment** refers to value increases in employment opportunities provided by the project.

16) **Access to heating** refers to the perceived benefits of having available heating services and represents the recognition of the value and importance of having reliable heating resources.

17) **Access to power and energy** refers to the perceived benefit of having available energy services and represents the recognition of the value and importance of having reliable power and energy.

18) **Access to waste treatment** refers to the perceived benefit of having available waste treatment services and represents the recognition of the value and importance of having reliable waste treatment services.

19) **Access to water supply** refers to the perceived benefit of having available water services and represents the recognition of the value and importance of having a reliable water supply.

20) **Power reliability** refers to the perceived benefits of having consistent and dependable availability of electrical power to meet the needs of users. It encompasses the ability to provide a continuous and stable flow of electricity with minimum interruptions and disturbance.

21) **Road safety** refers to the value of preventing accidents and injuries on roadways, and minimizing the consequences of traffic-related fatalities.

22) **Transport availability** refers to the perceived benefits of having available transport services and represents the recognition of the value and importance of having reliable transport services.

4.3 Monetization of the Value Drivers

After identifying the relevant outcome metrics and value drivers, we then assigned a monetary value to the outcome metrics to convert these material metrics into financial values according to 22 drivers. We constructed a database based on the list of financial proxies used. The list of financial proxies is flexible and varies across geographical locations, economic conditions, and market situations. The financial proxies were obtained from two sources – the existing database and research papers.

4.3.1 Utilizing the Existing Databases

We utilized the existing database to obtain some financial proxies to monetize the impact value drivers. By mining through these existing databases for relevant environmental quality parameters and social well-being indicators, we can then monetize these parameters. Such a process enabled us to build a more comprehensive understanding of the true costs and benefits related to energy transition projects. One example is the usage of labor and wages statistics from the International Labor Organization's database ILOSTAT (International Labour Organization Statistics).

4.3.2 Finding Proxies from Research Papers

A large number of research papers were used to build our financial proxy dictionary, especially those involving the measurement of Willingness to Pay (WTP) and those evaluating the cost of climate technologies.

Researchers have developed various methodologies, such as contingent valuation, to estimate individuals' WTP for environmental goods and services. These values allow us to have a better insight and quantify the value people place on environmental goods and services as well as their impacts. One example is the assignment of a value to the perceived benefit of public transport by riders. In our database, we utilized research studying the passengers, and WTP for improved public transportation and shift to public transportation in Malaysia (Almselati et al., 2015). From the research, the average WTP is US$0.68 for one rider per year in 2015.

Another types of research paper evaluated the cost and benefits of climate technologies. These evaluations provided us with information that allowed us to do a cost comparison. One example is the valuation of renewable energy generation. By comparing the Levelized Cost of Energy (LCOE) (IEA, 2020), we were able to measure the cost savings of generating renewable energy instead of generating energy from coal.

4.3.3 Establishing Database of Financial Proxies

By leveraging the two primary data sources, we have constructed a comprehensive database of financial proxies that can be employed in the impact valuation of project outcomes. Acknowledging the significant variations in these values across geographical locations and time, our research aimed to offer country-specific and year-specific proxies as much as possible.

For this paper, we have built a financial proxy database comprising ~1,000 data items for the harmonized 47 outcome metrics identified earlier. These proxies were constructed for different locations of the energy transition projects. It is important to note that this database is not exhaustive, and there is certainly room for improvement. The addition of more data points will be done as we collect more project-level information in future research.

Example of establishing financial proxy – LCOE of Solar

The International Renewable Energy Agency (IRENA) has developed a comprehensive Levelized Cost of Electricity (LCOE) cost database for renewable energy sources, covering both global perspective and insights into individual countries. This resource gave us access to the critical data for various renewable energy technologies. The database provided us with a weighted average LCOE, which served as an overarching benchmark for accessing the cost competitiveness of renewable energy. By leveraging on this study, we can establish an accurate cost estimate for solar energy generation. Subsequently, this information enabled us to compute the economic value of transitioning from coal-based energy generation to solar energy.

Figure 3:
LCOE of Solar.

Measurement	Country	Year	Financial Proxy Value	Currency/ Units	Source
LCOE of Solar Energy	Global	2010	0.3783	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Global	2015	0.1264	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Global	2019	0.0684	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Global	2020	67	USD / MWh	International Energy Agency (IEA)
LCOE of Solar Energy	China	2010	0.3012	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	China	2015	0.0931	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	China	2019	0.0541	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	China	2020	62	USD / MWh	International Energy Agency (IEA)
LCOE of Solar Energy	India	2010	0.3054	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	India	2015	0.0810	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	India	2019	0.0447	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	India	2020	44	USD / MWh	International Energy Agency (IEA)
LCOE of Solar Energy	Japan	2015	0.1787	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Japan	2019	0.1439	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Japan	2020	212	USD / MWh	International Energy Agency (IEA)
LCOE of Solar Energy	Korea	2010	0.5022	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Korea	2015	0.1648	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Korea	2019	0.0905	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Vietnam	2016	0.1808	2019 USD/kWh	International Renewable Energy Agency (IRENA)
LCOE of Solar Energy	Vietnam	2017	0.2694	2019 USD/kWh	International Renewable Energy Agency (IRENA)

4.4 Computation of Integrated Values

Once we constructed the financial proxy dictionary, we then applied the usual financial valuation methodology to calculate the integrated value created from each project. This valuation process would assist us to have a better understanding of each project, allowing for better investment decisions going forward. We list down four steps involved in the computation below:

1. **Identify Financially Material Metrics and Relevant Financial Proxy**
   After gathering the harmonized outcome metrics, we chose the corresponding financial proxies from our constructed dictionary for each metric. The general guideline for selecting input variables is as follows:

- Choose the specific country and year: Select the input variables from the financial proxy database for the exact country and year of interest.
- Closest Geographical Proximity: If data for the specified country is not available, opt for the country with the closest geographical proximity, which may provide relevant and comparable data
- Closest Year: In cases where data for the precise year is unavailable, select the year that is closest to the desired year. This ensures that the data remains relevant and minimizes temporal disparities.

2. **Build the Formulas to Compute Financial Drivers**

   We built the calculation to convert the outcome metrics using the financial proxies to the monetary terms for each of the 22 value drivers.

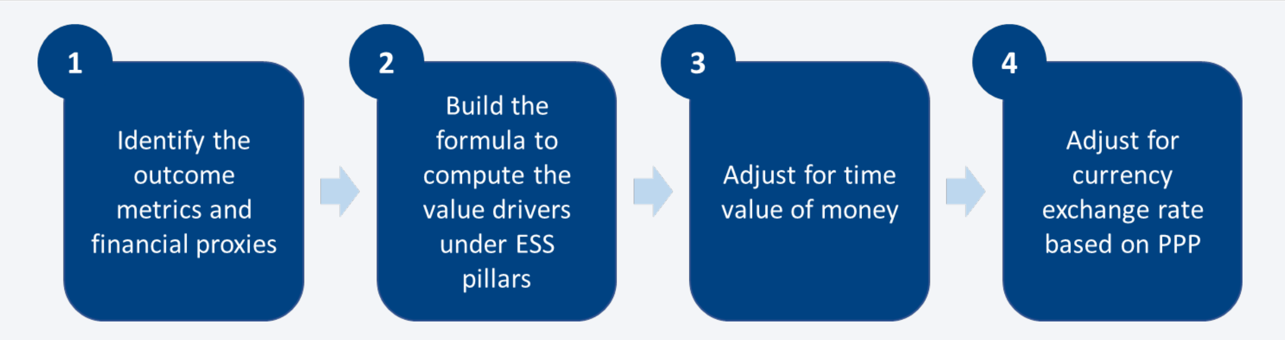
3. **Adjust for the Time Value of Money**

   When dealing with a financial proxy whereby the exact year is unavailable, it's essential to account for the change in the time value of money. To do this, we adjusted the financial proxy to the year of calculation by applying inflation rates. This step is crucial in ensuring the accuracy and relevance of the data used in the calculations for the specific year of interest, maintaining the integrity and reliability of financial analysis.

4. **Adjust for Currency Exchange Based on PPP**

   To facilitate meaningful comparisons of project impacts across different countries, we adjusted the values to US dollars based on purchasing power parity (PPP) in 2022, which considers differences in purchasing power and exchange rates.

Figure 4:
Total Impact Value Computation Process.



4.5 Computation of the Integrated Return on Investment (IROI)

Finally, we computed the integrated return on investment (IROI) to scale the impact value by the total amount of investment. The numerator in IROI includes the value drivers coming from three EES pillars: Economic, Environmental, and Social ones.

Figure 5:
Definition of Integrated Return on Investment (IROI).

$$IROI = \frac{EES\ Benefits\ -\ EES\ Costs}{Investment}$$

Economic, Environmental and Social values (EES) are included in the calculation of IROI

Part 5

Main Findings

We examined how cross-sectional differences across types of issuers, sectors, countries, and cost of capital.

Our analysis uncovered intricate relationships between project characteristics and financial valuations, providing novel insights for energy transition projects in Asia.

Key takeaways:

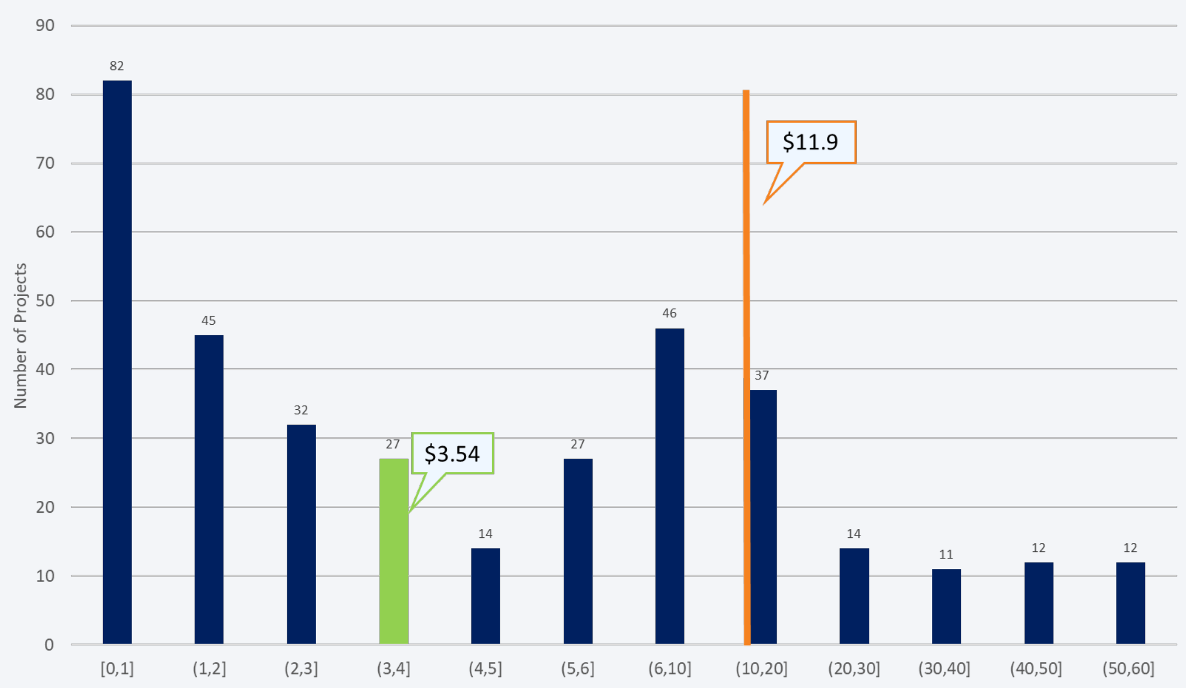
- Overall, the median IROI from 359 projects is at US$3.54 for each $1 investment whereas the average IROI is at $11.9.
- The main value drivers in IROI came from environmental value at 94%, followed by social value at 4%, and economic value at 2%.
- Projects financed by MDBs, on average, had much higher IROIs compared to Corporate which can be primarily attributed to the difference in reporting practices by different issuers.

Main Findings

In this section, we present the main findings from our analysis and interpretations of the results.

Overall, the median IROI from 359 projects is at US$3.54 for each $1 investment whereas the average IROI is at $11.9. We plot the distribution of the IROI for all projects in Figure (6) below. It showed that the majority of the projects have an IROI that is below $4.0. The reason for the high value for the average IROI is because some projects have very positive value due to the massive coal use reduction resulting from the project. The main value drivers in IROI came from environmental value at 94%, followed by social value at 4%, and economic value at 2%.

Figure 6:
Distribution of IROI.

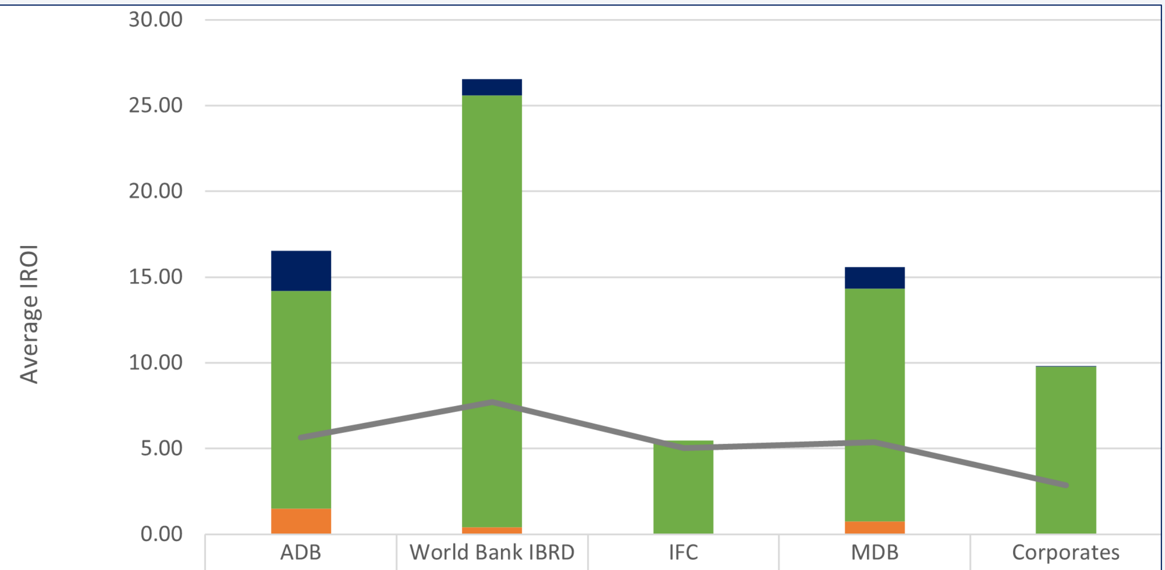


Next, we examined the cross-sectional differences across issuers, sectors, countries, and cost of capital. Our analysis aimed to uncover the intricate relationships between project characteristics and financial valuations, providing novel insights for energy transition projects in Asia. Moreover, we would extend the lens to benchmark the exemplary projects for different countries, recognizing the unique economic, political, and social landscape that framed each project's journey. This holistic view would further improve the understanding of how projects intersect with national contexts and offer a rational process for future investment decisions.

5.1 IROI by Issuer Types

As mentioned before, our project sample consisted of those financed by MDBs and corporates respectively. MDBs contributed to 131 projects whereas the corporates contributed to 228 projects. Among MDBs, we further differentiated the projects by the WB, ADB, and IFC respectively as they differ in their reporting and funding channels. We present the levels of the IROI based on four issuer types and the results are presented in the following Figure (7).

Figure 7:
IROI by Issuer Types.



	ADB	World Bank IBRD	IFC	MDB	Corporates
Social	2.32	0.94	0.00	1.25	0.00
Environmental	12.70	25.19	5.47	13.58	9.79
Economic	1.49	0.40	0.00	0.75	0.00
Median	5.63	7.70	5.02	5.36	2.85

Comprehensive reporting practices of Multilateral Development Banks lead to significantly higher IROI, underlining the imperative for corporates to broaden their impact reporting beyond a GHG-centric focus.

We found a notable disparity in IROIs across MDBs and Corporates. The projects financed by MDBs, on average, had much higher IROIs compared to Corporates. The MDBs' median and average IROI stood at \$5.36 and \$15.58 for each \$1 of the investment. The median and average IROI of corporate issuers were at \$2.85 and \$9.79.

The primary driver of this discrepancy can be attributed to the difference in reporting practices between by different issues. While projects financed by MDBs usually included a broader range of outcome metrics across the three EES pillars, Corporates, in the majority of cases, predominantly focused on environmental outcomes, specifically GHG emissions.

As a result, MDBs provided a more comprehensive list of outcome metrics that allowed us to derive more value drivers in the IROI computation, incorporating a diverse set of indicators that encompass not only environmental outcomes but also socio-economic aspects. The rich data provided by MDBs allowed us to delve deeper to understand a more holistic impact of ding of project impact, thereby resulting in higher IROI values.

Across three MDBs, we found that the highest median and average IROI came from projects financed by the World Bank at $7.70 and $26.53 for $1 of investment. The median and average IROI from ADB-financed projects stood at $5.63 and $16.52. The median and average IROI from IFC-financed projects were at $5.02 and $5.47 respectively. The lowest value creation from IFC is possibly due to the limited outcome indicators we have used in the computation. This further supports our arguments that more data disclosures would help us to have a more holistic understanding of different kinds of value creation surrounding each project.

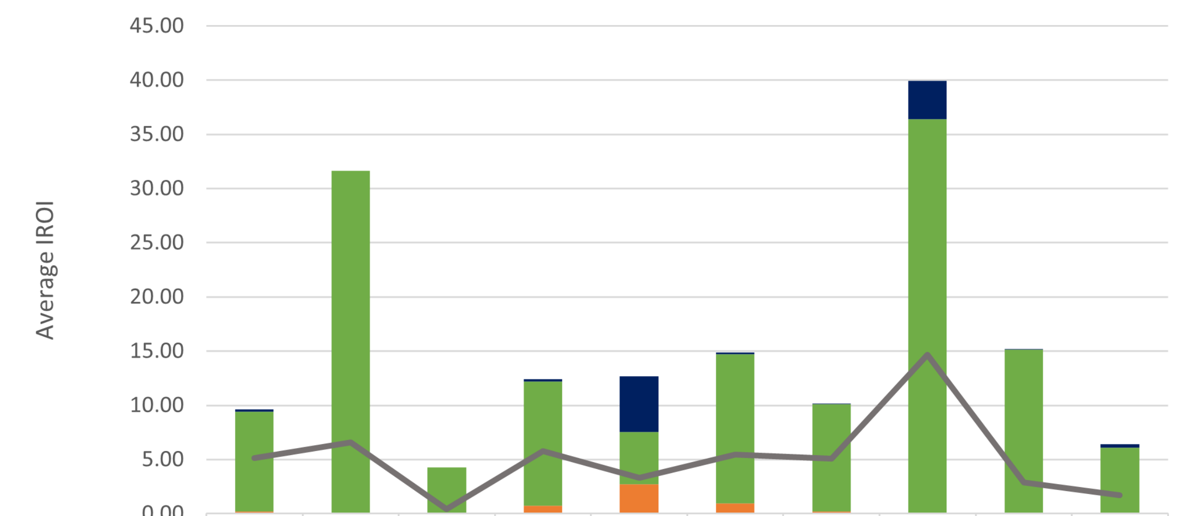
Among the three EES value pillars, most of the social value came from the projects financed by ADB at $2.32. The social value from the World Bank was $0.94 and $0 from IFC. A deeper investigation revealed that high social value mainly came from the ADB-financed energy transition projects located in Mongolia, Uzbekistan, and Vietnam whereas we did not find similar projects financed by the World Bank's green bonds in these countries. This also revealed that the World Bank and ADB sometimes covered different parts of Asian countries. Moreover, the computed social value allowed us to have a deeper understanding of the total value created by energy transition projects in these developing Asian countries where investment capital is much needed.

Our results suggested that there is an information gap between MDBs and corporate issuers. The latter can take reference from MDBs to broaden their scope in impact reporting to fully capture the multifaceted nature of value drivers beyond financial returns. The computation from IROI revealed that more value creation can be tracked, measured, monitored, and even financed one day.

5.2 IROI by Project Types

Here we present the levels of IROI based on different types of projects. In total, we identified 14 project types under the energy sector and one project type under the transportation sector. Figure (8) reports the average and median IROI of the ten project types as we further deleted those types with less than four projects. A closer look at the results revealed striking differences in the value creation by the ten project types.

Figure 8:
IROI by Project Types.



	Solar	Energy Efficiency	Green Buildings	Hydropower	Biomass	Geothermal	Wind	Transmission	Clean Energy	Transportation
Social	0.19	0.00	0.00	0.23	5.13	0.14	0.00	3.55	0.00	0.29
Environmental	9.21	31.65	4.28	11.43	4.79	13.77	9.93	36.40	15.12	6.08
Economic	0.21	0.00	0.00	0.77	2.74	0.94	0.19	0.00	0.04	0.02
Median	5.15	6.57	0.42	5.78	3.28	5.45	5.09	14.66	2.91	1.70

Economic Environmental Social Median

Large-scale, capital-intensive energy transmission projects consistently exhibited the highest IROIs, reflecting their pivotal role in fostering socio-economic development and access to essential services, while reducing GHG emissions.

Notably, the large-scale projects for energy transmission infrastructure stood out as the leaders, exhibiting the highest median IROI at $14.66. This result underscored the pivotal role of connecting different Asian regions and enabling essential energy services, including the seamless transmission of renewable energy. These expansive and efficient transmission networks not only facilitated the movement of vital resources but also played a key role in bolstering socio-economic development. The robust capacity to deliver essential services to underserved areas, coupled with the scalability and the multiplier effect these projects generated have resulted in substantial social and economic values from the IROI analysis. Moreover, the enduring benefits provided by transmission projects also came from their long lifespans. These results reinforced the common understanding that infrastructure projects would play a key role in driving positive societal outcomes.

> Renewable energy projects play a pivotal role in the global energy transition, significantly reducing greenhouse gas emissions and fostering a cleaner, more sustainable environment through their focus on clean energy generation for generations to come.

The second highest median IROI value came from "energy efficiency" projects at $6.57. This result is also consistent with the general understanding that the improvement of energy efficiency is an important element for achieving net-zero emissions by 2050 in alignment with the Paris Agreement (IEA, 2022). There were many benefits from cost-effective energy efficiency improvements such as more economic activities, reduced energy consumption, and increased employment.

The third highest median IROI value came from various renewable energy projects such as solar, wind, hydropower, and clean energy. From a total of 240 renewable projects in our sample, we obtained a median IROI value of $3.53.

Renewable energy projects were the direct drivers for sustainability and the mitigation of environmental concerns. Moreover, we also found that the renewable energy projects also generated social value such as increased employment opportunities increased energy access, and reduced GHG emissions. More specifically, Bioenergy in the form of waste-to-energy projects stood out as a front-runner in the renewable landscape, delivering substantial social value such as reducing the burden on landfills, minimizing environmental pollution, and creating employment opportunities in waste collection and conversion.

> The expansion of evaluation metrics for green building initiatives and transportation investments is essential for a more comprehensive assessment of their societal contributions, enabling more informed and sustainable decision-making.

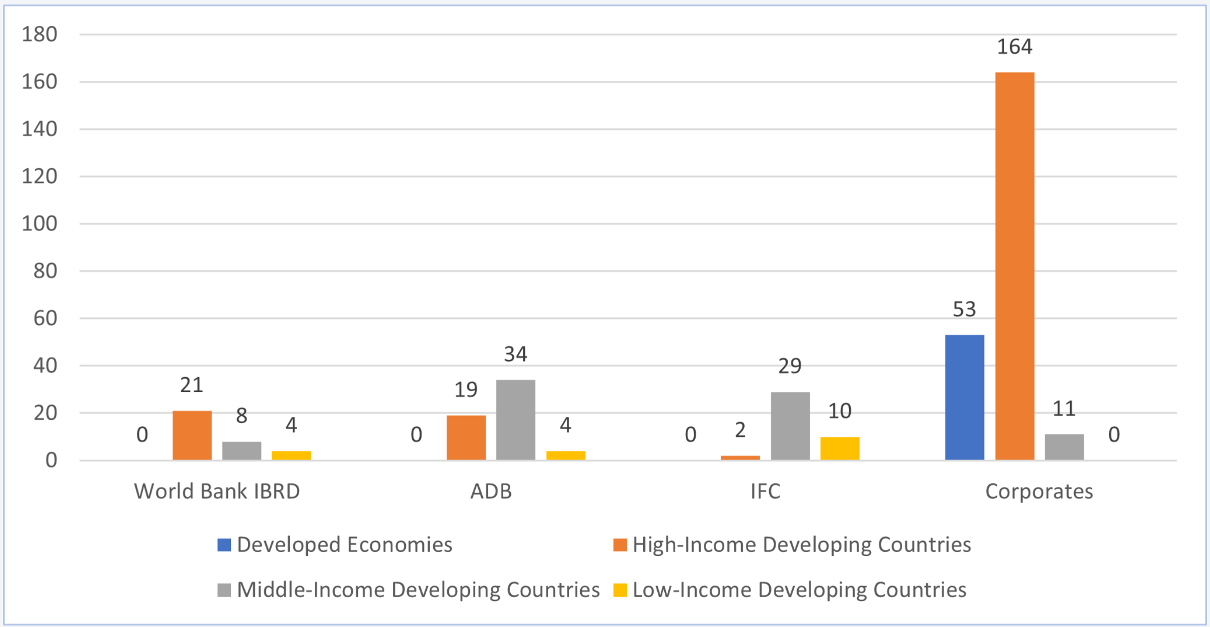
On the other hand, green building initiatives generated the lowest median IROI value at $0.42 for an investment of $1. The low number suggested either room for further value enhancement or a need to broaden the outcome metrics that may lead to more holistic value assessments.

Similarly, transportation projects had a median IROI of $1.70. Given that these projects were crucial for economic growth and connectivity, we found the relatively modest IROI value puzzling. This result might suggest that there is still room for better project planning or a better integration of a broader range of societal benefits. For example, by addressing accessibility, safety, and environmental sustainability concerns within transportation projects, there will be more social value drivers to enhance IROI. Our analysis indicated that this sector can help societal advancement if the project outcome metrics can be broadened in the process of investment, reporting, and performance monitoring.

5.3 IROI by Development Statuses of Countries

In this section, we present a comprehensive examination of IROI at the country level based on their economic development statuses defined by the United Nations (UNCTAD, 2023). By dissecting IROI data at this granular level, we aimed to uncover insights related to the nexus of political, economic, and sources of financing in energy transition projects in different Asian countries.

Figure 9:
Number of Projects by Development Status.



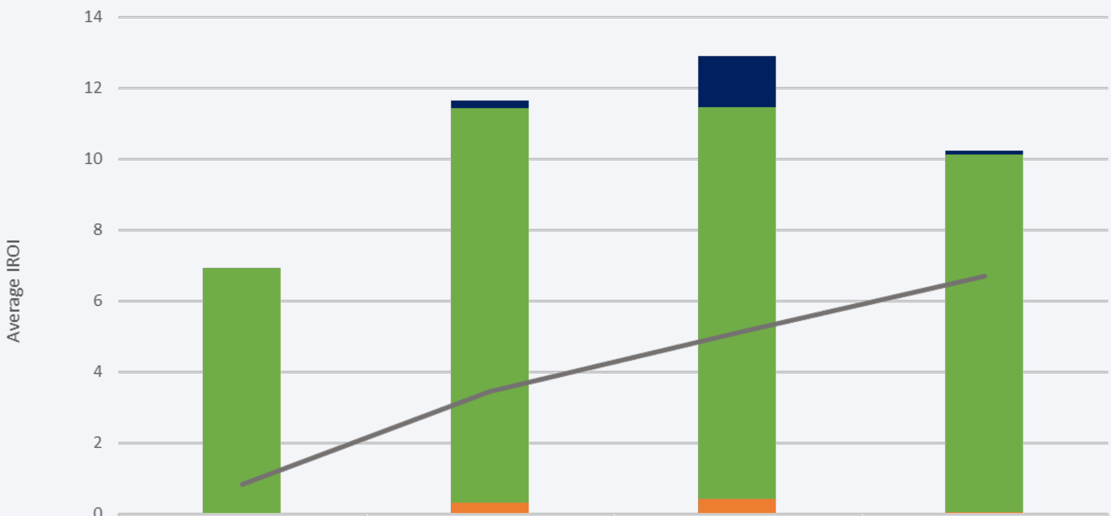
> Multilateral Development Banks (MDBs) primarily finance projects in developing countries to address critical socio-economic needs, while corporations tend to invest in more developed countries to pursue market-driven opportunities and innovation

Figure (9) presents the number of projects by different issuers and the economic development statuses of the geographical locations. It showed that MDBs and corporations adopted different approaches in their investment strategies. MDBs committed their financial capital to the projects exclusively in Asian developing countries, prioritizing those for addressing socio-economic challenges and advancing inclusive sustainable development. These projects supported critical sectors such as healthcare, education, infrastructure, and environmental sustainability.

In contrast, corporations predominantly channelled their investments into projects in more developed countries. These projects are aimed at leveraging market-driven opportunities, pursuing innovation, and maximizing profitability.

The differences in geographical locations underpinned the distinctive roles played by the MDBs and corporations in advancing sustainable development goals, promoting economic growth and technological progress, and advocating blended finance.

Figure 10:
IROI by Development Status.



	Developed Economies	High-Income Developing Countries	Middle-Income Developing Countries	Low-Income Developing Countries
Social	0	0.21	1.45	0.10
Environmental	6.91	11.13	11.03	10.08
Economic	0	0.30	0.42	0.05
Median	0.84	3.45	5.10	6.70

Developing countries have higher median IROI, reflecting the profound impact that targeted projects can have on addressing pressing social and economic needs in these regions.

Figure (10) presented the median IROI from four groups of countries based on their economic development statuses. The median IROI values increased from $3.45 to $6.70 as the development status worsened whereas the median IROI was the lowest in the developed Asian countries at $0.84.

This finding can be explained by a few reasons. First, developing countries often have more significant unmet social and economic needs such as poor living standards, and limited access to basic services and infrastructure development. Such needs, once addressed by the new projects, would naturally lead to higher IROI values. Second, it could be more cost-efficient to implement projects in developing countries where labour and resource costs were lower, allowing for a more extensive project impact with the same amount of investment. Moreover, in some developing countries, the baseline for social and economic indicators was in the low range, resulting in a higher

IROI value even with a small amount of improvement. Third, development agencies such as MDBs preferred to implement targeted interventions in developing countries and placed a lot of emphasis on essential sectors such as infrastructure. Such sectors usually had a higher IROI value due to the direct and measurable positive impact on people's well-being, generating significant positive externalities.

IROI tends to be higher in middle-income developing countries compared to low-income developing countries, primarily due to differences in country capacity and the perceived value of social services and projects within their respective contexts.

Furthermore, when we compared the average IROI values between middle-income developing countries and low-income developing countries, a notable disparity emerged. The average IROI value is slightly higher in the middle-income nations at $12.9 compared to that in the low-income developing countries at $10.23. The main value drivers for the difference came from social value. The highest average IROI from the social value stood at $1.45 from the middle-income developing countries. This finding is very interesting to see that the recognition of social values has been increasing in these countries.

5.4 IROI in Benchmarking Project

Given the normal distribution of the IROIs across different countries, we could see that the ranking of median and mean IROI values could be different, especially in the previous section. Hence, we delved deeper into each country and identified the projects with the highest IROI value and presented them in the following Table (2).

Table 2:
Benchmark Project in Each Country.

Benchmark Project in Each Country.				
Country	**Number of Projects**	**Highest IROI**	**Industry**	**Issuer**
Developed Economies				
Australia	15	16.95	Green Buildings	Corporates
Israel	1	3.64	Energy	Corporates
Japan	20	15.08	Energy	Corporates
New Zealand	3	0.1	Energy	Corporates
South Korea	14	18.25	Energy	Corporates
High-Income Developing Countries				
China	177	35.87	Energy	World Bank
Hong Kong	1	0.12	Energy	Corporates
Kazakhstan	2	3.45	Energy	ADB
Lebanon	1	0.2	Energy	Corporates
Malaysia	2	2.39	Energy	Corporates
Maldives	1	13.27	Energy	ADB
Saudi Arabia	1	46.43	Energy	Corporates
Singapore	3	43.88	Energy	Corporates

Continuation of Table 2

Country	Number of Projects	Highest IROI	Industry	Issuer
Taiwan	5	9.16	Transportation	Corporates
Thailand	7	14.56	Energy	ADB
Turkey	2	48.28	Energy	Corporates
UAE	4	13.19	Energy	Corporates
Middle-Income Developing Countries				
Armenia	2	20.84	Energy	ADB
Bangladesh	1	5.63	Energy	ADB
Cambodia	3	15.31	Energy	ADB
India	34	38.14	Energy	ADB
Indonesia	6	38.88	Energy	World Bank
Iraq	1	7.2	Energy	World Bank
Jordan	9	3.61	Energy	IFC
Mongolia	2	22.95	Energy	ADB
Papua New Guinea	1	1.01	Energy	ADB
Philippines	10	6.38	Energy	ADB
Samoa	1	1.29	Energy	ADB
Solomon Islands	1	0.33	Energy	ADB
Sri Lanka	2	7.87	Energy	ADB
Uzbekistan	4	8.93	Energy	ADB
Vanuatu	1	0.45	Energy	ADB
Vietnam	4	59.01	Energy	ADB
Low-Income Developing Countries				
Kyrgyz Republic	1	1.1	Transportation	ADB
Pakistan	17	49.12	Energy	World Bank
End of Benchmark Project in Each Country.				

One interesting pattern that emerged from Table (2) is that both public and private financing for best energy transition projects were observed in developed Asian countries and high-income developing countries. However, the best project financing only came from the MDBs when the project was located in middle-income and low-income developing countries. This result suggested that there is a lot of experience and value creation done by the MDBs in these developing countries.

As we examined the highest IROIs for each country, we realized that the starting point of the energy transition project for each country could be quite different. This benchmarking exercise could be very useful for the private sector such as big companies or financial intermediaries to understand the potential benefits and costs of the projects.

5.5 IROI by Cost of Financing

In this subsection, we further explored the opportunities for blended financing. Specifically, we derived the credit spread (CS) of each bond, which is the difference between the coupon rate and the 10-year government yield on the issuance year of the project. The results are presented in Table (3).

Table (3) showed that the CS for the bonds was largely on par with the comparable government yields with positive and negative CS around zero. However, the variations among MDBs were smaller than those among the corporate issuers, ranging from -1.5% to 3.8% whereas those from the corporate bonds ranged from -7.1% to 5.7%.

Table 3:
Credit Spreads of Projects.

Spread	(~,-2%]	(-2%,-1%]	(-1%,0%]	(0%,1%]	(1%,2%]	(2%,3%]	(3%,~)	Total
World Bank IBRD			7	15	11			33
ADB		4	16	8	11	12	6	57
IFC						24	17	41
Corporates	5	15	59	107	29	7	6	228
Total	5	19	82	130	51	43	29	359
Percentage	1%	5%	23%	36%	14%	12%	8%	100%

However, it is worth noting that the International Finance Corporations (IFC) exhibited relatively high and positive credit spreads that were above 2%. Such a result reflected the nature of IFC project financing being the pivotal financing source to crowd in more financing from the private sector such as financial intermediaries. This also suggested that the IFC was quite effective in mobilizing financing from private sectors for impactful projects while adapting to the unique challenges and considerations.

Given the variations in the credit spread across different issuer types, we could see that the cost of financing differed between the MDBs and the corporate sector. These results suggested that there is room for the blended financing model with different tiers of interest rates from the public and private sectors respectively to contribute to the much-needed energy transition projects in Asia. Blended financing often involves mixing concessional funding from governments with private sector investments to support projects with high social or environmental impact.

Nevertheless, we knew that blended finance may also introduce additional complexities and risks. Investors in blended finance projects may expect higher returns to compensate for the perceived risks associated with the concessional finance component or the more complex nature of this investment. Hence, our findings suggested that the expertise from IFC financing could hugely benefit the private funders who are interested in developing Asian countries.

5.6 Case studies

In this section, we presented two case studies from Pakistan and India to understand the detailed value drivers using the IROI analysis.

5.6.1 Case Study 1: Wind Energy Project in Pakistan

The energy deficit has been a significant constraint to Pakistan's economic growth. Pakistan has faced chronic energy shortages for many years, creating a detrimental impact on various sectors of the economy such as industry, agriculture, and households. These shortages have led to frequent power outages, reduced industrial productivity, and hindered the overall development of the country. To address this issue, the government of Pakistan has initiated several measures and projects to promote energy infrastructure development. The development of the following wind energy project contributes to this agenda (shown in Table 4).

Table 4:
Project information for a Wind Energy Project in Pakistan.

Project Type	Project Year	Project Life	Committed Amount (US$ Million)	Project Cost (US$ Million)	Total Value Created (US$ Million)	IROI
Wind	2019	20	75	360	2,416	6.71

The IROI stood at $6.71 for every $1 investment in this project. This return suggested that the project was very successful in creating significant value above the investment. Table (5) lays out the detailed five value drivers we computed from this project. The value drivers came from three EES pillars.

Table 5:
Reported Metrics and Captured Outcome of Wind Energy Project in Pakistan.

Reported Metrics	Values Reported	Pillar	Topic	Outcome Measured
Annual GHG emissions reduced/avoided - tCO2 – e. p.a	380,000	Environmental	GHG Emissions	The benefit of GHG Emission Reduction
Annual renewable energy generation - Wind - MWh	520,000	Environmental	Energy Generation	Energy Production Savings - Wind
Number of jobs created/supported during construction - Count	300	Social	Employment	Increase Employment Opportunities (Temporary)
Number of jobs created/supported - Count	35	Social	Employment	Increased Employment Opportunities (Permanent)
Annual domestic spending (during construction)	- $31,000,000	Economic	Incremental Revenue	Domestic Economic Spending

Specifically, we described the five value drivers below.

The Environmental Value Drivers:

- **GHG emissions**: This outcome metric measured the project's impact on GHG, indicating its contribution to mitigating climate change and environmental sustainability
- **Energy Generation**: This outcome metric assessed the cost difference in the generation of renewable energy compared to coal energy

The Social Value Drivers:

- **Employment (permanent)**: The outcome metric reflected the project's contribution to the local community and permanent workforce development.
- **Employment (temporary)**: The outcome metric reflected the project's contribution to the local community and temporary workforce development.

The Economic value driver:

- **Incremental Revenue**: This metric measured the additional revenue and income generated by the project.

Table 6:
Financial Proxies Used in Calculation of IROI for Wind Energy Project in Pakistan.

Outcome Measured	Outcome Metrics	Financial Proxy	Total Value Created (US$)
The benefit of GHG Emission Reduction	Annual GHG emissions reduced/ avoided (tCO2)	Social Cost of Carbon from India, US$86 per tonne (2020)	1,050,324,227
Energy Production Savings - Wind	Annual Renewable Energy Generation (MWh)	1. LCOE of Coal Energy (Global), US$97 per MWh (2020) 2. LCOE of Wind Energy (Global), US$53 per MWh (2020)	1,313,606,946
Increase Employment Opportunities (Temporary)	Number of jobs created/supported (Count)	1. Hourly Earnings of Employees from Pakistan, PPP$4.08 per hour (2019), PPP$3.89 per hour (2021) 2. Number of Hours Worked per Employed Person from Pakistan, 45.97 hours per week (2019), 46.69 hours per week (2021)	3,841,750
Increase Employment Opportunities (Permanent)	Number of jobs created/supported (Count)	1. Hourly Earnings of Employees from Pakistan, PPP$4.08 per hour (2019), PPP$3.89 per hour (2021) 2. Number of Hours Worked per Employed Person from Pakistan, 45.97 hours per week (2019), 46.69 hours per week (2021)	11,532,492
Domestic Economic Spending	Not Applicable. Already in financial value		37,473,755

Table (6) illustrates the financial proxies used to compute the environmental and social value created by the project. This conversion allowed for a more comprehensive assessment of the project's overall value creation, capturing both the economic value as well as environmental and social values. The integrated value based on our calculation stood at US$2.4 billion with an initial investment of US$360 million.

5.6.2 Case Study 2: Solar Energy Project in India

We presented a second case study based on the findings from a solar energy project in India. This project has contributed to the diversification of India's energy mix by increasing renewable energy capacity and facilitating progress toward the country's clean energy goals. India is actively promoting the adoption of renewable energy sources to advance its objectives of achieving sustainable, long-term economic growth. Solar energy is recognized for its security, reliability, and sustainability as a source of electricity, which is expected to enhance India's energy security and reduce its dependency on fossil fuels.

Table 7:
Project information for a Solar Energy Project in India.

Project Type	Project Year	Project Life	Committed Amount (US$ Million)	Project Cost (US$ Million)	Total Value Created (US$ Million)	IROI
Solar	2014	25	100	265	1,815	6.85

We computed the IROI of this project and reached to an integrated return of $6.85 for every $1 of investment.

Table 8:
Reported Metrics and Captured Outcome of Solar Energy Project in India.

Reported Metrics	Values Reported	Pillar	Topic	Outcome Measured
Annual GHG emissions reduced/avoided - tCO2 – e. p.a	380,000	Environmental	GHG Emissions	The benefit of GHG Emission Reduction
Annual renewable energy generation - Wind - MWh	520,000	Environmental	Energy Generation	Energy Production Savings - Wind
Number of jobs created/supported during construction - Count	300	Social	Employment	Increase Employment Opportunities (Temporary)
Number of jobs created/supported - Count	35	Social	Employment	Increased Employment Opportunities (Permanent)
Annual domestic spending (during construction)	- $31,000,000	Economic	Incremental Revenue	Domestic Economic Spending

We reported six value drivers from three EES pillars for this project in Table (8). The environmental value drivers came from the renewable energy generation and benefits from the reduced GHG emissions. The social value drivers came from the increased employment for both temporary and permanent workforce. Lastly, the economic value drivers were reported directly by the issuer such as increased revenue to the government and domestic economy.

Table (9) presents how we computed the monetary value for each of the six value drivers. The integrated value stood at US$ 1.815 billion with an initial investment of US$265 million. The majority part of the value came from the environmental value at US$ 1.6 billion (about 88% of the integrated value creation). In sum, this project generated three types of values from the EES pillars.

Table 9:
Financial Proxies Used in Calculation of IROI for Wind Energy Project in India.

Outcome Measured	Outcome Metrics	Financial Proxy	Total Value Created (US$)
Energy Production Savings - Solar	Annual Renewable Energy Generation (MWh)	1. LCOE of Coal Energy from India, US$91 per MWh (2020) 2. LCOE of Wind Energy from India, US$55.1 per MWh (2018), US$44.7 per MWh (2019), US$44 per MWh (2020)	852,283,286
The benefit of GHG Emission Reduction	Annual GHG emissions reduced/ avoided (tCO2)	Social Cost of Carbon from India, US$86 per tonne (2020)	1,050,324,227
Increase Employment Opportunities (Temporary)	Number of jobs created/supported (Count)	1. Hourly Earnings of Employees from India, INR$59 per hour (2018), INR$62 per hour (2019), INR$65 per hour (2020), INR$68 per hour (2021) 2. Number of Hours Worked per Employed Person from India, 50.03 hours per week (2018), 50 hours per week (2019), 48.61 hours per week (2020), 47.69 hours per week (2021)	5,003,529
Increase Employment Opportunities (Permanent)	Number of jobs created/supported (Count)	1. Hourly Earnings of Employees from India, INR$59 per hour (2018), INR$62 per hour (2019), INR$65 per hour (2020), INR$68 per hour (2021) 2. Number of Hours Worked per Employed Person from India, 50.03 hours per week (2018), 50 hours per week (2019), 48.61 hours per week (2020), 47.69 hours per week (2021)	14,420,155
Total Contribution to Government Revenue	Not Required. Already in financial value		81,702,124
Domestic Economic Spending	Not Required. Already in financial value		110,952,492

Part 6

Conclusions

An effective energy transition requires scaling up the quantity of capital being allocated to transition projects, and doing so with an accelerated level of effort.

We identify how additional EES value drivers can be factored in to investment decisions to support more efficient energy transition investment decisions in Asia.

Key takeaways:

- Our results revealed significant value creation from the projects especially from the environmental pillar.
- An integrated return on investment (IROI) framework is developed that aligns with multilateral development banks (MDBs) while also being relevant to corporates, where there remains a need for more consistent monitoring, reporting and evaluation of energy transition project impacts.
- Although the focus of our analysis is upon Asia, the framework is directly generalizable to any geographic context.

Conclusions

In this paper, we have presented the integrated value assessment for hundreds of energy transition projects funded by green bonds and sustainable bonds issued by MDBs and corporates. Our results revealed significant value creation from the projects especially from the environmental value. Such results are very different from the prevailing partial understanding that the transition projects are usually expensive to invest and have little financial returns or generated very low financial returns in the long run. This is because that the existing financial market has yet to fully compensate the investors with the environmental and social value created.

MDBs are in the lead to generate social value whereas the impact data disclosed by corporates only focused on the environmental ones. Such disclosures from MDBs helped greatly for us to understand better the additional social value created from the energy transition projects. For some developing Asian countries, MDBs were the only big investors for such projects and our results could be used to provide a more holistic evaluation of such projects. Our results also revealed that the corporate sector generated significant environmental value in more developed Asian countries.

From our findings, government agencies and private investors from these countries could identify the additional value drivers to have a more efficient and complete investment decision. We see the big potential from the blended financing as there is significant gap in the credit spreads from the MDBs and those from the corporates.

We also recognize the fact that many energy transition projects were also financed by other forms of capitals from MDBs and financial institutions besides green bonds. We hope that this research can help to advance further data cleaning and consolidation for us to understand the value created by other types of financing going forward. We at SGFIN are very encouraged by the constructive feedback from the industry partners for improvement of our research methodology and the data coverage. We hope that our research agenda in this field would continue to help to inform various stakeholders including public and private sectors to make better investment and financing decisions.

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Appendix

This appendix provides supplementary information for the IROI evaluation framework that was used in this Whitepaper.

Contents:

- **Economic pillar:** Table of pillar specific valuation metrics; table of pillar specific financial proxy measures.
- **Environmental pillar:** Table of pillar specific valuation metrics; table of pillar specific financial proxy measures.
- **Social pillar:** Table of pillar specific valuation metrics; table of pillar specific financial proxy measures.

Economic Pillar

Appendix Table A1:
Economic pillar valuation metrics overview.

Economic pillar valuation metrics overview			
Value Driver	**Description Outcome Metrics**	**Outcome Metrics**	**Financial Valuation of Metrics**
Improved Efficiency	Households Expenditure Reduced	Number of households provided access	Reduction in household expenditure ($)
Improved Efficiency	Private Opportunity Cost Avoided	Reduction in time spent on activities (hrs/yr)	Hourly Earnings of Employees - Total ($/hr)
Improved Efficiency	Value of Time	"Time saved from travel (hr) Annual Ridership (Count) "	Hourly Earnings of Employees - Total ($/hr)
Incremental Revenue	Improved Agricultural Income	Number of farmers benefitting from increase in agricultural income due to contract farming (Count)	Average income of small scale food producers ($)
Incremental Revenue	Spending	Domestic spending during construction ($)	Not Required. Already in financial value
Incremental Revenue	Spending	Domestic spending during ($)	Not Required. Already in financial value
Incremental Revenue	Total Contribution to Government Revenue	Total Contribution to Government Revenue ($)	Not Required. Already in financial value
Project Savings	Project Savings	Project Savings ($)	Not Required. Already in financial value
Transport Capacity	Increased Goods Transportation	Increase in volume of containers (No. of TEU)	Goods Transportation Capacity Value ($/TEU)
Transport Capacity	Value of Increased Efficiency of Freight Service	Increase in Annual Freight Handling Capacity (Tonnes)	GDP Growth Due to Increased Freight Capacity ($/Tonne)
End of economic pillar valuation metrics overview.			

The table provides a breakdown of the value drivers and their respective financial proxy formulas for various economic metrics. These financial proxy formulas provide a systematic way to assess the financial impact of the reported outcomes in each economic metric, aiding in the evaluation of their economic significance and potential benefits.

The financial proxies used in this report are adapted from the following sources:

Appendix Table A2:
Financial proxies for economic pillar valuation metrics.

Financial proxies for economic pillar valuation metrics				
Financial Proxies	**Country, Year of Reference**	**Source (Year of Publication)**	**Reference Report**	**Reference Link**
Goods Transportation Capacity Value	Global (2022)	Port Economics, Management and Policy (2020)	Value of Containerized Trade (new)	Click to link to report
Hourly Earnings of Employees - Total	Multiple (2011-2022)	International Labour Organization	Average hourly earnings of employees by sex and occupation	Click to link to report
Hourly Earnings of Employees - Total	India (2016-2022)	Labour Bureau, Government of India	Occupation Wages	Click to link to report
Hourly Earnings of Employees - Total	China (2010-2021)	National Bureau of Statistic of China	4.13 Average wage of employed persons in Urban Private Units by Sector	Click to link to report

Continuation of Table A2

Financial Proxies	Country, Year of Reference	Source (Year of Publication)	Reference Report	Reference Link
Average Income of Small-scale Food Producers	Multiple (2010-2021)	Our World In Data	Average income of small-scale food producers	Click to link to report
GDP Growth Due to Increased Freight Capacity	China (2006)	Economic Review (in Chinese) (2006)	The impact assessment of regional supply chain activities on local economic growth	Click to link to report
End of financial proxies for economic pillar valuation metrics				

Environmental Pillar

Appendix Table A3:
Environmental pillar valuation metrics overview.

Environmental pillar valuation metrics overview			
Value Driver	**Description Outcome Metrics**	**Outcome Metrics**	**Financial Valuation of Metrics**
Built Environment	Benefit of Green Spaces	Area of Green Spaces Added (Ha)	Urban Green Spaces Value ($/Ha)
Clean Vehicles	Cost of Switching to Electric Buses	Number of electric buses deployed	Total Ownership Cost Difference between Diesel and Electric Buses ($)
Clean Vehicles	Cost of Switching to Electric Trains	Number of electric buses deployed	Total Ownership Cost Difference between Diesel and Electric Trains ($)
Clean Vehicles	Electrical Vehicle Usage	Number of Electric Bikes/ Tricycles Deployed (Count)	WTP for Electrical Bikes ($)
Coal Use Reduction Price of Hard Coal ($/ tonne)	Reduced Spendings on Coal	Annual reduction from EE	RE projects (tce)
Energy Consumption	Savings From Reduced Energy Consumption	Annual Electricity Savings (MWh)	Cost of Electricity ($/MWh)
Energy Generation	Energy Production Savings - Biomass	Annual Renewable Energy Generation (MWh)	"LCOE of Coal Energy ($/MWh) LCOE of Bioenergy ($/MWh)"
Energy Generation	Energy Production Savings - Biomass	Annual amount of biogas produced - m3	"LCOE of Coal Energy ($/MWh) LCOE of Bioenergy ($/MWh)"
Energy Generation	Energy Production Savings - Geothermal	Annual Renewable Energy Generation (MWh)	"LCOE of Coal Energy ($/MWh) LCOE of Geothermal Energy ($/MWh)"
Energy Generation	Energy Production Savings - Hydropower	Annual Renewable Energy Generation (MWh)	"LCOE of Coal Energy ($/MWh) LCOE of Hydropower Energy ($/MWh)"
Energy Generation	Energy Production Savings - Solar	Annual Renewable Energy Generation (MWh)	"LCOE of Coal Energy ($/MWh) LCOE of Solar Energy ($/MWh)"
Energy Generation	Energy Production Savings - Wind	Annual Renewable Energy Generation (MWh)	"LCOE of Coal Energy ($/MWh) LCOE of Wind Energy ($/MWh)"
Energy Generation	Increased Income from Increase Power Supply	Annual increase in power supply from the grid (MWh)	Cost of Electricity ($/MWh)
Energy Generation	Increased Income from Increase Transmission Efficiency	Increase efficiency of transmission and distribution network (MWh)	Cost of Electricity ($/MWh)
Energy Storage	Energy Storage	Installed capacity of battery storage systems (MW)	Cost Savings of Battery Storage System ($/kW)
Environmental Protection	Improved flood protection	Area of field protected against floods (Ha)	Flood Protection Value ($/Ha)
Fuel Consumption	Savings from Reduced Fuel Consumption	Estimated reduction in fuel consumption (litres)	Pump Price for Gasoline ($/litres)
GHG Emissions	Benefit of GHG Emission Reduction	Annual GHG emissions reduced/ avoided (tCO2)	Social Cost of Carbon ($/tCO2)
GHG Emissions	Benefit of NOx Pollutants Reduction	Reduction of pollutants: NOx (Tonnes)	Benefit of reduced NOx ($/tonnes)
GHG Emissions	Benefit of Particulate Matter (PM2.5 &10) Pollutants Reduction	Reduction of pollutants: Particulate matter (PM 2.5 & PM 10) (Tonnes)	Benefit of reduced Particulate Matter ($/tonnes)
GHG Emissions	Benefit of SOx Pollutants Reduction	Reduction of pollutants: SOx (Tonnes)	Benefit of reduced SOx ($/tonnes)
Water Consumption	Value of Water Conservation	Amount of Water Conserved (m3)	Total Charge for Water Consumption ($/m3)
End of environmental pillar valuation metrics overview.			

Environmental metrics play a pivotal role in evaluating and monitoring the sustainability and environmental impact of various aspects of our modern world. These metrics collectively help us understand and mitigate the environmental impact of our actions and drive sustainability efforts in various sectors.

The financial proxies used in this report are adapted from the following sources:

Appendix Table A4:
Financial proxies for environmental pillar valuation metrics.

Financial proxies for environmental pillar valuation metrics				
Financial Proxies	**Country, Year of Reference**	**Source (Year of Publication)**	**Reference Report**	**Reference Link**
Cost of Electricity	Indonesia (2012 – 2021)	Perusahaan Listrik Negara	Average cost of electricity in Indonesia from 2012 to 2021	Click to link to report
Cost of Electricity	Singapore (2013-2022)	Energy Market Authority (Singapore)	Average inflation-adjusted electricity tariffs in Singapore from 2013 to 2022	Click to link to report
Cost of Electricity	Vietnam (2010 – 2021)	VinaCapital; Ministry of Industry and Trade (Vietnam)	Average electricity retail price in Vietnam from 2010 to 2021	Click to link to report
Cost of Electricity	China (2020-2022)	Global Petrol Prices (GPP)	Average household electricity prices in China from September 2020 to September 2022 (in U.S. dollar cents per kilowatt-hour)	Click to link to report
Cost of Electricity	India (2009 – 2020)	CERC (India); PFC	Average cost of state electricity supply in India from financial year 2009 to 2020	Click to link to report
Cost Savings of Battery Storage System	United States (2020)	Mahani et al (2022)	The Value of Storage in Electricity Generation: A Qualitative and Quantitative Review	Click to link to report
Flood Protection Value	India (2020)	World Resources Institute (2020)	RELEASE: New Data Shows Millions of People, Trillions in Property at Risk from Flooding — But Infrastructure Investments Now Can Significantly Lower Flood Risk	Click to link to report
Flood Protection Value	China (2021)	World Resources Institute	Accelerating Climate-resilient Infrastructure Investment in China	Click to link to report
LCOE of Solar Energy	Multiple (2010 – 2019)	International Renewable Energy Agency (IRENA)	Renewable Power Generation Costs in 2021	Click to link to report
LCOE of Solar Energy	Multiple (2020)	International Energy Agency (IEA)	Projected Costs of Generating Electricity 2020	Click to link to report
LCOE of Coal Energy	Multiple (2020)	International Energy Agency (IEA) (2020)	Projected Costs of Generating Electricity 2020	Click to link to report
LCOE of Coal Energy	Multiple (2010, 2015)	International Energy Agency (IEA)	Projected Costs of Generating Electricity - 2015	Click to link to report
LCOE of Hydropower Energy	Multiple (2010 – 2019)	International Renewable Energy Agency (IRENA)	Renewable Power Generation Costs in 2021	Click to link to report
LCOE of Geothermal Energy	Global (2010 – 2019)	International Renewable Energy Agency (IRENA)	Renewable Power Generation Costs in 2021	Click to link to report
LCOE of Bioenergy	Multiple (2000 – 2019)	International Renewable Energy Agency (IRENA)	Renewable Power Generation Costs in 2021	Click to link to report

Continuation of Table ??

Financial Proxies	Country, Year of Reference	Source (Year of Publication)	Reference Report	Reference Link
LCOE of Wind Energy	Multiple (2010 – 2019)	International Renewable Energy Agency (IRENA)	Renewable Power Generation Costs in 2021	Click to link to report
LCOE of WTE	United States (2013)	U.S. Department of Energy (2019)	Waste-to-Energy from Municipal Solid Waste	Click to link to report
Pump Price for Gasoline	Multiple	The World Bank Database	Pump price for gasoline (US$ per liter)	Click to link to report
Price of Hard Coal	Multiple (2019)	International Energy Agency (IEA)	Projected Cost of Generating Electricity 2020	Click to link to report
Reduction of pollutants: SOx	United States (2016, 2020)	United States Environmental Protection Agency (2018)	Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors	Click to link to report
Reduction of pollutants: SOx	China (2017)	Shell International and The Development Research Center (2017)	China's Gas Development Strategies (Chapter 4)	Click to link to report
Reduction of pollutants: NOx	United States (2016, 2020)	United States Environmental Protection Agency (2018)	Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors	Click to link to report
Reduction of pollutants: NOx	China (2017)	Shell International and The Development Research Center (2017)	China's Gas Development Strategies (Chapter 4)	Click to link to report
Reduction of pollutants: Particulate matter (PM 2.5 & PM 10)	United States (2016, 2020)	United States Environmental Protection Agency (2018)	Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors	Click to link to report
Social Cost of Carbon	United States (2020 – 2050)	United States Government (2021)	Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide	Click to link to report
Social Cost of Carbon	Multiple (2020)	Katerine Ricke (2018)	Country-level Social Cost of Carbon	Click to link to report
WTP for Electric Bikes	Macau (2015)	Energy Policy 127 (2018)	Exploring the determinants of consumers' WTB and WTP for electric motorcycles using CVM method in Macau	Click to link to report
Total Ownership Cost Difference between Diesel and Electric Buses	India (2018)	Anal Sheth (2018)	Life Cycle Cost Analysis for Electric vs Diesel Bus Transit in an Indian Scenario	Click to link to report
Total Ownership Cost Difference between Diesel and Electric Buses	United States (2019)	Peter Maloney (2019)	Electric buses for mass transit seen as cost effective	Click to link to report
Total Ownership Cost Difference between Diesel and Electric Buses	Global (2018)	Bloombeg New Energy Finance (2018)	Electric Buses in Cities - Driving Towards Cleaner Air and Lower CO2	Click to link to report
Total Ownership Cost Difference between Diesel and Electric Trains	United States (2021)	Natalie D. Popovich (2021)	Economic, environmental and grid-resilience benefits of converting diesel trains to battery-electric	Click to link to report
Total Charge for Water Consumption	Multiple (2022)	International Statistics for Water Services (2022)	Total Charges for Capitals for a consumption of 100m3	Click to link to report
Urban Green Spaces Value	China (2018)	Resources, Conservation & Recycling 162 (2020)	Uncovering the willingness-to-pay for urban green space conservation: A survey of the capital area in China	Click to link to report

Continuation of Table **??**

Financial Proxies	Country, Year of Reference	Source (Year of Publication)	Reference Report	Reference Link
Urban Green Spaces Value	Korea (2017)	Journal of Destination Marketing & Management (2021)	Estimating the economic value of urban forest parks: Focusing on restorative experiences and environmental concerns	Click to link to report
End of financial proxies for environmental pillar valuation metrics				

Social Pillar

Appendix Table A5:
Social pillar valuation metrics overview.

Social pillar valuation metrics overview			
Value Driver	**Description Outcome Metrics**	**Outcome Metrics**	**Financial Valuation of Metrics**
Access to Heating	Access to centralized heating	Number of people provided with access to heating services (Count)	WTP for centralized heating ($/person)
Development and Training	Improved Productivity of Employees	Number of staff trained to support project	Output per worker ($ / year)
Development and Training	Increased Knowledge	Number of people who benefited from training programs	Cost of basic skills programmes
Employment	Increase Employment Opportunities (Temporary)	Number of jobs created/supported (Count)	"Hourly Earnings of Employees - Total ($/hr) Number of Hours Worked per Employed Person (hr/ week)"
Employment	Increased Employment Opportunities (Permanent)	Number of jobs created/supported (Count)	"Hourly Earnings of Employees - Total ($/hr) Number of Hours Worked per Employed Person (hr/ week)"
Power and Energy Access	Benefits of Energy and Power Access	Number of people provided access to energy and power	WTP for access to energy ($)
Power and Energy Access	Benefits of Energy and Power Access	Number of household provided access to energy and power	WTP for access to energy ($)
Power Reliability	Improved reliability of power	Reduction in Power Outage in a year (Days)	WTP to Avoid Power Outage
Power Reliability	Increase Reliability of Power	Number of beneficiaries (count)	Total Outage Cost Due to Load Shedding ($/yr)
Road Safety	Reduced Road Fatalities	Number of road fatalities reduced	Cost of Fatality ($)
Transport Availability	Perceived Benefit of Public Transport	Public Transport Ridership Increased (Annual) (Count)	WTP for public transport ($/ride)
Transport Availability	Value of Non-Motorized Transport	Number of Non-Motorized Trips Taken (Count)	Social Value Per Non-Motorized Trips ($/15mins)
Waste Collection and Treatment	Benefit of Improved Municipal Waste Collection and Treatment	Amount of municipal waste that is separated/collected and treated annually (Tonnes)	Value of Urban Waste Treatment ($/ Tonnes)
Water Supply Access	Benefit of Water Supply Access	Number of household with access to water supply systems	WTP for access to water supply ($/household)
End of social pillar valuation metrics overview			

These social metrics encompass a diverse range of indicators that reflect the quality of life and well-being of communities and individuals. These social metrics are vital for gauging the well-being and quality of life within communities, guiding policies, and investments to create inclusive and sustainable societies.

The financial proxies used in this report are adapted from the following sources:

Appendix Table A6:
Financial proxies for social pillar valuation metrics.

Financial proxies for social pillar valuation metrics				
Financial Proxies	**Country, Year of Reference**	**Source (Year of Publication)**	**Reference Report**	**Reference Link**
Cost of Basic Skills Program Click to link to report	Global (2005)	Global Campaign for Education	Action Aid (2005)	Global benchmarks for adult literacy
Hourly Earnings of Employees - Total	Multiple (2011 - 2022)	International Labour Organization	Average hourly earnings of employees by sex and occupation	Click to link to report
Hourly Earnings of Employees - Total	India (2016 – 2022)	Labour Bureau, Government of India	Occupation Wages	Click to link to report
Hourly Earnings of Employees - Total	China 2010 – 2021)	National Bureau of Statistics of China	4.13 Average wage of employed persons in Urban Private Units by Sector	Click to link to report
Number of Hours Worked per Employed Person	Multiple (2011 - 2022)	International Labour Organization	Mean weekly hours actually worked per employed person by sex and economic activity	Click to link to report
Output per Worker	Multiple (2011 - 2022)	International Labour Organization	Output per worker (GDP constant 2017 international $ at PPP)	Click to link to report
Total Outage Cost Due to Load Shedding	Pakistan (2012)	Hafiz A. Pasha and Wasim Saleem (2013)	The Impact and Cost of Power Load Shedding to Domestic Consumers	Click to link to report
Urban Waste Treatment Value	China (2015)	National Academy of Development and Strategy, RUC (2017)	Social cost assessment report of biomass/household waste incineration in Beijing (in Chinese)	Click to link to report
Urban Waste Treatment Value	China (2022)	Chengdu Development and Reform Commission (2022)	Standards for urban waste treatment cost (in Chinese)	Click to link to report
Urban Waste Treatment Value	Japan (2020)	Sapporo Environmental Bureau Environmental Planning & Waste Management Department (2023)	Waste disposal costs (financial fiscal 2020, FY2021 budget)	Click to link to report
WTP for Access to Energy	India (2015 – 2018)	Council on Energy, Environment and Water	Access to Clean Cooking Energy and Electricity	Click to link to report
WTP for Access to Energy	China (2007)	Yu Tang, Prof. Massimo Filippini and Dr. Mehdi Farsi (2010)	Willingness to Pay for Renewable Energy in China: A Case Study of Chongqing City	Click to link to report
WTP for Access to Water Supply	Bangladesh (2009)	Herath Gunatilake, Masayuki Tachiiri (2012)	Willingness to Pay and Inclusive Tariff Designs for Improved Water Supply Services in Khulna, Bangladesh	Click to link to report
WTP for Access to Water Supply	Bangladesh (2019)	Md. Karimul Islam, Rabbani Akter and Mohammed Ziaul Haider (2022)	Willingness to pay for improved water supply service in coastal urban settings: evidence from Khulna, Bangladesh	Click to link to report
WTP for Access to Water Supply	China (2016)	JiaWang , Jiaoju Ge, and Zhifeng Gao (2018)	Consumers' Preferences and Derived Willingness-to-Pay for Water Supply Safety Improvement: The Analysis of Pricing and Incentive Strategies	Click to link to report
WTP for Access to Water Supply	China (2011)	Jin Jianjun, Wang Wenyu, Fan Ying and Wang Xiaomin (2016)	Measuring the willingness to pay for drinking water quality improvements: results of a contingent valuation survey in Songzi, China	Click to link to report

Continuation of Table A6

Financial Proxies	Country, Year of Reference	Source (Year of Publication)	Reference Report	Reference Link
WTP for Access to Water Supply	Kazakhstan (2012)	Kamshat Tussupova (2015)	Investigating Willingness to Pay to Improve Water Supply Services - Application of Contingent Valuation Method	Click to link to report
WTP for Access to Water Supply	Pakistan (2018)	Sana AKHTAR*, Sarah DEAN, Faiza ANJUM and Maryam JAVED (2018)	Determination of Willingness to Pay for Improved Water Supply in Selected Areas of Lahore	Click to link to report
WTP for Access to Water Supply	South Korea (2010)	So-Yoon Kwak (2013)	"Measuring the Willingness to Pay for Tap Water Quality Improvements: Results of a Contingent Valuation Survey in Pusan"	Click to link to report
WTP for Access to Water Supply	South Korea (2018)	Taehyeon Kim, Jihoon Shin (2021)	Willingness to Pay for Improved Water Supply Services Based on Asset Management: A Contingent Valuation Study in South Korea	Click to link to report
WTP for Access to Water Supply	United States (2016)	Chiradip Chatterjee (2017)	Willingness to Pay for Safe Drinking Water - A Contingent Valuation Study in Jacksonville, FL	Click to link to report
WTP for Access to Water Supply	Vietnam (2019)	Bui, N.T.; Darby, S.; Vu, T.Q.; Mercado, J.M.R.; Bui, T.T.P.; Kantamaneni, K.; Nguyen, T.T.H.; Truong, T.N.; Hoang, H.T.; Bui, D.D. (2022)	Willingness to Pay for Improved Urban Domestic Water Supply System: The Case of Hanoi, Vietnam	Click to link to report
WTP to Avoid Power Outage	India (2021)	Bigerna, Simona and Choudhary, Piyush and Kumar Jain, Nikunj and Micheli, Silvia and Polinori, Paolo (2022)	Avoiding unanticipated power outages: Households' willingness to pay in India	Click to link to report
Cost of Fatality	Global (2000)	L. Blincoe, A. Seay, E. Zaloshnja, T..Miller, E. Romano, S.Luchter, R.Spicer (2002)	The Economic Impact of Motor Vehicle Crashes, 2000	Click to link to report
Cost of Fatality	Multiple (2008)	Joanne Leung, Financial and Economic Analysis Team, Ministry of Transport New Zealand (2009)	Understanding Transport Costs and Charges - VOSL	Click to link to report
Social Value Per Non-Motorized Trips	USA (2000)	BIAN Yu and Lü Hongfang (2011)	Interpretation of the National Fitness Program of the United States and its inspirations to China	Click to link to report
WTP for Public Transport	Malaysia (2015)	Aldukali Salem I. Almselati, Riza Atiq bin O.K. Rahmat, Othman Jaafar, Hussin A.M. Yahia (2015)	Using spike model to reduce traffic congestion and improve public transportation in Malaysia	Click to link to report

End of financial proxies for social pillar valuation metrics

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