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Case Report

Scaling up Renewable Energy Assets: Issuing Green Bond via Structured Public-Private Collaboration for Managing Risk in an Emerging Economy

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Abstract: Green bonds have increasingly been utilized around the world as a source of financing for renewable energy development, designed with compliance requirements and measurable economic returns to investors, while mitigating climate change. However, the efficacy of green bond arranged in the emerging economies for financing renewable energy assets and how the underlying risks are managed have remained to be explored. The paper aims to examine the evolving green financial system sponsored by both public and private institutions in managing such risks within China's emerging economy. A case study of green financing for a bundle of wind power assets led by a state-owned enterprise (SOE) reveals an alternative approach by structuring public–private collaboration while stipulating market-based financial incentives to institutional stakeholders under a political economy. This institutional consortium is composed of a state development bank, a commercial bank, credit rating agencies, institutional and private investors, regional power purchasers, and carbon trading entities. Financial stakeholders' risk in such emerging sustainable investment is moderated by these participating institutions and structured "upsides" from carbon trading aligned with the framework of green finance and standards for green bond development. The results reveal the potentials of scaling up the development of renewable energy by adequately managing and sharing key risks, while allocating substantial funding into renewable energy projects under such a green financial system that is to be complementary with a scalable post COVID-19 economic recovery.

Keywords: renewable energy; wind power; green bond; China; climate change; public–private collaboration; risk management

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1. Introduction

1.1. Challenges in Scaling up Renewable Energy Assets

As the second largest economy in the world, China seeks to reduce greenhouse gas (GHG) emissions due to ongoing concerns over climate change. Similar to other sizable economies, China has taken noticeable efforts to transform its existing energy infrastructure into renewable and sustainable energy assets on a large scale [1,2]. Developing renewable energy is considered to be a strategic area of focus for China as an emerging economy to meet its future energy demands while reducing greenhouse gas emissions that provoke climate change. To make significant progress, the Chinese government seeks to scale up such strategic development in the country by intensifying efforts aimed at favorable regulatory policies that stimulate investment in large-scale renewable energy power generation projects. It is envisaged there will be a substantial increase in installed onshore wind capacity to 500 GW by 2030 and an additional 60 GW capacity in offshore wind, whereas solar PV capacity is expected to reach a total installed capacity of 308 GW by 2030 in China [3]. However, obtaining finance for such a substantial energy transition for a major

economy could be a considerable barrier to scalable adoption over time. This challenge and related risks are comparable to that experienced by other developing economies, such as India, which have developed a complementary "national renewable finance framework" that embraces a set of financial instruments for renewable energy development [4].

Unlike other traditional infrastructure investments, renewable energy projects that involve certain emerging technologies were yet to be fully proven in terms of power generation efficiency [5]. A higher financial risk might be perceived to be associated with such types of equipment in the past. Only limited source of funding might be available for renewable energy ventures in the early stages of technological development [6]. As pertinent technologies become mature and operations predictable, more funding types will be relevant and therefore available for project financing and investing. The concept of green bond being defined largely as long-term financing for green and sustainable projects through an acquisition or a new development has emerged [7]. The use of green bond as a means for long-term financing is gradually considered a viable financial instrument for financing renewable energy projects in the developing countries as a means to mitigating the underlying risks) [7].

More recently, the international capital market has realized sustainability as a criterion in its investment decision-making processes. However, such developments towards sustainable financing and investment need to be supported by complementary regulatory measures and environmental standards that stimulate technological innovation of sustainability measures within an industry [8]. The ongoing development of a green financial system in China, complemented by its emergence as a global financial center, suggests an important trend that promotes greater investments into green and sustainable energy developments [8]. The experience of China in tackling such developmental challenges towards sustainability in a large scale by deploying green financing mechanism would be a relevant lesson for other developing economies that are seeking a sustainable development model for post-COVID-19 economic recovery.

1.2. Impetus in Developing and Financing Wind Power under China's Market Socialism

Among various types of renewable energy sources, wind energy has been identified as one of the most widely adopted renewable energy sources in China. The country as a leading one in terms of wind energy installation capacity is arguably driven by its determined supportive policies for the wind turbine equipment suppliers and developers [9]. Specifically, its domestic wind power industry has significantly grown and developed into a global leader. The development of China's wind power industry is affected by a number of factors, including the demand for renewable energy generation, power generation costs, wind power distribution, clustering of wind turbine manufacturers, and policy incentives granted to the wind power industry [10]. However, sustainability of the wind power industry might be challenged by the future integration of wind power into the overall power system on a large scale and in a pragmatic manner [11]. The availability of comparable domestic green financing at economies of scale though the capital market would determine whether the wind power industry can further grow and develop to provide a significant share of China's sustainable energy mix of 30–40% from renewable energy sources by 2030 as planned. On one hand, China's system is considered as a political economic system of "market socialism with Chinese characteristics and dominance of state-owned enterprises (SOEs) that may yet be fully aligned for market-based financing" [12]. On the other hand, the domestic capital market is considered critical for nourishing the development of renewable energy in the country [13]. In particular, there have been regulatory concerns related to green bonds issued in China that could deviate from those regulated under the international standards [14]. A national policy is considered particularly crucial to facilitating the development of a country's green bond market [15]. Although recent studies suggest that green bond could be a positive potential source for climate finance among the developing countries [16,17], how green bond financing is implemented for the

development of renewable energy, particularly under the political economy of China and how such risks are managed, have not been explored with depth.

Against such queries, this study has an objective to review the ongoing development of the green financing system and related policies within China with a focus on green bond as a financial instrument for developing its domestic wind power projects and pertinent risk management approach. The issuance of domestic green bonds has been used to raise capital for financing and investing in renewable energy projects, including solar, wind, and hydropower generation. A main purpose of this study is to unveil the underlying policy and practice of issuing green bonds in China in light of comparable development in the international capital market. This is complemented by a case study on how green bond is structured and issued by a SOE for financing a portfolio of wind power projects while managing the risks involved. This study as a whole contributes to the existing body of knowledge by revealing a distinct practice in structuring public-private collaboration in green bond issuance that effectually contains risks in financing and investing in renewable energy projects within an emerging economy. The implications of green bond to other emerging economies as a financial instrument for financing large-scale renewable energy projects with respect to risk management are articulated.

2. Materials and Methods

2.1. Policy and Practice Review

2.1.1. Green Bond Development for Global Sustainability

The world is expected to continue experiencing extreme weather events caused by climate change that will cause adverse impacts to ecosystems and human health resulting from heat waves, heavy rain, drought, wildfires, and coastal flooding. According to a report by the Intergovernmental Panel on Climate Change, it is envisaged that "climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5 °C and increase further with 2 °C" [18]. The Joint Report on Multilateral Development Banks Climate Finance indicates that overall climate finance commitments totaled USD 194 billion during the period of 2011–2017 in the emerging economies [19]. Institutional investors participating in international financial markets have perceived this to be a long-term investment opportunity for addressing climate change concerns [20,21]. For example, the issuance of green bonds as a mechanism of climate finance has been advocated as a significant funding source to finance infrastructure projects for sustainability improvements. The total amount of capital raised in the form of green bonds worldwide has reached USD 167 billion in 2018 alone and is expected to grow further [22].

2.1.2. Green Financing Policy under a Political Economy

Prior studies on political economy point out the significance of the government sector and politics in shaping the development of a financial system over time [23–25]. As deliberated in a prior study [12] (p. 4), "Political Economy refers broadly to the collection of beliefs, practices and laws underlying the creation and evolution of a nation's distribution of good and services, but often is limited to relationship between government, through its decision makers and institutions, and the operation of various markets under its direct or indirect control". More recently, a study unveils the underlying public-private collaboration among the financial policy makers and regulated financial institutions in enhancing the development of the green bond market of Hong Kong as China's global financial center that frequently adopts international standards [8]. Another study suggests that both macroeconomic and institutional factors would stimulate green bond issuance volumes through a local capital market [15].

In response to global concerns over climate change and environmental sustainability, China's political leadership has determined that the reform of ecological civilization should be accelerated, and that green finance should be developed as a new and effective method for promoting and expediting sustainable initiatives [26,27]. The concept of green gover-

nance has also emerged to examine effectiveness of the Chinese firms in environmental management as well as in reducing greenhouse gas pollution emission [28]. A recent study further suggests the growing relevance of green bond for climate finance among the emerging economies [16]. China as an emerging economy has reckoned the significance of developing green finance into the national-level strategy under a centralized economic planning system while complemented by a market-based innovative financing mechanism [29]. As China's economic development progresses into a new era, the development of domestic green financial market is expected to keep in line with international standards to achieve China's sustainable development strategy in the context of globalization [27,30].

2.1.3. China's Emerging Green Financial System

In fact, the Guidelines for Establishing the Green Financial System were promulgated by the People's Bank of China, the Ministry of Finance, and other ministries in 2016 [31]. Initiated with support by the central government, these directives presented a range of policies that shape China's emerging green financial system. Table 1 summarizes the pertinent elements in such a green financial system which systemically consists of green credit, green bonds, green stock index, green insurance, and green funds, etc.

Table 1. Key Components of China's Emerging Green Financial System.

Elements	Products and Services	Policy Tools	Pertinent Stakeholders
Green Credit	Commercial banks providing financing for ecological protection, ecological construction, a low-carbon economy and green industry through a credit mode	In 2012, the China Banking Regulatory Commission (CBRC) issued the Green Credit Guidelines for the key evaluation indicators for the implementation of green credits; and the green credit policies formulated by commercial banks themselves.	Commercial banks, business enterprises
Green Bonds	Corporate bonds issued specifically to support green projects	In 2015, the People's Bank of China (PBOC) issued the "Green Bond Support Project Catalog". In 2015, the National Development and Reform Commission (NDRC) issued the guidelines on the issuance of green bonds.	Commercial banks, state banks,
Green Stock Index	Stock price index for green stock selection among listed companies according to specific criteria	In 2015, the Shanghai Stock Exchange officially released a Carbon Efficiency Index.	Listed companies, individual and institutional investors
Green Funds	Special investment funds established for energy savings and emissions reduction strategies, low-carbon economic development and environmental optimization and transformation projects	In 2015/16, the Ministry of Finance, PBOC and other ministries jointly released the Guidelines for Establishing the Green Financial System.	Local governments, business enterprises, investment funds, private capital

Table 1. *Cont.*

Elements	Products and Services	Policy Tools	Pertinent Stakeholders
Green Insurance	Also known as environmental pollution liability insurance, targeting the risk of enterprise pollution and related accidents caused by damage to third parties in accordance with the law to bear such liability	In 2017, the Ministry of Environmental Protection and the China Insurance Regulatory Commission (CIRC) jointly released the "Guidance on Environmental Pollution Liability Insurance" and the "Guiding Opinions on the Pilot Work of Compulsory Liability Insurance for Environmental Pollution". The administrative measures on compulsory liability insurance for environmental pollution were issued as a draft.	Insurance companies, business enterprises

Source: People's Bank of China (2016); People's Bank of China and UNEP (2015); Securities and Futures Commission (SFC) (2018) [27,31,32].

Under this system, all green financial instruments are expected to serve the needs of and provide financial support for environmental protection projects and green industries [27,30]. For example, the primary market participants in green credit are commercial banks and enterprises, specifically referring to the process by which commercial banks issue loans and extend credit to green industries or for ecological protection, ecological construction, and a series of green environmental protection projects [33]. For green bonds, the primary market participants include financial institutions, business enterprises, and policy-driven banks, primarily through the issuance of bonds to raise funds to support green projects. The participants in the Green Stock Index mainly include individual investors and institutional investors who subscribe to the green shares of listed companies. Green insurance was also developed to address the damage liability of third parties caused by enterprises in the event of pollution accidents.

In response to these measures, the business and financial sectors in China have been gradually developing various products and services as influenced by the central government's proactive green financing policy. In particular, it is observed that there has been noticeable improvement in environmental and social performance among the Chinese banks as realized from various sustainability initiatives [34]. Such sustainability performance is arguably reinforced by the central government's pertinent package of green finance initiatives.

2.1.4. Green Bond Characteristics

Although the green bond market has only emerged in recent years, it has attracted attention in the international green bond market because of its potentials to be deployed in a large scale in alignment with a nation's sustainable development strategy [8]. First, green projects typically involve an extended investment payback period. Securing financial commitments to improving the sustainability of infrastructure projects is one of the key obstacles to scaling up such development. Green bonds exhibit a series of complementary characteristics such as an extended repayment period and relatively low financing costs, which have enabled them to become appropriate financial instruments for green infrastructure projects in recent years. While green bonds promote the focus of investing in long-term environmental protection, the prescribed return period of green bonds is perceived as an extended mitigating measure to climate change [22]. Furthermore, green

bonds are considered as a special type of fund issued by entities that utilized the proceeds to invest in specific green projects, as permitted in an agreement [22,32]. Endowed accounts are established for designated green projects to ensure that the funds raised are used for specific purposes. Green bonds are intended to comply with strict disclosure requirements monitored by a third party or an authorized agent. As such, green bonds are conceived as one of the most effective green financial products in alignment with the quest for global sustainable development [22,31].

Under China's national policy that supports the development of green bonds, the People's Bank of China promulgated an announcement supporting the issuance of green bonds in 2015 [27]. This marked the establishment of a concerted effort by China to develop its green bond market as a key component of its emerging green finance system based on its own range of green bond standards [26].

2.1.5. Knowledge Gap

While some recent studies suggest the relevance of green bond as a source of finance among the emerging economies [16,17], there is arguably a knowledge gap as to its applications within the political economy of China. Exploration of real-life cases would unveil the underlying business and financing model to facilitate issuance of green under such a domestic environment which could be dissimilar to the international practice. The following section discusses the case study approach adopted in examining the particular green bond issuance experience within the country.

2.2. Case Study

As the main objective of this study is to explore the phenomenon of using green bonds as a financing instrument to scale up China's investments in renewable energy, case study method is adopted to investigate green bond issuance experience in the context of the political economy of China [35]. In-depth case studies are frequently utilized in social science research to look into complex phenomena that are distinct in its course of development. Case study is deployed in various situations to explore new knowledge pertinent to individuals, groups, and organizations under particular social and political influences. Such an approach enables the investigators to articulate issues that are connected with holistic characteristics of real-life matters [35,36]. An exploratory case study is considered useful for examining initial research questions as well as developing propositions for further inquiry [35,36]. The underlying issues being examined are relevant to the evolving greening financing system within an emerging economy. Employing an SOE as the green bond issuer as the unit of analysis, a case study is performed to examine the pioneering use of a financing mechanism for renewable energy development and the distinct experience in managing the financial risks via structuring succinctly around the issuance of green bond.

Limitation of the case study method as adopted is recognized as there is no access to internal documentation or interview conducted with the company management; the results of this case study is not expected to be generalizable. In this study, core information and data associated with the selected company are extracted from its annual reports, financial disclosures, public announcements, and external reports associated with its issuance of green bond for financing its wind power projects. Insights are drawn based on an extended qualitative content analysis of the publicly available information and accessible disclosures by the selected company—an SOE, which took an innovative approach by issuing a green bond to finance its portfolio of wind power projects. The interrelationship among the institutions participated in structuring such green bond issuance is to be examined predominantly. In fact, a similar case study approach has been adopted in the past to reveal experience in the development, financing, and management of renewable energy projects [8,37]. This case study can unveil incentive-based policies designed to stimulate investment and reduce transaction costs through collaboration between public and private actors so as to scale up renewables deployment [38].

The case selected for this study is the China General Nuclear Power Group (CGNPG), a large-scale clean energy enterprise governed by the State-owned Assets Supervision and Administration Commission of the State Council. Being dedicated to the business of nuclear power production, engineering construction, technology research and development, and nuclear fuel supply security systems, CGNPG has a portfolio of clean energy facilities composed of wind power, hydropower, solar energy, and energy conservation industries [39]. The CGNPG operates 10 nuclear power plants with a total installed capacity of 10.5 million kilowatts, comprising 62% of the total installed nuclear power in China. In particular, these plants include Daya Bay Nuclear Power Station No. 1 and No. 2, Ling'ao Nuclear Power Plant Units 1 and 2 in Phase I and Units 1 and 2 in Phase II, Units 1 and 2 of the Ningde Nuclear Power Plant, Unit 1 of the Hongyanhe Nuclear Power Station, and Unit 1 of the Yangjiang Nuclear Power Plant. Fourteen other units are under construction, with a total installed capacity of 16.62 million kilowatts, comprising 52% of the total installed nuclear power in mainland China [39]. CGNPG's pioneering experience in successfully issuing green bond for its portfolio of wind power facilities from the domestic capital market in scale is the rationale for being selected as the case in this study [39,40].

3. Results

3.1. Pioneering Public-Private Initiative

In 2014, the CGNPG successfully issued its first green-carbon bond in the amount of 1 billion yuan with a 5-year term (China Emission Exchange, 2018; CGNPG, 2018) [39,40]. As this is considered the first green bond in China that includes carbon trading features, the success of the CGNPG in issuing this green bond is complementary to the relatively more mature national debt and corporate bond issuance mechanism, in light of the rapid development of the domestic capital market. Indeed, the CGNPG began participating in the Clean Development Mechanism (CDM) carbon market as early as 2007. Back in 2012, a wholly owned subsidiary of the CGNPG was established—CGNPG Carbon Asset Management Co., Ltd.—which was further developed into China's carbon trading market. Participating in the CDM allows the CGNPG's emission-reduction projects to earn Certified Emission Reduction (CER) credits, one of which is equivalent to approximately one ton of carbon dioxide. As such, the CGNPG is able to trade its CERs as utilized by various industrialized nations to meet their emission reduction targets as stipulated by the regulator.

3.2. Structured Financial Arrangement

Green bond issuance of this type is structured to fill the gap in direct financing needs for domestic carbon assets as China promotes the development of its domestic carbon trading market, such as the Shenzhen Emission Rights Exchange. The CGNPG launched this bond on the basis of asset-backed securities linked to carbon asset income. China-Guangzhou Nuclear Wind Power Co., Ltd. (CGNWP), a subsidiary of the CGNPG, is utilized as the vehicle to issue the green bond through public offerings. Detailed relationship among the key public and private institutions involved in structuring this green bond issuance is illustrated in Figure 1. The key parties and terms of this green bond instrument are summarized in Table 2.

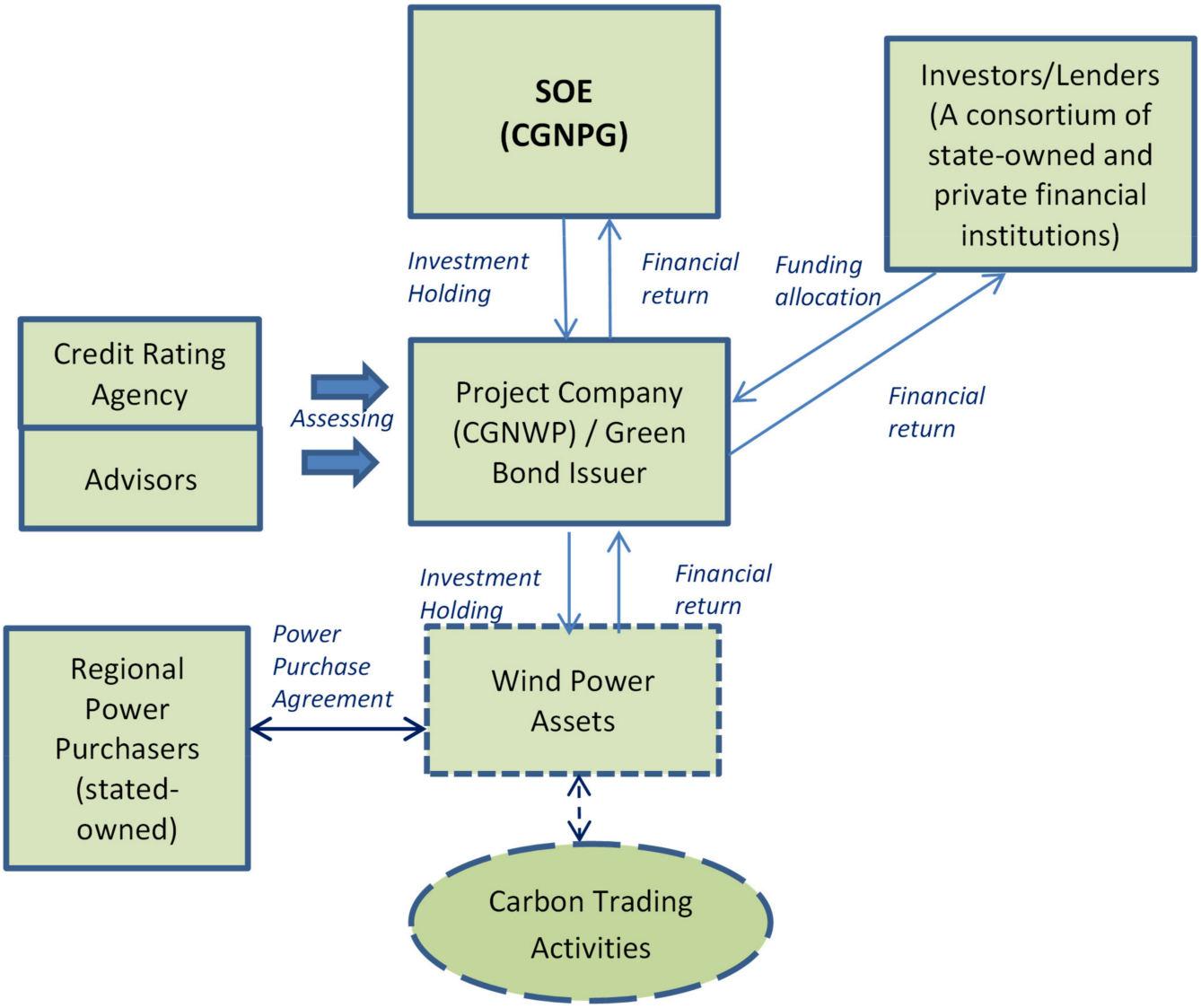

Figure 1. Structured Public-Private Collaboration for Issuing Green Bond.

Table 2. Key Parties and Terms Arranged for the Green Bond.

Issuer	**China-Guangzhou Nuclear Wind Power Co., Ltd. (CGNWP)**
Release time	12 May 2014
Release size	1 billion yuan
Term	5 years
Interest rate	5.65% (fixed), plus 5–20 bp (floating)
Release method	Public offerings
Principal underwriter/co-principal underwriter	Pudong Development Bank/China Development Bank
Rating agency	United Credit Evaluation Co., Ltd.
Financial advisors	China-Guangzhou Nuclear Financial Co., Ltd.; Shenzhen Emission Rights Exchange

Table 2. *Cont.*

Issuer	**China-Guangzhou Nuclear Wind Power Co., Ltd. (CGNWP)**
Basic assets	Issuer's subordinate project company, sales revenue and income from carbon assets generated from 5 wind power projects
Issue pricing mechanism	The pricing method of fixed interest plus additional income is used, in which the sales revenue generated from the wind power project is used to repay the principal and fixed interest of the asset-backed instruments, and the income from the carbon assets generated by the wind power project is used to pay the additional benefits attributable to the investors with reference to the asset support notes.

Source: CGNPG (2018); China Emission Exchange (2018).

The main underwriter and the co-main underwriters are the Shanghai Pudong Development Bank and the China Development Bank, respectively. The underlying assets of the instrument are the revenues generated from electricity sales and the income from trading the carbon assets generated by the five wind power projects under the project company affiliated with the issuer. The specific pricing of the bond is based on the fixed returns associated with sales of the power generated plus the income generated from carbon trading under the CDM related to wind power assets. The produced cash flow is used to repay the principal and fixed interest expenses of the asset-backed financial instrument. The carbon trading proceeds generated by the wind power projects would be the "upside" returns to the investors of the asset-backed financial instrument.

In order to formulate for the green bond issuance, CGNWP has, during the early stage of development, established a special green bond consortium in collaboration with Shanghai Pudong Development Bank and China Development Bank, a commercial and a state-owned bank, respectively. It formed an agreement with the Shenzhen Emissions Exchange for carbon trading activities. In finalizing the terms and conditions, CGNWP negotiated to determine the financing terms of the medium-term notes, carbon revenue structure, as well as the fixed interest rate and the floating interest rate partly due to a lack of reference data from similar deals in the past.

3.3. Bundled Wind Power Assets

In this particular green issuance exercise, wind power assets owned by the issuer are bundled together for economy of scale. Details of the bundled wind power-generating assets covered by the bond and the related power purchase arrangements are summarized in Table 3. The on-grid price of wind power consists of the price of the desulfurization benchmark plus the state subsidy for the price of wind power generation.

Table 3. Summary of the Bundled Wind Power Assets.

Geographical Location of Wind Power Assets	Installed Capacity	Annual Power Supply	Online Electricity Tariff	Regional Power Purchasers
Inner Mongolia	49.3 MW	110,751 MWh	0.51 yuan/kwh	Inner Mongolia Electric Power (Group) Company
Inner Mongolia	49.5 MW	131,564 MWh	0.51 yuan/kwh	Inner Mongolia Electric Power (Group) Company
Xinjiang	49.5 MW	122,364 MWh	0.58 yuan/kwh	Xinjiang Electric Power Company
Gansu	49.5 MW	91,130 MWh	0.58 yuan/kwh	Gansu Electric Power Company
Guangdong	35.7 MW	61,740 MWh	0.61 yuan/kWh	Jiangmen Power Supply Bureau of Guangdong Grid Company

Source: CGNPG (2018); China Emission Exchange (2018) [39,40].

3.4. Generating Carbon Trading Income from Wind Power Projects

Since wind power projects reduce CO_2 emissions, such projects under the CDM are approved by the national governmental authorities for registration with the UN CDM Executive Board or are based on international and domestically recognized greenhouse gas reduction commitments. The provisions of the emission reduction project standards released in June 2012 issued by the National Development and Reform Commission prompted the "Closing Measures for the Management of Voluntary Emission Reductions of Greenhouse Gases" and the certification of the emission reduction data of such projects by independent third-party certification agencies. The GHG CERs generated after the operation of a wind power project are used by companies with mandatory emission reduction obligations to fulfill their commitments to reduce emissions (i.e., purchase CERs) and offset their excess carbon emissions as non-mandatory emission reduction entities (including enterprises or individuals). Thus, such "carbon neutral" intention for the pursuit of environmental protection and public welfare can be achieved. While there is no mandatory emission reduction obligation, the purchase of emission reduction is considered entirely for public welfare purposes. Regardless of the abovementioned buyer type, when CERs are purchased from wind power companies, there is an Emissions Reduction Purchase Agreement (ERPA) or domestic greenhouse gas emission reduction purchase agreement, which stipulates that wind power projects will enable over a certain future period of time. The pertinent transactions are driven by the emission reduction obligation of the wind power company (seller) that triggers the condition and payment obligation of the buyer.

Based on the above arrangements, the expected income from the sale of carbon dioxide emission reductions, deducting all fees charged by the competent authorities and intermediaries during the filing of emission reductions, will result in net income generated from the bundle of wind power projects. The specific amount of carbon asset trading income can be measured according to the agreed-upon delivery amount and the selling price minus the fixed issuance/recording costs, subject to the evaluation of the carbon assets issued by a third-party company, which also assesses the predicted cash flow income to be generated in the future operations.

4. Discussion

In China, green bonds have emerged as a growingly important domestic financial instrument for renewable energy assets, as demonstrated in the case of an SOE. This in-

strument is conducive to reducing financing costs while optimizing a debt-equity structure through a well-structured arrangement among multiple complementary parties and commercial arrangement for generating adequate financial returns to investors. This case study illustrates through structured financing and risk sharing among the participating institutions the proceeds raised from issuing green bonds are reallocated to a bundle of renewable energy projects. The following highlights the salient points arising from this study that are pertinent to policy and practice in green financing for renewable energy projects.

4.1. Leveraging on a Strong Credit Rating

As an SOE, the CGNPG maintains an AAA rating in China, conceived as indicating a business entity with a high credit rating, low default risk and wide financing channels. According to its disclosure data, the company's primary financing channels in its early stages of development were bank loans and bond financing. Bond issuance is not only flexible but can also be utilized for financing project development and for the repayment of existing bank loans. As such, green bond issuance is considered as an attractive financing option for the company. Due to its popularity, the green bond coupon rate is expected to be lower than that of the conventional bond coupon rate; therefore, green bond coupon can be deployed to reduce the overall cost of capital. In the case of CGNWP as the bond issuer, it manages to structure an effective green bond financing model with a term life according to its overall expected cash flow while enabling carbon emission reductions.

4.2. Investor Risk Protection and Incentives

Given the high credit rating of the parent company of the bond issuer, the probability of default was determined to be rather small. To ensure the smooth payment of this green bond, CGNWP set up a debt repayment plan and safeguard measures for green bonds and clarified the debt repayment obligations and debt service obligations of the CGNPG. For example, even if the parent company—CGNPG defaults on its payments, dissolves, or goes bankrupt and is unable to pay, CGNWP is still obliged to bear the liability for breach of contract; in the case of postponed interest payments, the CGNPG is required to pay liquidated damages at a predetermined daily interest rate. Under such an arrangement, the bondholders can file a lawsuit against the issuer according to the regulation. As a result, bondholders' investment risk is considerably reduced and comparable to that of equity investing since the investors are also entitled to the financial return upsides from carbon trading.

4.3. Financing Renewable Energy in Scale to Reduce Carbon Emissions

The experience of CGNPG green bond issuance represents an innovative attempt in China to link up its capital market in coordination with the emerging carbon trading market and bond market. The successful issuance of the CGNWP, to a large extent, initiated the transformation of China's green enterprises from an indirect financing mode to a direct financing mode with the domestic capital market, which is conducive to broadening the financing options of sustainable and renewable energy projects. The transaction structure presented in the case is embedded with upside incomes generated from carbon trading for emission reduction. It demonstrates potential scalability of significance for the development of other renewable energy sources such as hydropower, thermal power, nuclear power, and solar energy. To sustain this carbon trading advantage, it is nonetheless crucial to ensure a fair carbon pricing mechanism for economic incentives as reflected in experiences from other countries [41–43]. The adoption of a complementary trading system would enable building up the necessary infrastructure to reduce carbon emissions for the nation's commitment in an appropriate scale [2].

The introduction of green bonds provides a noticeable reference for enriching China's bond varieties, promoting the development and application of innovative green financial products in China, as well as advancement of China's green industries that are eligible for green bond financing in compliance with the stipulated standards. In order to be compatible

with the mature international green bond market, the country also needs to review and consider corresponding policies for green financing, such as carbon abatement [44,45].

4.4. Work in Progress

In comparison with the international green bond market, discrepancies can be found among China's green bond-specific legal regulations and selection criteria for green project. In the international market, the introduction of the Green Bond Principles has guided the issuance of green bonds and facilitated the rapid growth of the international green bond market in recent years (ICMA, 2016, 2018) [46,47]. After its initial years of development, China's bond market has seemingly upgraded the relevant laws and regulations related to bond issuance, but comprehensive regulatory and enforcement measures for green bonds are still lacking. Investing and financing institutions are still unable to rely on a detailed, harmonized set of guidelines in issuing green bonds. Further, the consortium as disclosed by the case required advisors but not independent professionals to assess compliance with green bond standards prior to and subsequent to issuance.

According to the report by CBI and CCDCC (2018) [48], the total amount of green bonds issued in China was approximately equivalent to USD 37 billion in 2017, representing an annual increase of 4.5%. However, approximately 38% of the bonds issued (USD 14.2 billion) did not meet international standards. This discrepancy was higher than that in 2016, when only 33% of the bonds issued did not meet international standards, due to differences in the eligibility of green projects. These projects are related to legacy fossil-fuel power-generating facilities that seek to improve their efficiency by using clean coal technologies as well as the electricity grid transmission infrastructure that is linked with fossil fuels. Other projects include the development of new hydropower projects with capacities greater than 50 MW and landfill waste disposal projects, among others. The CBI and CCDCC also highlighted that domestic guidelines from the NDRC allow bond issuers to use up to 50% of the proceeds for the repayment of bank loans or for general capital purposes, which is not typically permitted by international standards [26]. With the aim of reducing greenhouse gas emissions, explicit disclosure of the intended use of proceeds from the issuance of green bonds is required according to international standards.

5. Conclusions

The case reveals a distinct structured approach for financing renewable energy sponsored by an SOE through issuing green bonds structured around a consortium of participating domestic financial, investing, and industrial institutions from both the public and private sectors for managing pertinent risks. While there is a significance of the country's top-down approach within its political economy to instigate the development of green finance, this study unveils the dynamics of its domestic capital market in formulating a green bond mechanism integrated with financial incentives for the participating private investors. Meanwhile, China's green bond regulatory framework and related measures are yet to be fully aligned with the international standards. Comparison between domestic and foreign green bond standards reveals that domestic green bond standards would require alignments so as to ensure stringent use of funds for sustainable developments. Imperfection in "green" standards may result in skepticism about potential adverse selection of projects that are meant to contribute to enhancing sustainability. The following concluding notes are deliberated on the future development of green bonds for renewable and sustainable energy in the country. Three main contributions to the existing literature are highlighted.

First, green bond is demonstrated in this case as an effective instrument of financing wind energy assets in an emerging economy as suggested in prior studies [16]. The significance of a well-structured public-private collaboration is revealed in this study. Wind power can be in fact well received by investors, though not been fully recognized in the past due to concerns over the financial risks related to renewable energy projects [5,10]. After initial years of development, green bonds have now been favored by the market

owing to their long-term approach and low capital costs when technically structured to manage the pertinent risks. Commercial banks and large business enterprises are engaged in issuing similar types of green bonds to finance renewable energy projects in collaboration with SOEs as legitimate sponsors for the emerging green finance system as illegitimately advocated in central planning.

Second, this study echoes that green finance has the potential of becoming a substantive local source of capital for scaling up for renewable and sustainable development in an emerging economy in Asia through the domestic capital market [1,13,17]. During the rapid development of China's economy in the recent decades, improvement in the environment is anticipated for better quality of life among the public. However, with constant increases in living standards among the general public, the carrying capacity of the ecological environment is seen to have exceeded the load. The society as a whole is now aware of the relevance and significance of sustainable economic development. The development of green industries with complementary efforts from the domestic capital market has incrementally become a noticeable political and economic agenda. Green financing appears to be an appropriate tool for providing financial support for long-term green development. In fact, the country has raised the development of green financing and related facilities to the national strategic level [49]. Similar strategic approach would be relevant to other key developing economies.

Third, this study suggests national regulatory measures for green financing that stimulate direct investments in renewable energy would entail public-private collaboration in the case of China under its political economy despite divergence from the international approach [14,15]. The development of the green finance market is facilitated by the country's specific regulatory system to effectively safeguard green bond issuance, related carbon trading activities, quality information disclosures and investor protection [32,45,50]. These complementary measures for public–private collaboration would support a healthy and orderly market environment to manage financial risks while promoting market-based financing innovation and scalability of renewable energy projects [29,38]. In particular, it is critical to ensure that green bonds will have a profound impact on green and sustainable development, while avoiding any "greenwashing" or false green projects. Financial integrity is considered necessary to strengthen the confidence of investors regarding the efficacy of green bonds.

The country has been ranked high globally in green bond issuance as the most active players in the international green bond market [48]. With the implementation of the nation's internationalization development, China's green bond development is expected to be further expanded through adopting mechanisms and standards that are aligned with the international capital market. Such integration with the international capital market would be augmented through active participation in the growingly international green bond market via Hong Kong, China's global financial center, where free flow of capital is permitted [8]. According to the CBI and CCDCC Climate Bonds Initiative and China Central Depository & Clearing Company, clean, renewable wind, and solar energy, in compliance with the Climate Bonds Taxonomy, accounts for the greatest allocation of green bond proceeds, at an equivalent of USD 6.8 billion, or approximately 30% of the internationally aligned green bonds issued in China [48].

With respect to policy development for scaling up renewable energy assets, the key to the regulation and supervision of the green bond market lies in two main aspects. One is controlling the use of raised funds from the domestic capital market through green bond issuance with measures to disallow the use of the term "green bond" for any noncompliant financial instruments in terms of effectually reducing greenhouse emissions. There should also be some restrictions on how funds raised are used and the misappropriation of funds. Since China's green bond market is still emerging, there are differences between the international and domestic green bond standards. The international standards are largely characterized by a more restrictive definition of green projects and require compliance and assurances by an independent party on an ongoing basis, beyond initial bond issuance.

Meanwhile, China is expected to implement measures over time to harmonize local green bond guidelines with those of international markets, specifically aiming to gauge the consistency of green finance definitions and standards between China and the EU [48]. To support financing clean energy project, the China Development Bank has released a restrictive green bond framework by eliminating projects related to clean coal and fossil fuel-related technologies [50,51].

The other aspect is about the authenticity, accuracy and completeness of the issuer's information disclosures that need to be assured. The engagement of independent professionals, which had not been arranged in the case, would be a much-needed mechanism for providing assurance on the information disclosed about the use of funds and related green compliance. As a comprehensive set of green bond standards is considered as the foundation for the further development of green bonds, pertinent compliance services performed in an independent manner to reinforce environmental, social governance (ESG) are expected to be increasingly complementary for a predominantly market-based financing mechanism. Such enhancement of the existing green financing system would better prepare an emerging economy for a desirable sustainable economic recovery from COVID-19 [52,53].

Given the uniqueness of this case as reported, it is relevant to note that the authors have no intention to generalize the results from this case study alone. In the future, empirical studies on green bond issuance for financing renewable energy projects among the developing and developed economies based on a collection of qualified transactions can be conducted to examine how an extended sample of projects are structured to manage their respective risks.

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