



Scaling up Renewable Energy Financing through Islamic Blended Finance: Case Study in Indonesia

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Received: 08 May 2023

Accepted: 13 August 2023

DOI: <https://doi.org/10.32479/ijeep.14710>

ABSTRACT

This paper outlines to explore the influencing factors of unachieved target of the energy mix from renewable energy (RE) sources in Indonesia, to develop an integrated Islamic blended finance model for financing RE projects in Indonesia, and to analyse the costs and benefits of the proposed model. This research employs an exploratory sequential mixed method with the qualitative phase through in-depth interviews and Focus Group Discussions and quantitative phases using primary and secondary data to simulate the Agent-Based Model (ABM) of the proposed model. The paper found three main financing issues on RE sector in Indonesia, including high investment costs and long payback period of RE projects, high risk perception to finance RE projects, and the uncertainty of investment return for RE developers. Besides, based on ABM simulation, Islamic blended finance can contribute to reduce the required period to achieve the energy mix target. Despite the less familiarity of Islamic finance instrument for the RE sector, an initial of a pilot project in place of the proposed business model might increase common awareness regarding this potential. Hence, policy implication delivered in this paper should be a key component to scale up RE sector via Islamic blended finance instrument.

Keywords: Renewable Energy, Green Financing, Islamic Blended Finance, Agent-Based Model

JEL Classifications: Q42, Q43, Q56, G23

1. INTRODUCTION

The importance of the energy sector has been noted in previous studies (Aissa and Hartono, 2017). This sector contributes to economic growth and the country's sustainability to meet the needs of the society. The 21st Conference of Parties United Nations Framework Convention on Climate Change in 2015 in Paris has resulted in agreements from several countries to commit in overcoming the problem of global warming by reducing greenhouse gas emissions with a target of 29% by 2030 (Lisbet, 2015). Therefore, the high demand for energy encourages a shift from fossil fuels to renewable energy (RE) based that is more environmentally friendly. RE is needed to suppress the problem of global warming and promote sustainability of the planet.

The Government of Indonesia has defined a target energy mix of 23% in 2025 and 31% in 2050 to aligns with the Nationally Determined Contribution (Den, 2019). However, the contribution of RE in energy mix is only 4,1% (Hasibuan et al., 2021). The potential of the large RE resources still has problems in its optimization until now. For example, the achievement of electricity capacity from RE resources at the end of 2021 only reach 11,2 GW (ESDM, 2022b). This achievement is far below the target of the General National Energy Plan, which targets the capacity of RE power plant (PP) at 45,2 GW in 2025 as mentioned in President Regulation (Perpres) Number 22 year 2017.

(Lestari, 2021) noted that financing represents among the main issues to develop RE sector. Indonesia needs an investment of up to

USD 36.95 billion by 2025 (EBTKE, 2020). Moreover, Indonesia requires financial supports to achieve the emission reduction target in 2030 which is estimated at about USD 118 billion to generate RE PP (Boer et al., 2021). From total cumulative Green Sukuk issuance (USD 3,24 billion), only 8% and 5% allocated for RE in 2018 and 2019 respectively (Ministry of Finance, 2021). According to Climate Policy Initiative Report, the investment gap in Indonesia to produce electricity from RE reach up to 98% annually (Wijaya et al., 2020). According to IRENA (IRENA, 2022) it can be noted that from 2011 up to 2020, RE projects are mainly funded by debt.

Debt-based represent the primary sources of existing funding in RE (Wijaya et al., 2020), which ironically causes unsustainability for the respective countries (Ari and Koc, 2018, 2019). Financial instrument in the forms of loans or the debt has long played an essential role in financing the RE agenda (Financial Instruments for Energy Efficiency and RE, 2017). According to performance report of Indonesian Ministry of Energy and Mineral Resources 2021 (ESDM, 2022a) the financing allocated to the RE sector in Indonesia has reached about IDR 26 trillion/year since 2015. Therefore, innovation in providing attractive financing schemes is urgently needed.

Previous studies regarding to green and/or sustainable economy discourse attempted to seek funding alternatives, including blended finance (Deloitte, 2017; OECD, 2017), Islamic blended finance (Ascarya et al., 2022; Ibrahim et al., 2021; SESRIC, 2019), green financing (Deschryver and de Mariz, 2020; Gilchrist et al., 2021), impact financing (Listiana, 2019). Specifically regarding to RE projects, Waqf-owned financial intermediary (WOFI) (Ari and Koc, 2021b) and Philanthropic-Crowdfunding-Partnership (Ari and Koc, 2021a) have been proposed. These seminal studies have simulated the proposed concept to provide a proof of concept using the Agent-Based Model (ABM). However, previous studies highlight the effect to wealth inequality and only focus on solar PPs. In addition, these simulations have not considered the risk dimension, which generally can be minimized through a takaful (guarantee) scheme.

Therefore, to address these gaps, the current study accommodates the different RE plants that are potential, especially within the Indonesian environment, including solar PP, bioenergy PP, and micro-hydro PP. In addition, the takaful scheme is included in the simulation to accommodate the risk dimension in financing RE projects using the proposed Islamic blended finance.

Essentially, this study has three research objectives. First is to explore what factors related to financing aspect have caused the unachieved target of the energy mix from RE sources in Indonesia. Second is to develop integrated Islamic blended finance model suitable for financing RE projects considering the Indonesian context. Third is to analyse the costs and benefits of the proposed integrated Islamic blended finance model in developing RE projects. Not only has a concept, this research provides a modelling simulation as proof of concept using the ABM.

With regards to the defined target of the Indonesian Government, the current study represents among the pioneer to propose Islamic

blended instruments in supporting energy transition through the achievement of the energy mix target. This paper is expected to be a recommendation for regulators to provide directions for stakeholders in the field of both Islamic economics and finance and the RE industry. The synergy between the Government, Islamic financial institutions, practitioners of Islamic economics and RE, and academics is needed to develop RE projects in the context of energy transition to achieve energy security and energy independence in Indonesia.

2. LITERATURE REVIEW

Blended finance is also defined as the use of public resources and philanthropy to attract more private investors into sustainable development projects (OECD and WEF, 2015). In addition, blended finance is also a form of using public funds to minimize risks in development and utilizing private investment to fill the funding gap for the Sustainable Development Goals (SDGs) program through philanthropic funds and Government-owned financial institutions (Tew, 2016). Three main components of blended finance are philanthropy, the private sector, and the Government. The Convergence Report also mentioned the importance of the public sector and philanthropy to mobilize private sector investment to achieve SDGs (Convergence, 2018).

The blended finance scheme can also be carried out with contracts that are in accordance with Islamic law by combining commercial and social aspects, which is called Islamic blended finance. In general, Islamic finance is divided into two, namely Islamic commercial finance and Islamic social finance. Islamic blended finance involves Corporate Social Responsibility (CSR) funds, Zakat, Waqf, Infaq, payment penalties, private investment, and other alms (Ascarya et al., 2022; Badjie, 2019; Khan, 2020).

Besides, green financing is a form of investment and financing from financial institutions for projects that have an environmental impact as an effort to preserve the earth (Volz et al., 2015). The important scope of green financing is developing RE sources (Volz et al., 2020). For example, since 2017, Indonesia has issued green sukuk to finance eligible green projects including those related to new and RE, waste-to-energy management, and other environmentally friendly energy conversion projects (Azhgaliyeva et al., 2020). Interestingly, green sukuk are not only used in Muslim-majority countries, countries with Muslim minority populations such as Italy also apply green sukuk in funding green projects in their country (Morea and Poggi, 2017).

Several studies have proposed Islamic financial instrument such as sukuk to fund RE projects. Blended finance also has been proposed with some varieties. However, from review of the existing literature, works of (Ari and Koc, 2021a; 2021b) represent among the very limited studies that propose explicitly the Islamic blended scheme which include Waqf to finance the RE projects. Current research uses these works and other relevant articles by the same authors to develop the proposed theoretical framework of Islamic blended finance for RE development. ABM and Anylogic were used in research by (Ari and Koc, 2021b) to examines the alternative equity-based financing models and develops a WOFI for RE

investment. In addition, the authors use an ABM with AnyLogic (version 8.5). Software developed by The Anylogic Company, Chicago, United States to propose the conceptual model. ABM is also used by (Ari and Koc, 2019) develops a set of policy guidelines for sustainable financing models as a solution for RE investment.

3. METHODOLOGY

3.1. Empirical Strategy and Data Collection

This study employs an exploratory sequential mixed method, which is designed to combine qualitative and quantitative methods sequentially. The qualitative phase is first explored before the quantitative phase with different data (Creswell and Creswell, 2018). The qualitative phase will be carried out through, first, In-depth interviews with a semi-structured approach of 15 informants include the authority from ministry of energy and mineral resources, ministry of finance, ministry of National development planning, central bank, the Indonesian financial services authority (Indonesian: Otoritas Jasa Keuangan [OJK]), as well as state-own company and National company. National energy council, masyarakat energy terbarukan Indonesia, Waqf Center for Indonesian Development and Studies, climate policy initiative, New Energy Asia, Cakrawala Energi Nusantara, Bintang Terbarukan Indonesia Energy and UPC Sidrap. The respondents represent the expert in the field of Islamic economics and finance and RE, practitioners, academics, and think-tank with senior managerial positions. The informant was identified by the code R (Respondent) from R1 to R15. So the explanation below will use the code R1-R15 to express the opinion of each source.

Semi-structured interviews will be conducted to accommodate themed discussions and facilitate the in-depth elaboration of the informants. Second, Focus Group Discussion (FGD) to identify the factors that have hindered the achievement of the energy transition target and the appropriate Islamic blended finance funding scheme to encourage this achievement. FGD was attended by 11 experts as active informants. The FGD results in the information regarding the real case RE project and a glance update related to the FGD topic. In addition, cost and benefit analysis of the proposed scheme will also be conducted and provided.

Meanwhile, the quantitative phase will use relevant primary and secondary data to simulate the ABM of the funding scheme proposed in this study (Ari and Koc, 2021b; Putriani et al., 2020). The combination of research methods was carried out as an attempt to triangulate (Bowen, 2009).

3.2. Data Analysis

The data and information obtained from the qualitative approach (interviews and FGD) are analysed using a thematic approach (Braun et al., 2018). Verbatim transcription of conducted interviews and FGD is produced and analysed thematically and elaborated in the result and discussion section.

In addition, the ABM simulation is carried out using Anylogic Edition 8.7.12. According to (Grigoryev, 2021a) Anylogic is a unique simulation software program that enables the creation of multi-method models. It includes ABM, system dynamics,

and discrete event modelling (Ari and Koc, 2019). Moreover, AnyLogic is compatible with any operating system that supports the Java Virtual Machine (Oracle Corporation, Redwood City, CA, USA), including Linux, Windows, and macOS. AnyLogic allows the inclusion of custom Java code in an ABM (Ari and Koc, 2019). It could also support a few visual modelling languages, including process flowcharts, state charts, action charts, and stock and flow diagrams. Anylogic was the first tool to introduce multimethod simulation modelling, and it is still the only software with the capability and provides very high flexibility (Anylogic, 2022) (Garifullin et al., 2007).

3.2.1. AnyLogic steps

Agent-based is a relatively new method compared to system dynamics and discrete event modelling. It is highlighted that agents are not always represented by people but also by a project, an idea, an organization, an investment, etc. The proposed steps of agent-based modelling are visualized in Figure 1.

In this step, the authors create the simulation process modified from (Grigoryev, 2021b) based on authors' purposes. With regards to the creating agent population, the authors could select the option of agent type that meets their needs, which could be a population of agents or a single agent or agent type only. The chosen agents include solar PP, micro-hydro PP, and Bioenergy Powerplant. Then, the authors continue developing the model by defining agent characteristics and behaviour. The behaviour is described as if the available funds are more significant than the required Initial Investment Cost, and the powerplant is ready to be built by the project owner (PO). Then, if the available funding is greater than the funds needed for investment, the RE project is ready to be produced. Following that, in the next 3rd, 4th, and 5th steps, each proposed scenario simulation will be deployed. Finally, from the previous simulation, each scenario results in different energy capacity (EC) achievements.

3.3. Data Sources and Description

3.3.1. Islamic blended agent-type

In this study, the total Islamic blended finance (TIBF) consists of the allocated amount of deposits in Islamic banks (DEP), potential corporate Sukuk to be issued (SUK), and part of potential cash Waqf funds through Waqf institutions (WAQF) (Equation 1 and Table 1).

$$TIBF = DEP + SUK + WAQF \quad (1)$$

Information regarding total third-party fund is taken from published statistics report as of December 2021 by OJK. 12.5% is the maximum investment in a specific sector as informed by R13. (Handayani and Surachman, 2017) demonstrated that financially, sovereign sukuk is potential to fund the RE projects in Indonesia. In addition, (Abi Suroso et al., 2022) specifically propose green sukuk issued by the Government to fund RE projects. However, from the interview session with R5 from Ministry of Finance, it was discovered that the collected fund from sovereign sukuk can only be utilized through approved budget in relevant ministries. In fact, the role to provide electricity for public lies in state electricity company (Indonesian: Perusahaan Listrik Negara [PLN]) and their

Figure 1: Agent-based modelling. Source: Modified from (Grigoryev, 2021b)



Table 1: Estimated potential Islamic blended finance fund for agent-based model simulation

Agent	Amount (IDR trillion)	Assumption
DEP	67	12,5% of third-party fund of BUS and UUS 2021
SUK	6	Total issued Sukuk by State Electricity Company 2013–2020
WAQF	18	10% from cash Waqf potential calculated by Indonesian Waqf Board
TIBF	91	

DEP: Deposits in Islamic banks, SUK: Sukuk to be issued, TIBF: Total Islamic blended finance

the overnight capital cost. Further, there are construction periods (CP) to build each type of PP before it could become operational. The duration of CP depends on the scale of each project which is displayed at Table 2.

To produce electricity, PP requires operational and maintenance costs for covering salaries, land leasing, material replacement, utilities, and miscellaneous expenses. This study also assumes the lifetime (LT) period of each PP to capture their depreciation expenses each year.

The PP agent-type primarily communicates to external agent-type through single operating company. On this occasion, all three PPs would examine the instruments of Islamic blended finance. Besides, The PP agent-type has important role to achieve energy mix target through proposed Islamic blended financing. The PP agent-type would contribute TEC from EC produced by RE PPs. This study would formulate total capacity produced by solar, bioenergy and micro-hydro PPs (Equation 3).

$$TEC = EC_s + EC_m + EC_b \tag{3}$$

Where, EC represents the number of EC in watt hours (Wh) produced for every IDR 1 investment fund allocated to PP.

4. RESULT AND DISCUSSION

4.1. Financing Issues in Renewable Energy Sector in Indonesia

According to information collected from the interview and FGD, the financing barriers lead to the most significant factor that causes under achievement in pursuing energy mix target in Indonesia. As informed by (R10, R8, R13), high capital expenditure which need long term financing scheme is less relevant to be financed from any banks. Moreover, there are very limited insurance companies that could cover the risks of that scheme (R12).

4.1.1. High investment costs and long payback period of renewable energy projects

One financing issues that threaten development of RE projects are high investment costs which lead to long payback period of the investment (R8, R10). High capital expenditures of RE projects are caused by advanced technology of the RE equipment which are mostly imported from abroad. This technology is still peculiar among our domestic industry in which knowledge transfer for such future technology should be encouraged. Further, the nature of RE project has low return on investment which led to long payback period. The cost of funds in financing RE becomes more expensive because it refers to the interest rate in the banking system. The interest rate hence causes the overall investment cost to be expensive (R10). Also, most RE projects in Indonesia have

partners. Therefore, the usage of corporate sukuk is more suitable. Current study uses the total issued sukuk by PLN to estimate the potential fund from sukuk which can be utilized through Islamic blended finance scheme. Information regarding the total issued sukuk and bond is taken from audited annual report PLN 2021. In average, PLN issues sukuk and bond around 7 trillion/year, more than estimated amount to be collected from sukuk. While information regarding potential cash waqf calculated by waqf authorities amounting to IDR 180 trillion can be found in both in official website of Indonesian Waqf Board (Indonesian: Badan Wakaf Indonesia [BWI]) and National Islamic Finance Committee (Indonesian: Komite Nasional Ekonomi dan Keuangan Syariah). Ten percentage allocation from the calculated potential is considered to accommodate the variety of investment alternative which can be choose by the waqf institutions. As informed by R11, R14, R1, the existing Waqf Institutions have not considered investment in RE as a priority sector.

This TIBF will then be invested through PO company which focuses on developing and managing RE projects. In the context of this research, RE focuses on three sectors, namely solar, bioenergy and micro-hydro (Equation 2). In the end, the total EC (TEC) that will be generated from the total percentage of each type of RE can be simulated.

$$TIBF = Investment\ to\ PO = x\%SOLAR + x\%BIO + x\%HYDRO = TEC \tag{2}$$

The TEC would contribute to the achievement of energy mix target from RE sources. Indonesia needs to have 45,2 GW PP capacity as baseline target to achieve 23% of energy mix target in 2025.

3.3.2. Power plants agent-type

This study conducts three PP agents differentiated by their source of energy: Solar, micro-hydro, and bioenergy. Those three sources of RE represent the most efficient PP in terms of investment costs based on Presidential Regulation No.112/2022. PP particularly aims to yield revenue by generating electricity. To develop these PPs, certain amounts of investment should be placed to finance

Table 2: Estimated potential Islamic blended finance fund for ABM simulation

Agent	Variable	Abbreviation	Unit	Value
Solar power plant ¹	Overnight capital cost	OCC	IDR	149.023.925.000
	Lifetime	LT	Year	25
	Construction period	CP	Month	8
	Power capacity	CAP	kWp	5.000
	Daily energy output	DEO	kWh	21.893
	Estimated O and M cost (first year)	OMC	IDR	2.386.683.000
	Total operating expenses	TOE	IDR	8.347.640.000
Micro-hydro power plant ²	Overnight capital cost	OCC	IDR	2.164.906.105
	Lifetime	LT	Year	15
	Construction period	CP	Month	6
	Power capacity	CAP	kW	65
	Daily energy output	DEO	kWh	1.560
	Estimated O and M cost (first year)	OMC	IDR	169.551.224
	Total operating expenses	TOE	IDR	313.878.297
Bioenergy power plant ³	Overnight capital cost	OCC	IDR	38.652.833.402
	Lifetime	LT	Year	25
	Construction period	CP	Month	18
	Power capacity	CAP	kW	1.200
	Daily energy output	DEO	kWh	20.010
	Estimated O and M cost (first year)	OMC	IDR	1.001.571.897
	Total operating expenses	TOE	IDR	2.547.685.233

¹The inputs of solar power plant are adopted from a project implemented at Weh Island, Aceh (Rahmawati et al., 2020), ²The inputs of micro-hydro power plant are adopted from a project at Technopark, Politeknik Negeri Malang (Indahsari et al., 2018), ³The inputs of bioenergy power plant are adopted from a project at PT BAM, Muaro Jambi, Jambi (Djufri, 2016),

⁴Inflation rate is year on year inflation per Mei 2022 taken from the Central Statistics Agency BPS website, ⁵BI rate data is taken from Bank Indonesia website, ⁶According to Law Act No.

⁷Year 2021 concerning Harmonization of Tax Regulations, tax rate for corporation is 22%. OCE: Overnight capital cost, CP: Construction periods, OMC: Operational and maintenance costs, OCC: Overnight capital cost, LT: Lifetime, DEO: Daily energy output, TOE: Total operating expenses, BPS: Badan Pusat Statistik

payback period length between 7 and 11 years. For example, the small-scale off-grid solar PV project at Sumba Island which spend the initial investment about IDR 3,86 billion, needs 7,1 years to achieve its break-even point (Wijaya et al., 2020). Therefore, those characteristics of RE project are also considered as financial barriers which affect to the achievement of energy mix target from RE sources.

4.1.2. High risk perception to finance renewable energy development

RE projects are perceived as high-risk investment for the financial institution (R1, R4, R7, R8, R10, R13). This is the main reason why the number of financings for RE project remain small. The total value of financing that are disbursed for RE projects from commercial bank in Indonesia was USD 4–9 billion in 2018, which means only 11% of total financing in utility sector (Wijaya et al., 2020). The most reason which lead lack of financial institution appetite to support RE projects is low ability of the PO to provide sufficient equity required (R13). Bank as financial institution would operate with the rule of thumbs to finance 70%–80% of capital investments. Since the PO could not fulfill the rest of requirement funds, banks most likely reject the RE project proposal. Besides, lack of appetite from banks including Islamic banks is caused by limited RE companies which have good portfolio and committed potential power off-taker (R13). Banks are generally interested in energy financing projects if the energy project has a buyer or takeover (R8, R9).

In the other side, there is no big company in Indonesia which enter to RE business so far. As bank follow the industry, the decision to finance RE project depends on whether the big capitals would enter or not that business field (R13). Further, the PO must strive to meet the 5C requirements, namely character, capital, capacity,

condition, and collateral (R10). According to R9, technical aspects include feasibility studies, design, and other technical matters such as vital equipment to consider in RE project financing. In addition, the RE project must have all complete permits, be commercially accountable, have a healthy Internal Rate of Return (IRR) level, and have a payback period that is not too long (R13). As RE project is considered as new for Financial Institution like banks, so they need more efforts to assess the feasibility of the project rather than others. Moreover, RE projects are perceived to have high risk profile (R1, R4, R7).

4.1.3. The uncertainty of investment return for renewable energy developers

The uncertainty of investment return is also significant financial barrier for RE developers. Pricing mechanism is very important factor to attract investors for developing RE projects in Indonesia. The regulation regarding purchasing power price in regulation of the minister of energy and mineral resources of the republic Indonesia number 50 of 2017 and number 4 of 2020 afford an opportunity to negotiate between PLN and Independent Power Producer (Lestari, 2021). Besides, Government regulation of the republic Indonesia number 14 of 2012 also regulate the mechanism of pricing agreement for business entity in providing electricity for the society in which the final price is decided by the House of Representative (ESDM, 2022b). Those mechanism led to uncertainty in purchasing power price which is not attractive for the investors to put their funds in RE projects (R2, R3). Thus, there should be attractive regulation in pricing decision which assure the certainty for the investors to develop green energy projects in Indonesia.

Besides, cost of financing for RE project also causes the uncertainty of investment return since it uses project financing

scheme (R13). Project financing usually applies high margin rate rather than other financing schemes particularly for RE project which seems unfamiliar. For example, project financing for RE project at Islamic bank has higher margin rate than working capital financing (R13). Moreover, cost of financing also increases significantly today since the global inflation is uncontrollable. Therefore, it makes higher uncertainty of investment return in RE development projects.

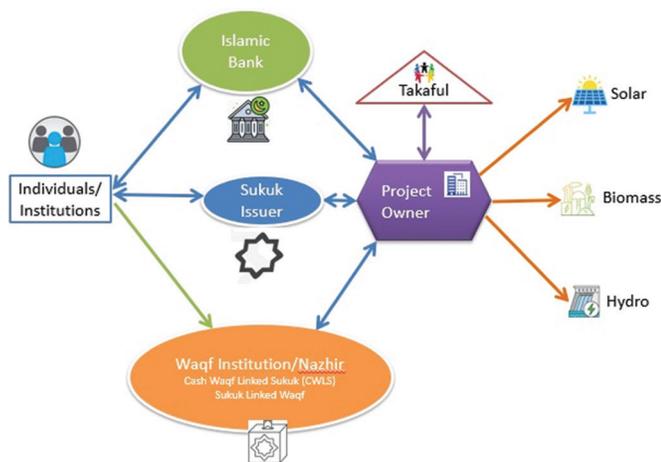
4.2. Islamic Blended Finance as Alternative Financing Instrument for Renewable Energy Development

This study attempts to propose an Islamic blended finance scheme to scale up green energy projects, specifically solar plants, bioenergy, and micro hydro, to achieve the targeted energy mix. According to the interview sessions, the proposed model was initially adapted from (Ari and Koc, 2019) and (Ari and Koc, 2021b) as can be seen in Figure 2 and it is developed and revised.

Individuals/institutions represent agent with investors' rules/behaviors, which can involve funding the RE projects. In this research, the Islamic blended finance instruments are represented by deposit in Islamic banks, sukuk (can be either sovereign or corporate), waqf fund through waqf institutions which later can invest to the PO. The PO is assumed as the operating company which main activities are limited in solar, biomass, and hydro to produce the energy. The expected produced EC and other assumption is elaborated in Table 2.

Different proposed transaction and/or mechanism is represented by different line color in the proposed framework. The green line represents waqf, which in practice, can be either cash or non-cash. Current research limited the scope into cash waqf considering the flexibility dimension, compared to other form of waqf. The main characteristic of this scheme is that there is no direct return for the waqif, therefore the cash flow only from waqf institution to the individual/institution. The blue line represents participation in form of investment via Islamic time deposit and/or sukuk. The collected fund, either from waqf and investment participation can be later be invested in the PO company.

Figure 2: Proposed theoretical framework. Source: Modified from Ari and Koc (Ari and Koc, 2019; 2021b)



There are three main proposed scenarios that have been simulated. The scenarios are described as follows:

Scenario 1: Business as usual, the RE projects that are financed by the debt-based instruments. With this scenario, expected output is in form of production capacity and achievement of energy mix in certain year.

Scenario 2: Proposed Islamic blended finance through involvement of Islamic banks, sukuk, and waqf institutions to develop the operating company. This model enables equity-based financing for green projects, which part of the capital comes from waqf institutions. In this case, the return of investment can be distributed to various social projects. Proposal to involve waqf institutions as place their collected waqf fund in RE sector represents among of the novelty of this research. With this scenario, expected output is in form of production capacity, achievement of energy mix, capital shifting from debt based to equity based.

Scenario 3: Add a takaful scheme to provide a guaranteed mechanism for the green projects' investment. With this scenario, information about production capacity, achievement of energy mix, capital shifting from debt based to equity based can be collected with the consideration of risk dimension.

According to the information collected from the informants, in the context of Indonesia, RE projects are seen as high capital investment with long term payback period. In contrast the conventional financing scheme through bank is considered less suitable for RE projects since bank normally prefers for short term project, although several informants noted that banks (mostly conventional) can provide longer financing scheme for RE project.

In this case, waqf is seen by most informants to be very potential to involve in RE projects, especially in providing electricity with initial contract with PLN. RE projects with this scheme can be considered as less risk since there is off taker guarantee. However, to be independent power producer (IPP), good portfolio is needed. To build the portfolio and develop suitable business model, waqf institution can start to provide fund for community-based projects. Although most informants (R1, R3, R5, R6, R7, R9, R11, R12, R13) see the potential of waqf, it is important to note that informants R11, R14, R15 assert that waqf institutions have not seen urgency to involve in RE projects.

Alternatively, companies can issue corporate sukuk and collect funds from this sukuk to finance RE projects. Combining and blending all the financial instruments could increase the achievement of the targeted energy mix. For example, the practice of Islamic blended finance that has been running is in the health sector, such as the Dompot Dhuafa Hospital in Parung. The project is funded using CSR funds, waqf, and accelerated by funding from Islamic banking (R11). Align with the feedbacks from FGD, R5 and R15 suggested that the model of Islamic blended finance can be in form of sukuk linked waqf or syndicated blended financing through Islamic bank. In the first model, the waqf institutions may have collaboration with interested companies which are eligible as sukuk issuer, including PLN. For instance, Wakafestasi (sukuk linked waqf scheme) which was launched on October 7,

2022 with pilot project in health sector might be replicated for RE project. While in the second model, the Islamic bank will be the coordinator to mobilize the funding from individual and/or institutional investors through investment and/or waqf scheme.

Informants also highlight that in general attractive return will also bring interest of the potential institutional investors such as pension fund institutions to place their fund with Islamic blended finance mechanism. (Yoshino and Taghizadeh-Hesary, 2018) and (Taghizadeh-Hesary and Yoshino, 2020) are among those who identified that pension fund and insurance companies represents among the largest sources of capital with long term characteristics.

Since RE is considered as new technology, the risk perception become high. High risk perception from most informants regarding RE projects also need alternative risk management strategies, especially since the takaful companies face capital limitation (R12). Takaful function is to ensure the continuity of the project. In fact, financial institution is primarily afraid of the real sector because no takaful company could cover it, especially related to RE. Another takaful benefit is that it helps the PO get easy bank financing. As mentioned by R12, the bank would not accept RE financing except for a takaful guarantee. Islamic insurance (takaful) does not only cover assets but also the possibility of a loss of profit or business interruption due to floods and fires (e.g., an engine on fire). Takaful can also make replacements, calculated from the loss of profit (R12). However, due to the significant investment capacity of RE, takaful parties have not been able to accept 100% of the PO’s needs. This is because the takaful capacity to accept RE projects is calculated from the capital, while the capital they have is still limited (R12).

This study specifically proposed sukuk to finance RE projects as part of commercial scheme, other than Islamic bank. However, compared to corporate sukuk, green sukuk in Indonesia is still dominated by Government issuance, so private sukuk still needs to be encouraged. In addition, the target market for corporate sukuk is not yet into RE. Especially during the COVID-19 pandemic, private investment has significantly decreased. On the other hand, although the company has a triple-A ranking, private sukuk are less promising, and their security investment is low (R10). Therefore, when a company issue corporate sukuk, the company also needs to guarantee that the investment value will return to investors.

Considering the potential of Islamic blended finance scheme, current study estimates that around IDR 91 trillion might be annually mobilized for RE projects (Table 1 for detail assumptions). Compared to the required funding for RE development as elaborated in performance report EBTKE 2020 and Biennial Update Report (BUR) 2021 (Table 3), Islamic blended finance may contribute up to 66% and 22% respectively, if the collection has been started in 2023.

4.2.1. Agent-based model findings on proposed Islamic blended finance for renewable energy development

The table below provides information on the allocated fund for each scenario and the result of ABM simulations. The fund of the first scenario worth IDR 26 trillion is cited from performance

report of Indonesian Ministry of Energy and Mineral Resources 2021 (ESDM, 2022a) mentioned that the financing allocated to the RE sector in Indonesia has reached about IDR 26 trillion/year since 2015. Meanwhile, the total fund of scenario two is accumulated from an Islamic deposit fund from Islamic banks, corporate sukuk fund issuance, and waqf fund.

Additionally, in scenario 3, the total fund of the Islamic blended finance instrument is lowered by 5% of the total takaful contribution that the PO is required to pay, generating IDR 86 trillion. Referring to Financial Services Authority Number 6/SEOJK.05/2017 about determining premium rates or contributions to Property Insurance and Motor Vehicle Insurance Business Lines, the total contribution must be made 5% every year.

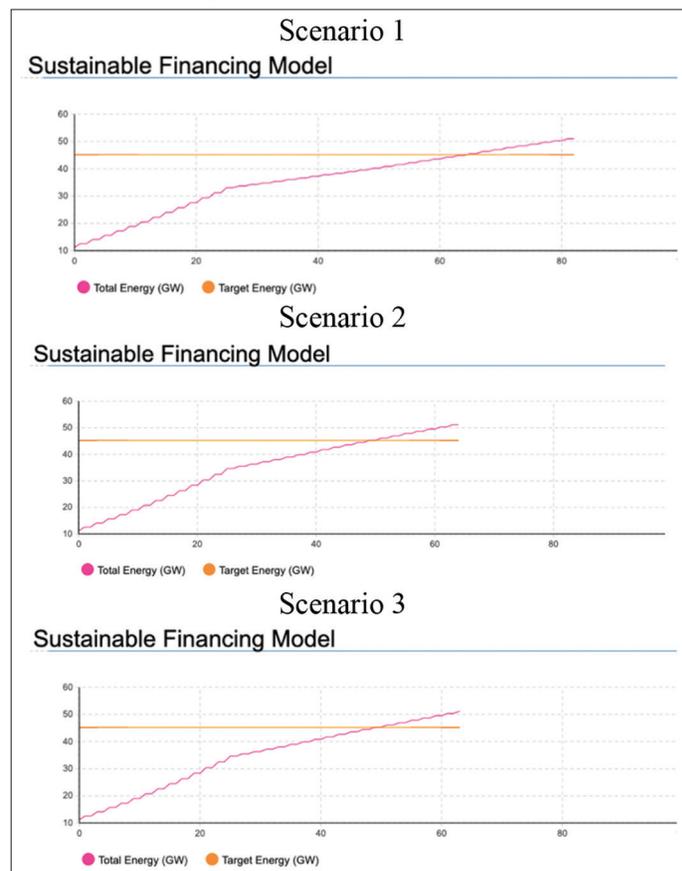
The Business as usual scenario with the small number of funds IDR 26 trillion achieved the energy mix longer than other scenarios, which are 65 months. In contrast, the Islamic blended finance

Table 3: Potential financial contribution from Islamic blended finance

Required funding (IDR trillion)	Potential financial contribution (%)	Remarks
554	49	According to performance report EBTKE 2020
1.688	16	According to Indonesia third BUR 2021

BUR: Biennial update report

Figure 3: Agent-based model analysis of all scenarios



instrument of Scenario 2, with the highest amount of funds IDR 91 trillion, achieved the Energy mix target faster than others which are 48 months. Meanwhile, scenario three, where the Islamic blended finance instrument plus Takaful with IDR 86 trillion, reached the energy mix target in 50 months.

From the Figures 3, it can be highlighted that Scenario 2 outperforms the first and third scenarios in terms of energy mix achievement tenor by incorporating holding company capitalizing Islamic banks financing, sukuk corporate fund, and waqf fund. In the meantime, each plant type's construction time and LT are dissimilar across all the scenarios (Table 2). In addition even though the achievement of the energy mixed target in Scenario 3 is longer than in Scenario 2, takaful can accommodate risks that are likely to arise in Scenario 2. Hence, scenario three can be considered as a complement to Scenario 2.

4.3. Costs and Benefits Analysis

A prudent action to conduct a cost and benefit analysis is significant to evaluate the potential costs and advantages generated from the proposed project. The cost and benefit analysis results from the researcher's data collection, outlined in cost and benefit Scenario 1, Scenario 2, and Scenario 3 following the proposed scenario. A summary of the costs and benefits of each scenario is provided in Table 5.

4.3.1. Cost and benefits scenario 1

Based on ABM analysis results, the instrument would take some time longer to achieve the energy mix target and could not achieve it in 2025 but 63 months. Along with the 5C requirements, namely character, capital, capacity, condition, and collateral, banks frequently reject RE projects because they lack the capacity to carry out the project in terms of finances and technical issues (R13).

Moreover, interest rate benchmark, long-term investment and guarantee issue are also considered as the cost in Scenario 1. The interest rate in conventional banking system creates expensive cost of funds and investment in financing RE sector (R10). Besides,

Table 4: Summary of estimated energy mix achievement

Scenario	Amount (IDR trillion)	Estimated energy mix achievement (month)
Business as usual	26	65
Involvement of IBF	91	48
Involvement of IBF, including allocation for takaful contribution	86	50

IBF: Islamic blended finance

Table 5: Summary of costs and benefits of each scenarios

Item	Costs	Benefits
Scenario 1	<ul style="list-style-type: none"> • Institutional and administrative barriers • Interest rate benchmark • Long-term investment • Guarantee issue 	<ul style="list-style-type: none"> • The instrument meets the incentive for financing needs • PLN company acts as a project takeover
Scenario 2	<ul style="list-style-type: none"> • Guarantee issue on the financing from the bank • To raise of RE awareness for nazhir • To develop nazhir competence in dealing with waqf investment • Lack of sukuk corporate branding 	<ul style="list-style-type: none"> • Interest-free financing solution • Involvement of mass investors in sukuk • Maximizing the potential of waqf • Accelerating the achievement of the energy mix target
Scenario 3	<ul style="list-style-type: none"> • Lack of Islamic insurance products for Islamic social finance instruments • Lack of capital of the insurance company • Administrative barriers 	<ul style="list-style-type: none"> • Takaful overcomes risks • Takaful guarantee to access bank financing • Preservation of mal or property

RE: Renewable energy

the unavailability of guaranteed return on financing the bank's interest rate will be higher (R8). In addition, the RE product LT also become the consideration for the banks when applying for financing since banks prefer on <10 years financing project (R9). Therefore, it is assumed that Scenario 1 cannot help to achieve the target, the next step is to find a particular financing scheme that fits RE projects and appropriate financial products, not only from bank.

Despite the costs of debt-based instruments towards RE projects, quoted from (Wishlade et al., 2017) financial instrument in the forms of loans or debt has long played an essential role in financing the RE agenda. From the current funding, almost 90% of RE projects are financed by debt from conventional banks, while the rest are supported by private equity or foreign loans (R9). The conventional bank shows its interest in financing RE projects will be taken over by the PLN (R9). So, there is a guarantee that the PP has a buyer and will bring profits which motivates the banks to support the RE project.

4.3.2. Cost and benefits scenario 2

In Scenario 2, there some costs in accommodating Islamic blended finance scheme for RE. The issue of guarantees seems never to end since banks need collateral and the capacity to pay debts from the PO. Considering the non performing financing, the bank will seize and sell the asset. R11 stated that waqf assets cannot be pledged, sold or inherited, hence the issue of guarantees must also be a concern when using Islamic blended finance scheme through bank funding (R11).

Moreover, issue on RE awareness for Nazhir should be highlighted as they still lack of knowledge in projects management including waqf assets. R13 mentioned that very few institutions still have a professional with future plan to develop waqf assets. Especially those live in big cities who do not have issue with energy issue. On other hand, RE practitioners are not familiar with waqf mechanism which possible to involve in RE projects (R2, R4, R13). Therefore, there is homework to spread awareness for both the waqf institutions regarding the potential scheme of IPP which can provide off taker guarantee and for the RE institutions regarding the potential of waqf to mobilize source of fund. Also, Nazhir must have financial management knowledge to manage and maintain waqf assets.

Besides, although the company has a triple-A ranking, private sukuk are less promising, and their security investment is low (R10). Hence, when a company issue corporate sukuk, the

company also needs to guarantee that the investment value will return to investors.

Regardless the costs, based on ABM analysis Islamic blended finance concept has evidently shown its ability to accelerate the energy mix target. The concept of Islamic blended finance brings financial value added in an Islamic investment beyond what debt-based instruments are willing to provide. The Islamic bank provides interest-free financing instruments based on profit and loss sharing. The potential number of Muslim communities in Indonesia would be an advantage for a company to raise funds from Muslim investors called Corporate Sukuk. As mentioned by the regulator (FGD6), Sukuk could also be a sharia financing option to support green energy. Sukuk as part of the capital market has the benefit to be traded in long-term securities based on sharia principles. Sukuk is also less risky compared to a conventional bond (Nasir and Farooq, 2017).

According to (Khan, 2019), waqf could be used to fund the development of green projects related to 0 waste initiatives because it is in accordance with maqashid sharia. According to the BWI, the potential for cash waqf in Indonesia reaches IDR 180 trillion/year. As mentioned by R9, waqf is a unique Islamic social instrument since it has double benefits in social and commercial aspects. A study by (Fauziah, 2021) and (Fauziah and Kassim, 2022) outlined that waqf funds can be used commercially, and the benefits can be used for social activities through the social enterprise sector.

4.3.3. Cost and benefits scenario 3

In Scenario 3, there is no guaranteed mechanism in the aspect of waqf (R9). Then, it is necessary to define the specific takaful products to guarantee the PO to ensure the business is running well. Besides, due to the significant investment capacity of RE, takaful parties have not been able to accept 100% of the PO's needs due to the lack of takaful capital (R12).

Despite the costs, in Scenario 3 information about production capacity, achievement of the energy mix, and capital shifting from debt-based to equity-based can be collected with the consideration of the risk dimension. Takaful would be an advantage to mitigate the risk which likely to exist in Scenario 2. The takaful industry has been proactive in assisting customers affected by the highly uncertain economic and operating environment. Takaful might overcome risks by securing the projects and Islamic instruments.

With the mutual help (*tabarru'*) concept in takaful, the risks in RE should be shared together. Takaful exists to ensure the continuity of the project. According to R12, RE projects are related to environmental and social aspects, and must be considered in RE financing. According to him, sharia insurance programs certainly support environmental and social aspects, because this is one form of minimizing disaster risk. Besides, the insurance company will pay attention to technology usage that is not too harmful to the environment or its pollution that causes disasters such as earthquakes and landslides. In addition, takaful concepts are similar to the Islamic principles of social justice or Maqashid Shariah-preservation of mal or property.

According to (Afridi, 2016), Islam forbids trespassing and acquiring another person's property without legal justification and a valid contract.

5. CONCLUSION AND POLICY IMPLICATIONS

5.1. Conclusion

According to 15 interview sessions, and a FGD, this study identifies three main financing issues on RE sector in Indonesia, including high investment costs and long payback period of RE projects, high risk perception to finance RE projects, and the uncertainty of investment return for RE developers. While the first issue cause challenge to find suitable financing scheme, the perceived high risk cause lack of appetite from financial institutions and hinder the investment decision to involve in this sector. The changes of Government regulations regarding RE, including pricing mechanism and lack of guaranteed mechanism are considered to cause investment uncertainty. In general, these findings have similarity with previous studies in other countries.

Informants from interview sessions and FGD acknowledge the potential of proposed Islamic blended finance model, which combine between source of fund from Islamic bank, sukuk issuer, and waqf institutions. In Indonesia, the existing regulations enable for implementation of sukuk linked waqf and syndicated blended financing through Islamic bank. Moreover, Islamic blended finance mechanism which involve waqf fund has been implemented in health sector.

It is important to note that informants with RE background is typically less familiar with Islamic finance instruments, especially that waqf can involve in this sector. On other hand, several informants with Islamic economic and finance background have not been aware regarding the IPP mechanism and possibility of collaboration with PLN to contribute in RE financing. In addition, direct use alternative might also be considered to as a potential business model. Therefore, there is a necessity to have successful pilot project in place and ongoing efforts to increase common awareness regarding this potential.

According to the ABM simulation, involvement of Islamic blended finance to build solar plant, micro hydro, and biomass plants can contribute to speed up the achievement of energy mix, although will not meet the target in 2025. Assume that the proposed Islamic blended financing scheme is successfully mobilized the capital in form of investment and waqf up to IDR 91 trillion, the number of months to achieve energy mix will decrease from 65 to 48 as elaborated in Table 4. Since this amount is considered as an equity-based financing, the benefit of utilizing the Islamic blended finance will not only in term of shorter time to achieve energy mix, but also capital shifting from debt based to equity based. Having a start to mobilize the potential fund from Islamic blended finance in 2023, potential funding in addition to business-as-usual mechanism will contribute to the required funding for energy mix as stated in EBTKE performance report 2021 and BUR 2021 up to 49% and 16% respectively.

5.2. Policy Implications

5.2.1. Waqf as equity fund for financing

The utilization of waqf fund as Islamic social finance instrument that low cost of fund could be blended with Islamic commercial finance instrument such as *mudharabah* or *musyarakah* applied by Islamic bank. Since Islamic bank only could provide maximum financing about 70%, the waqf fund could cover the 30% of equity fund. Thus, this mechanism is most likely feasible to be implemented rather than only rely on 100% financing from the bank. The regulator such as OJK and BWI should encourage cooperation between financial institution and waqf institution. This initiative could catalyze the development of RE project that have low-cost fund then the PO could reduce their payback period of the investment.

5.2.2. Perusahaan Listrik Negara and its subsidiaries more feasible as project owner

Considering high investment and long-term payback period, PLN and its subsidiaries such as PT PJB or Indonesia Power are encouraged to develop RE PP project. This could optimize Islamic blended financial instrument to the companies which have long experience in electrical industry to guarantee the financial institutions or waqf institutions. Therefore, the cooperation between Islamic banking association, BWI, and PLN should be initiated. Those stakeholders could innovate financial instrument to support PLN or its subsidiaries to achieve RE PP development target in 2025.

5.2.3. Renewable energy literacy and education

High literacy and education of RE technology as well as the business model of RE PP, is crucial to reduce high risk perception of RE projects. Most financial institutions including banks are not familiar to this business which lead them to perceive higher risk factor rather than others. As consequences, the POs bare higher cost of funds which reduce their investment returns. Therefore, all stakeholders such as Government, academician, business entity, mass media and communities should encourage RE literacy through formal or informal education. For example, BWI could initiate training or workshop to *nazhir* about business opportunity in RE as an alternative of productive waqf that could be managed by *nazhir*.

6. ACKNOWLEDGEMENT

This research is funded by Research Grant Bank Indonesia.

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