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Toward a Sustainable Energy Transition: The Architecture of Islamic Finance in Indonesia's Biogas Sector

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Abstract

Indonesia is an agricultural country with abundant potential for bioenergy (biodiesel, bioethanol, biomass, and biogas), with Indonesia's biofuel consumption and production expected to increase by 50 percent. This potential is one of the foundations for reducing carbon emissions by replacing fossil energy with new and renewable energy. Therefore, this study aims to analyze the government's initiative to use biogas through PLTBg. This study uses SWOT analysis through the Berlian Porter model approach with secondary data to prepare a strategic architectural framework. The research results are based on the findings in the development of financing for biogas utilization through PLTBg in the preparation and acceleration (short term), expansion (medium term), and final goal achievement (long term). The financing process uses the build, own, operate, and build-own transfer business model approach by implementing the 5C Principles integrated with ASRI principles. In order to optimize the biogas financing process, an agreement was made between the stakeholders involved to create new and renewable energy efficiency in the biogas sector through PLTBg and create a healthy business climate competition to avoid agency problems. The hope is that when this strategic architecture is used correctly, the acceleration of the transition project in the new renewable energy sector, especially biogas, through PLTBg through a funding scheme or financing for the financial services industry can be realized.

Key words : Strategic Architecture, Biogas, Financial Services Industry, Financing, PLTBg

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INTRODUCTION

Global population growth and industrial development have increased the demand for energy use. Energy use in most countries is still dominated by fossil fuels, which are affecting global warming and climate change. When fossil fuels are burned, they release large amounts of carbon dioxide and greenhouse gases into the air. Greenhouse gases trap heat in the atmosphere and cause global warming and climate change (United Nations Department of Economic and Social Affairs, 2021). Fossil fuel dependence impacts climate change and affects human health and well-being directly through volatile and unpredictable fossil fuel markets, weak supply chains, and geopolitical conflicts (Romanello et al., 2022). The International Energy Agency estimates that global energy demand will increase by 47 percent in the next 30 years, driven by population and economic growth, especially in developing countries in Asia, which will require increased production of oil and natural gas (Hays, 2023).

Reducing dependence on fossil fuels is one of the challenges, both for the government and society. In parallel, limited natural resources and increasing amounts of waste have led to the circular economy concept gaining importance over the last decade (Bowman et al., 2022). The basic principles of optimal and responsible use of resources for goals that lead to a transition to a circular economy are contained in the SDGs, supporting sustainable development between the economy, environment, and society (Kapoor et al., 2020). Concern over energy supply and security has prompted the government to provide incentives for faster implementation of a paradigm shift from fossil fuels to renewable energy that is environmentally friendly (Hosseini et al., 2023), thereby encouraging the commitment of countries to The Paris Agreement in efforts a shift away from fossil fuels as an effort to tackle climate change with a target of reducing carbon emissions by 30 percent in 2030 and reaching net zero by 2050 (Cevik, 2022).

Renewable energy and the circular economy concept are important in replacing fossil energy. It is an effort to reduce carbon emissions on the planet (Takman & Skold, 2021) and sustainable energy (Satpathy et al., 2022). The commitment of countries to the use of renewable energy and the impact of the stigma of the energy crisis provides new opportunities and challenges for countries in the world in the use of renewable energy; it is estimated that global renewable energy capacity will increase by nearly 2,400 gigawatts (nearly 75 percent) between 2022 and 2027 (International Energy Agency, 2022a).

Biogas boosting can play a key role among renewable energy sources thanks to its lower operating and capital costs and distinct organic biomass waste. Produced from the anaerobic fermentation of organic matter, biogas is considered a renewable energy source, which belongs to the "short carbon cycle" (Zito et al., 2022). Biogas can play a significant role in developing the renewable energy market. Biogas use worldwide is estimated to double in the coming years, from 14.5 gigawatts in 2012 to 29.5 gigawatts in 2022 (Khan et al., 2017). Demand for biogas in the global market is expected to increase from 26 to 39 billion USD from 2020 to 2028 (Zito et al., 2022). Biogas production has increased rapidly in the last decade due to the introduction of striking incentives for biogas production from renewable biomass (Brienza et al., 2021).

Indonesia is an agricultural country that has Abundant potential for bioenergy (biodiesel, bioethanol, biomass, and biogas) (Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi, 2014). Indonesia's biofuel consumption and production are expected to increase by 50 percent during 2022-2027 (International Energy Agency, 2022a); the Government of Indonesia has committed to implementing renewable energy through biofuels as stated in the Presidential Regulation of the Republic of Indonesia Number 22 of 2017 concerning the National Energy General Plan by establishing the target to achieve 23 percent utilization of renewable energy into the national energy mix and to provide biogas digesters with a target of 1.7 million households by 2025.

Table 1. Modeling of EBT Development for Direct Utilization of 2015-2050

Type	Unit	2015	2020	2025*
Biofuel	Million KL	2.3	8.0	13.9
Biomass	Million Tons	5.6	6.7	8.4
Biogas	Million m3	25.2	131.9	489.8
Coal Bed Methane	MMSCFD	0.3	0.9	46.0
Type	**Unit**	**2030***	**2035***	**2040***
Biofuel	Million KL	20.8	26,60	34,10
Biomass	Million Tons	10.7	12,10	16,30
Biogas	Million m3	783.5	1015,80	1346,30
Coal Bed Methane	MMSCFD	68.8	91,65	223,50

Description = * predictive data
Source: Presidential Regulation No. 22 of 2017 About the National Energy General Plan

The utilization of biogas is one of the targets for developing bioenergy-based renewable energy, as set out in the National Energy General Plan. However, the achievement of biogas utilization is still far from the target of the 2025 National Energy General Plan. Biogas Power Plants are targeted to reach a capacity of 5.5 gigawatts in 2025, of which only around 1.33 percent has been realized (Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi, 2020). Indonesia will need additional investment in renewable energy of around USD 8 billion per year by 2030 (International Energy Agency, 2022b).

Sharia-compliant financial services play a crucial role in financing renewable energy projects in Indonesia, particularly biogas development. The principles of Islamic finance, which emphasize equity, transparency, and ethical investment, align well with the sustainable and environmentally friendly goals of biogas energy. In the context of Indonesia's national energy targets, Islamic finance could provide much-needed capital to bridge the gap between current investments and the ambitious renewable energy goals set for 2025 and beyond (Hosseini et al., 2023; Satpathy et al., 2022).

Islamic finance offers several tools that could be leveraged for financing biogas projects, including Sukuk (Islamic bonds), Murabaha (cost-plus financing), Ijarah (leasing), and Musharakah (joint venture). These instruments can help mitigate the risks associated with renewable energy investments by offering risk-sharing models that are in line with the principles of fairness and social responsibility (Nassar, 2021). For instance, Sukuk could be used to raise capital for large-scale biogas infrastructure projects, allowing investors to participate in the growth of the renewable energy sector while generating returns in a Sharia-compliant manner. Musharakah, on the other hand, could be utilized to create partnerships between private investors, Islamic banks, and local communities to fund biogas plants and energy production (Sodagar et al., 2020).

Moreover, Indonesia's Islamic financial institutions, including Bank Syariah, Baitul Maal wat Tamwil (BMT), and Islamic microfinance institutions, could play an integral role in supporting small-scale biogas initiatives at the local level, especially in rural areas. These institutions, with their strong community ties and ethical investment focus, are well-positioned to provide microfinancing solutions for farmers, cooperatives, and rural households to adopt biogas technology. They could offer interest-free loans or low-interest financing options that would enable local communities to invest in biogas digesters, thus contributing to the overall national goal of increasing biogas capacity (Ahmad & Darwish, 2021).

The Government of Indonesia can encourage the integration of Sharia-compliant finance in renewable energy development through incentives and regulatory frameworks that recognize and support Islamic financial products. For example, tax exemptions or subsidies for biogas projects financed through Islamic finance instruments could provide a significant boost to investment in this sector (Hosseini et al., 2023). Furthermore, aligning Sharia-compliant finance models with the National Energy General Plan (RUEN) could provide a framework for Islamic banks and financial institutions to structure their products in a way that directly contributes to the country's renewable energy targets (Cevik, 2022).

Another promising model is the use of Zakat, Infaq, and Waqf funds for financing renewable energy projects in underserved areas. Zakat, a form of almsgiving, could be directed towards subsidizing energy access for low-income households through the construction of biogas digesters. Waqf, which involves endowment funds for charitable purposes, could also be leveraged to create a long-term fund for the maintenance and expansion of biogas energy infrastructure in rural areas. This would align with both the Islamic principle of social justice and the government's broader goal of ensuring equitable access to clean energy (Hassan et al., 2020; Khan et al., 2017).

By integrating Sharia-compliant finance into the biogas development framework, Indonesia has the opportunity to tap into an underutilized source of funding that is aligned with its social, environmental, and economic goals, ultimately accelerating the transition to a more sustainable energy future. This paper will present the models and strategies of financial institutions for financing in Indonesia. This paper aims to provide an overview of biogas, development strategies, and financing models for biogas in Indonesia.

RESEARCH METHODS

Research Approach

This study uses a qualitative approach with SWOT analysis introduced by Albert S. Humphrey (1960), where the determination of indicators of strengths, weaknesses, opportunities, and threats uses Porter's Diamond of National Advantage introduced by Michael Porter (1990) with the consideration that this method can explain, assessing and visualizing and modeling the architectural strategy of the financial services industry in initiating the development of biogas financing in Indonesia.

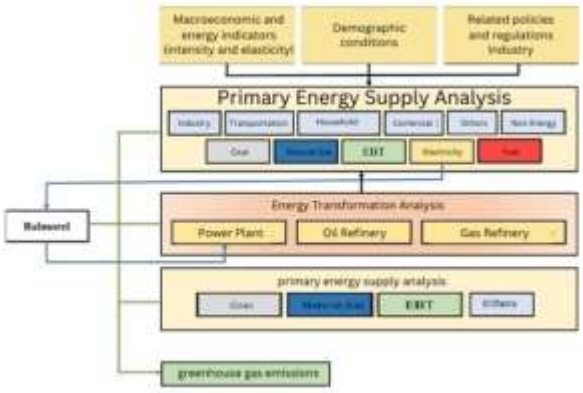
Data Types and Sources

The type of data used is secondary data, which can support studies in formulating the strategic architecture of the financial services industry in developing biogas-based financing. The data source for this research was obtained from literature studies through observation techniques, and literature was obtained from several reports issued by agencies involved in biogas development through financing in the financial services industry, as well as some other literature.

Research Framework

Within the framework of the research analysis, it starts from the relatively enormous bioenergy potential and has an area that has not been optimized. So, the government initiated the development of biogas financing by the financial services industry in Indonesia to formulate its strategic architecture. Analysis of the research analysis framework is divided into three stages, namely (see Figure 1) (Direktorat Jenderal Energi Baru, Terbarukan, dan

Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral, & United Nations Development Programme, 2021): (1) final energy demand analysis, which is carried out using several macroeconomic assumptions such as GDP growth, demographic growth and considering policies, strategic plans and roadmaps for the development of new and renewable energy; (2) energy transformation, considering RUPTL, RUEN and emission reduction; (3) analysis of primary energy supply, which takes into account the utilization of various types and potential sources of energy including various applicable policies and existing technological developments. Calculating new renewable energy needs uses the Balmoral model, an application of planning modeling that uses optimization (least cost).



Source: Sekretariat Jenderal Dewan Eergi Nasional, (2019)

Figure 1. Research Analysis Framework

The research conceptual framework starts from the problems and obstacles that have an impact on slowing down the mobilization of investment in the development of biogas financing, thus affecting the not-yet-optimal use of biogas as new renewable energy and slowing down the reduction of greenhouse gas emissions. The financial services industry, as a provider of funds (direct lending), initiated the design of the financial services architecture as a strategic map to achieve the initiation of biogas financing development in Indonesia through PLTBg. This idea emerged with a build-own-operate business model scheme or a build-own-transfer business model that applies the 5C principles, integrated with ASRI principles to pay attention to social, economic, and environmental aspects. The successful development of biogas financing investment as a new renewable energy through PLTBg is hoped to accelerate the transition project for the new energy sector.

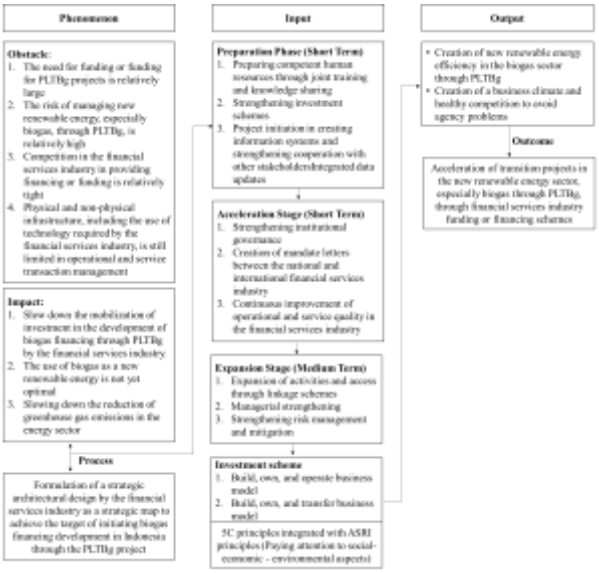


Figure 2. Initiation of Strategic Architecture Design as the Acceleration of the EBT Sector Transition Project for Biogas development through the PLTBg project

Analysis Tools

The analysis tool used is SWOT analysis, which is considered appropriate as a tool that can measure the capabilities and deficiencies of organizational resources, market opportunities, and threats to its future (Team Financial Management for Emergencies, 2013; Ferdinand & Tresyanto, 2020). The same thing was also expressed by Gulam (2011) and Gürel & Tat (2017), where SWOT analysis is a significant tool for conducting situation analysis with a

strategic planning framework consisting of internal factors (organizational factors in the analysis of strengths and weaknesses) and external factors (environmental factors in the analysis of opportunities and threats).

The use of Porter's Diamond of National Advantage was first introduced by Michael Porter (1990) with consideration of four characteristics used, namely (Watchravesringkan et al., 2010; Bakan & Doğan, 2012): (1) influencing circumstances; market conditions; (3) affiliated and additional industries; (4) business strategy, organization and competitiveness. Porter's Diamond Model analysis is considered appropriate in describing how the financial services industry formulates a framework related to competitiveness, which can give value to a country (Smit, 2010). This implementation is used to formulate the financial services industry's strategic architecture for biogas financing development.

Strategy architecture describes how "meta-strategies guide the selection and teaching of core competencies (Hamel & Prahalad, 1996). The same thing is explained by Mansfield, Fourie, & Gevers (2005), where strategy architecture is a complex construction passed on to measure organizational competitive behavior with a basic philosophy or orientation that reflects management attitudes and behavior to explain competitive advantage for the business being run.

RESULTS AND DISCUSSION

Overview of Biogas Development in Indonesia

In general, the use of biogas is the handling of organic waste through an anaerobic digestion system, which allows organic matter to decompose and become a source of energy and has the potential to reduce pollution from this waste (United States Environmental Protection Agency, 2020). According to Otoritas Jasa Keuangan (2014), where the agricultural sector, sewage, and urban waste are the most dominant sectors in producing biogas (see Table 2). This is because this sector provides a suitable substrate for anaerobic digesters in terms of both characteristics and supply levels, which makes it possible to run the Anaerobic Digestion system technically and economically (Wahyuni, 2011).

Table 2. Material Sources from Biogas

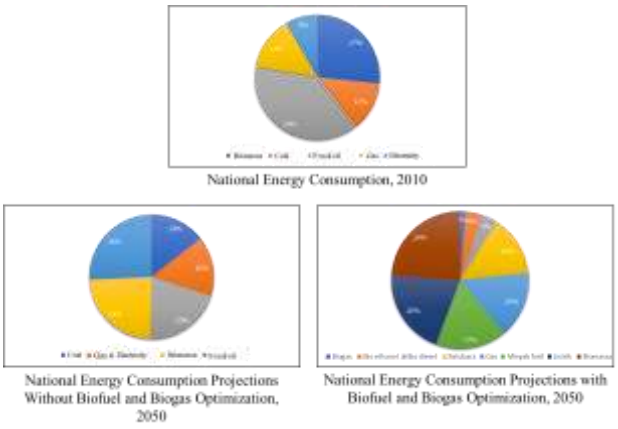
Source	Description
Agriculture	Sourced on waste from livestock production facilities such as pigs and cattle, and waste streams from agro-industrial operations such as palm oil refineries, tapioca flour processing plants, dairy processing facilities, refineries, slaughterhouses, and other food processing facilities
Liquid waste	Sourced municipal wastewater either directly treated by Anaerobic Digestion systems or sludge derived from factory sludge activated to be digested separately from this process
Urban solid waste	Sourced on urban solid waste which has a significant organic content of 15-35 percent, which can be treated with the Anaerobic Digestion system

Source: Otoritas Jasa Keuangan (2014)

Data from the Kementerian Energi dan Sumber Daya Mineral (2020) shows that the national energy consumption mix is dominated mainly by fossil oil at 38.24 percent, followed by biomass at 26.65 percent and gas at 14.02 percent. However, along with the awareness of clean and low-carbon energy, the government has begun to invest in bioenergy power plants as a new renewable energy source, especially biogas through PLTBg. PLTBg development status supplies 825 MW to bioenergy-based power plants in the ASEAN region. Indonesia is third after Thailand and Malaysia, with 112.2 MW or 13.6 percent (International Renewable Energy Agency, 2020; Kementerian Energi dan Sumber Daya Mineral, 2020). Considering this, Indonesia has a relatively large area and

potential for bioenergy energy compared to Thailand, which is leading the development of PLTBg in the ASEAN region. If viewed regionally, the highest biogas potential is in East Java Province (45,000 MW), followed by Central Java (17,000 MW), South Sulawesi (14,000 MW), West Nusa Tenggara (10,000 MW), and East Nusa Tenggara (9,500 MW) where 81 percent of its sources come from POME with a utilization scheme of 40 percent for internal utilization or captive power, 49 percent for excess power and 11 percent for IPP (Forum Kelapa Sawit Berkelanjutan Indonsia, 2017; Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral dan United Nations Development Programme, 2021).

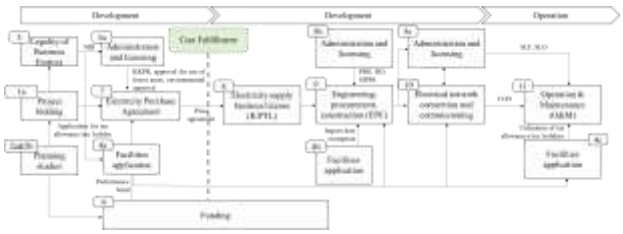
Despite its enormous potential, its utilization is still not optimal, so new and renewable energy production achievement targets need to be increased. Anwar Muhammad Foundation (2021) compares projected national energy consumption with and without optimizing biofuels and biogas. Where the projected energy consumption without optimizing biofuels and biogas is still dominated by fossil oil at 25.75 percent, followed by 23.88 percent and gas at 15.62 percent, while the projected energy consumption by optimizing biofuels and biogas reduces the dominance of the use of fossil oil. Karen is substituted for new and renewable energy such as bio-ethanol, bio-diesel, and biogas so that the highest position is the use of gas at 25.62 percent, followed by biomass at 23.88 percent and electricity at 20.39 percent (see Figure 3).



Source: Anwar Muhammad Foundation (2021)

Figure 3. National Energy Consumption Mix with or Without Optimization of Biofuel and Biogas Energy Sources, 2010 and 2050

In general, the biogas development and utilization cycle can be obtained through PLTBg, which is classified into three phases, namely: (1) the development phase, (2) the construction phase, and (3) the operating phase, which of these three stages has 11 stages which can be described in the Grant Chart and flow chart, namely (Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral, 2022): (1) project tender; (2) planning studies; (3) the legality of business entities; (4) application for facilities; (5) administration and licensing; (6) funding; (7) power purchase agreement; (8) business license for electricity supply; (9) engineering, procurement, and construction; (10) connection to the electricity grid and commissioning; and (11) operation and maintenance. The implementation of PLTBg development in Indonesia is contained in the Business Plan for the Supply of Electricity with Independent Power Producers (IPP) and PT PLN as the developers themselves (see Figure 4).



Source: Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral, (2022), modified

Figure 4. Biogas Development Cycle in PLTBg

Information:

Development Phase

- **Phase 1,** where PT PLN (Persero) conducts project tenders using a direct selection mechanism
- **Phase 2a**, Business entities participating in the auction prepare a planning study which includes (a feasibility study and connection study) which will be evaluated by PT PLN (Persero) as a consideration for determining the winner of the auction
- **Phase 3**, the business entity winning the auction as a prospective developer must form a new business entity by carrying out business entity legality
- **Phase 4a**, prospective developers must carry out the procedures for filing fiscal facilities (tax allowance or tax holiday)
- **Phase 5a**, prospective developers must also submit administrative and licensing procedures that are in line with the suitability of space utilization activities and environmental approvals
- **Phase 2b and 6,** prospective developers carry out a more detailed planning study as a requirement for submitting funding applications to funding providers
- **Phase 7**, the prospective developer signs a power purchase agreement to carry out a power purchase transaction with PT PLN (Persero) with a financial close

Construction Phase

- **Phase 8,** development candidates who have entered into a power purchase agreement can apply for a business license to act as a developer and can apply for a business license to supply electricity.
- **Phase 4b**, the developer can apply for an import duty exemption facility to carry out PLTBg construction with an electricity supply business license as a requirement
- **Phase 5b,** developers can also apply for building approvals and other business permits (disturbance permits, permits for taking and utilizing water
- **Phase 9,** the developer can carry out PLTBg construction
- **Phase 10**, when the construction activities have been completed, the developer must apply to connect the electricity network and commissioning
- **Phase 10**, the developer must carry out administrative and licensing procedures (certificate of proper function and certificate of operational worthiness)

Operation Phase

- **Phase 11,** if the construction and commissioning activities of the PLTBg have been completed, a commercial operation date will be issued so that after that, the operation and maintenance activities will be carried out
- **Phase 4c**, submitting facilities in the form of utilizing tax allowances and tax holidays

Utilization of Biogas as Renewable Energy

One of the fundamental problems of the energy sector in Indonesia is the energy

trilemma, which consists of (World Energy Council, 2016): (1) energy security, the creation of primary energy supply management that can meet current and future demand; (2) energy equity, creating accessibility and affordability of energy supply for the community; and (3) environmental sustainability, the creation of clean and environmentally friendly energy utilization. One of the government's main agendas in anticipating problems from the energy sector, which has the potential to result in an energy crisis, is to utilize new renewable energy, one of which is biogas (Thamrin, Sari, & Setioningrum, 2019). Biogas development programs are quite diverse, starting from household biogas, communal biogas, industrial biogas, biomethane, and compressed biomethane gas. According to the National Energy General Plan, the target for the contribution of biogas in the national energy mix is 498.8 million m3 in 2025; however, the achievement has only reached 32.47 m^3, or 6.5 percent, in 2022.

The Government carries out efforts to accelerate the processing and utilization of industrial-scale biogas through collaboration with various parties in the development of PLTBg, which considers pre-feasibility, economic studies, policy studies, trade systems, industrial studies, and raw materials (Dilisusendi, 2022). This is done because the biogas utilization scenario can convert electricity, gas, and fuel (see Table 1). According to Kristoferson, & Boldakaders (1991); Setyono, Mardianysah, & Astusti (2019), based on the biogas equivalent value, each application of 1 m3 is equivalent to: (1) lighting 60-100 watts of light bulbs for 6 hours; (2) cooking three types of food for the family (5-6 people); (3) substitute fuel 0.7 kg of kerosene; (4) power capable of running one horsepower motor for 2 hours; (5) a power plant that produces 1.25 kWh.

Table 3. Biogas Utilization Scenario

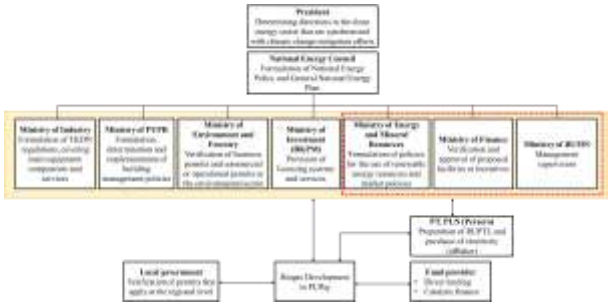
Scenario	Benefits
PLN grid interconnection power	Sales of electricity to PLN
Own electricity use	Savings of diesel fuel
Boiler (thermal energy)	Replaces shell waste or other solid waste
Gas for cooking	Sales of biogas for households
Biogas for transportation	Replaces vehicle fuel

Source: Otoritas Jasa Keuangan (2013)

The Role of Stakeholders in the Development of PLTBg in Indonesia

The development of biogas through PLTBg in Indonesia involves various stakeholders, including both central and local governments, fund providers, PT PLN (Persero), and its developers. Institutionally, given the complexity of the business process or investment in biogas development, the Government of Indonesia has developed a strategy by involving the roles and functions of relevant Ministries or Institutions, including regional governments, in the formulation of policies and regulations, licensing systems, investment processes and others related to the use of biogas as a source renewable energy resources (Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi, Kementerian Energi danSumber Daya Mineral dan United Nations Development Programme, 2021). Each stakeholder plays a crucial role in biogas development in Indonesia in order to create an attractive investment climate and encourage investment mobilization by utilizing clean energy and efforts to reduce greenhouse gas emissions in the energy sector (Lembaga Penyelidikan Ekonomi dan Masyarakat,

Fakultas Ekonomi dan Bisnis, Universitas Indonesia, 2016) (see Figure 5).



Source: Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral and United Nations Development Program (2021), modified

Figure 5. Stakeholder Institutions in Biogas Development in Indonesia

This biogas development is a strategic plan as one of the targets for the development of bioenergy-based renewable energy, which the Government of Indonesia prioritizes because it sees its massive potential. According to the Kementerian Energi dan Sumber Daya Mineral (2006), by 2025, PLTBg is targeted to reach a capacity of 5.5 gigawatts. However, the current realization is still 1.33 percent for both household and communal biogas. Therefore, future strategic plans for biogas development, namely (Kementerian Energi dan Sumber Daya Mineral, 2022): (1) synchronization and synergy of biogas development programs between stakeholders through the preparation of a National Biogas Development Roadmap; (2) development of biogas utilization technology that is integrated with other productive things; (3) optimizing sources of funding from government, private and foreign grants to finance biogas development and development; (4) education, socialization and technical guidance for biogas recipients; (5) conduct studies with stakeholders in the development and development of biogas.

The government's seriousness in managing this manifests in establishing a regulatory framework for utilizing biogas resources for electricity supply, which includes laws and their derivatives, such as government, presidential, and ministerial regulations. The overall regulations are classified into eight categories related to developing biogas-based power plants through PLTBg (see Table 4).

Table 4. Regulatory Framework for Biogas Development through PLTBg

Regulations	Poured on	Information
Energy resources	Law Number 30 of 2007 concerning Energy	This legislation regulates energy accessibility in Indonesia and has also formed the National Energy Council, which has the authority to formulate the National Energy Policy. Apart from that, this category has derivative regulations that regulate the use of renewable energy sources.
Electricity	Law Number 30 of 2009 concerning Electricity	This legislation regulates electricity-related processes and provisions, especially in business activities providing electricity and electricity purchase and sale agreements.
Waste management	Law Number 18 of 2008 concerning Waste Management	This legislation regulates the implementation of waste management as a renewable energy source to improve public health and environmental quality.

Job Creation	Law Number 11 of 2020 concerning Job Creation	This legislation regulates creating a quality business and investment climate for business actors, including foreign investors. One concrete proof is the simplification of business licensing related to electricity supply. Apart from that, this category has derivative regulations that regulate the licensing process and management of renewable energy sources.
Environment Life	Minister of Environment and Forestry Regulation Number 22 of 2018 and Minister of Environment and Forestry Regulation Number 26 of 2018	This regulation regulates the procedures and requirements for business licensing related to the environment
Fiscal Facilities	Minister of Finance Regulation Number 66 of 2015; Regulation Minister of Finance Number 11 of 2020; Regulation Minister of Finance Number 11 of 2020	This regulation regulates increased investment for developing PLTBio, including biogas through PLTBg, which has various facilities developers can utilize. This regulation also regulates the procedures and requirements for granting and utilizing fiscal facilities (tax allowances and tax holidays) the government provides to developers.
Domestic Component Level	Law Number 3 of 2014 concerning Industry	This legislation regulates the obligations of users of domestic products according to the quantity of domestic components.
Regulation by PT PLN (Persero)	PT PLN (Persero) Board of Directors Regulation Number 0062 of 2020	This regulation regulates the purchase of electricity from new renewable energy generators, including regulating the mechanisms and procedures for purchasing electricity from renewable energy, including biogas, through PLTBg.

Analysis of Expenditures and Risks in the PLTBg Project Cycle

The Indonesian economy has experienced relatively stable growth over the last decade. This is evidenced by the increasing use of energy and environmental impact. Where the development of clean energy is one of the solutions, the seriousness of the Government of Indonesia through the Ministry of Environment and Forestry in encouraging investment, making progress through initiatives and policies in the field of clean energy (renewable energy and energy efficiency) (Otoritas Jasa Keuangan, 2014). Another vital thing is the government's collaboration with other stakeholders in providing financial support for the development of financing for the financial services industry that applies sustainable finance principles to the clean energy sector. PLTBg project development requires a relatively inexpensive investment that

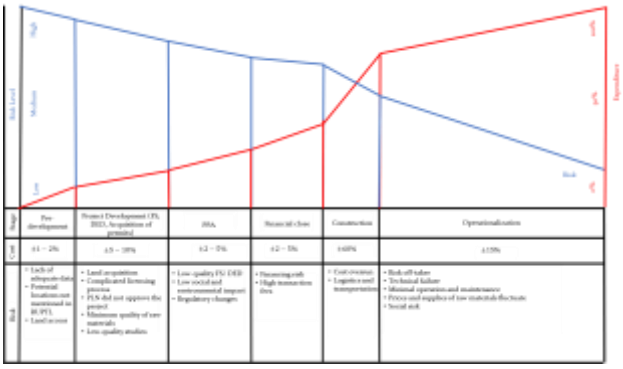
can be met from public investment and private investment (see Table 5). According to Perkumpulan Prakarsa (2021), sustainable finance is an important instrument in encouraging the creation of adaptive funding goals and climate change mitigation. This is done because there is a relatively large financing gap, due to the limited capacity of the State Budget, which requires support from private sector financing, particularly banking.

Table 5. Estimated Investment Costs in the Clean Energy Sector for PTBg Projects (USD, KW)

Technology	Economic life (years)	Capacity factor (%)	Net output level (kw)	Project Cost (USD, KW)					
				Machine design	Material	Civil	Installation	Contingency	Total
Biogas 500 kw	20	85	425	300 - 360	1.050 – 1.200	350 – 450	350 – 770	300 – 330	2.350 – 3.050
Biogas 1 mw	20	85	850	200 – 250	1.750 – 1850	450 – 520	450 – 550	250 – 300	2.950 – 3.330
Biogas 2 mw	20	85	1.700	130 - 150	1.600 – 1.750	350 – 375	230 – 300	170 – 200	2.580 – 2.975

Source: Otoritas Jasa Keuangan (2014)

If analyzed based on expenses, the PLTBg project is divided into four groups, namely (Otoritas Jasa Keuangan, 2019): (1) pre-investment costs, which include feasibility study costs, project management costs, design and permit engineering; (2) investment costs, which include civil and mechanical electical generator construction services costs, including financing for land acquisition, costs for obtaining funding and working capital costs for the first three months of operation before generating cash flows; (3) operating costs, which include costs incurred while PLTBg is in operation (fixed costs and variable costs) and maintenance; and (4) loan interest costs, which include loan fees charged by banks for development. Badan Kebijakan Fiskal (2020) also disclosed the same thing, the PLTBg project development process is divided into six stages, namely: (1) pre-development; (2) project development; (3) PPAs; (4) financial close: (5) construction; (6) operationalization.



Source: Pusat Studi Energi Universitas Gadjah Mada (2021), modified

Figure 6. Estimated Cost and Risk Expenditures from PLTBg Development

Of all the stages, the most significant risk of PLTBg is detected before the construction period to obtain financial close because these stages are the stages of project identification and development, which take into account the condition, availability, and continuity of the feedstock needed for the sustainability of the plant when it has entered the operationalization stage (see Figure 6). For the construction phase, PLTBg development has the highest cost expenditure with risks that also tend to be high because it involves the construction of a biogas reactor, which is used for priority-scale electricity generation. Entering the operationalization stage, biogas production has a low risk because the PLTBg project relies on cooperation with land owners who also control waste.

The Importance of the Financial Services Industry Involved in Financing Biogas Development in Indonesia

In the last few decades, national banks have started to actively participate in financing the new and renewable energy sector. This is done so that banks can become actors of change that encourage development in a more

sustainable direction while solving the climate crisis problem through green funding and emphasizing carbon-intensive sectors (Perkumpulan Prakarsa, 2021). Unfortunately, this has not been supported by targets and commitments to get out of fossil financing immediately, and national banks do not yet have emission reduction targets in funding and investment activities that align with the Paris Agreement targets. According to the Otoritas Jasa Keuangan (2019), banks need to be involved in financing a sustainable business sector, which is realized by integrating environmental and social aspects in lending. In addition, banking policies and procedures that show the roles and responsibilities of banks in carrying out their policies need to be included in determining capacities and procedures as well as evaluation and monitoring in lending, including risks and their mitigation in environmental and social aspects when carrying out processes and monitoring lending.

Financial services banking will not consider environmental and social aspects because they cannot review them themselves, so banks cooperate with independent consultants to obtain objective opinions. The thing to note regarding biogas development through PLTBg is financial analysis, which generally uses NPV and IRR with several assumptions that must be considered and considered, namely (Otoritas Jasa Keuangan, 2019): (1) assumptions used; (2) the completeness of the cost and revenue structure to predict cash inflows and outflows; (3) potential cost overruns; (4) sensitivity analysis to test the assumptions used when the project experiences disruptions. Generally, banks will fund 70 percent of the investment cost, while the project sponsor will provide the other 30 percent. Winrock International (2015) states that the financing structure, investment costs, PLTBg project location, and usage scenarios will affect the NPV and IRR. To consider credit analysis from banks for biogas development through this PLTBg, an analysis of the 5C principles was carried out, which also included ASRI aspects (see Table 6).

Table 6. Analysis of Principle 5 C on Banking Credit Provision in Biogas Development through PLTBg

Principle	Information
Capacity	Demonstrate the ability to repay the loan. ASRI integration in this principle considers the financial analysis of PLTBg, which considers financial and non-financial assumptions used to estimate future cash flows to assess the ability to pay loans and interest.
Collateral	Shows the PLTBg credit guarantee, which generally constitutes the PTBg itself. The ASRI concept is fundamental to evaluate because the cash flows and project assets used for collateral are used for loan payments, which are assets that have both environmental and social risks. When conditions require a bank to take over collateral, the bank will be directly affected by the impact of environmental and social risks
Capital	Shows the capital strength of the project sponsor (the other 30 percent), where this credit analysis considers the financial requirements required by PT PLN (Persero) or the Ministry of Energy and Mineral Resources for the project sponsor.
Conditions	Demonstrates the characteristics of PLTBg in producing electricity by utilizing waste close to the community. So, credit analysis must realize that the success of PLTBg is closely related to social and environmental risks, including changes and dynamics.

Character	Shows aspects of the debtor's characteristics and behavior. ASRI integration, where credit analysis needs to pay attention to the credit applicant's track record and whether they have been involved in environmental and social violations.

Source: Otoritas Jasa Keuangan (2014).

The Role of Sharia-Compliant Financial Services in Indonesia's Biogas Financing Framework

The architecture of Indonesia's financial services industry in supporting biogas finance development must not overlook the significant potential of Islamic finance. As an integral part of the national financial ecosystem, Islamic finance offers unique instruments and institutional models that align with the objectives of sustainable energy, ethical investment, and inclusive development—values that are inherently embedded in biogas projects.

Islamic finance plays a strategic role in supporting the development of biogas financing in Indonesia. As part of the financial services industry grounded in Islamic values, this system offers alternative financing that emphasizes not only profitability but also principles of fairness, transparency, and sustainability. These principles align closely with the ethos of renewable energy development—particularly biogas—which promotes environmental sustainability and community economic empowerment.

Several Islamic financial instruments such as mudharabah, musyarakah, and ijarah muntahiya bittamlik (IMBT) can be utilized across various scales of biogas projects. Under a mudharabah scheme, the investor provides the capital while the entrepreneur (such as a farmer or community group) manages the biogas project, with profits shared according to a pre-agreed ratio. Musyarakah, as a joint partnership based on shared ownership, allows multiple parties to co-finance and co-manage the biogas operation. Meanwhile, IMBT is suitable for biogas installations leased to end-users with an option of ownership transfer at the end of the contract.

Beyond financial instruments, the role of Islamic financial institutions is also crucial. Islamic commercial banks, Islamic rural banks (BPRS), and microfinance institutions such as Islamic cooperatives and Baitul Maal wa Tamwil (BMT) can act as financing partners for biogas projects of various sizes. Microfinance institutions are particularly well-positioned to support rural communities through small-scale, household, or community-based biogas installations.

In addition to commercial financing, Islamic finance also allows for the utilization of Islamic social funds such as zakat, infaq, sadaqah, and waqf (ZISWAF). These funds can be allocated to support non-commercial aspects of biogas development, including training, education, and the initial installation for underprivileged groups. For example, productive waqf can be implemented in the form of cash waqf to finance biogas installations in Islamic boarding schools (pesantren) or model villages. This approach has been demonstrated through a collaboration between Bank Syariah Indonesia (BSI) and the Indonesian Waqf Board (BWI), which launched a *waqf-linked microfinancing* program targeting green energy initiatives, including biogas projects.

From a regulatory standpoint, the application of Islamic finance in biogas projects is well supported. Relevant fatwas issued by the National Sharia Council of the Indonesian Ulema Council (DSN-MUI), such as Fatwa No. 115/DSN-MUI/IX/2017 on musyarakah and Fatwa No. 106/DSN-MUI/X/2016 on IMBT, provide the necessary shariah-compliant

frameworks. Furthermore, regulations by the Financial Services Authority (OJK) on the issuance of environmentally-oriented bonds (POJK No. 60/POJK.04/2017) may be adapted for *green sukuk* in renewable energy sectors. BWI regulations also support productive waqf schemes, including those under the green waqf model.

To ensure systemic impact, a comprehensive Islamic finance architecture strategy for biogas should also include: (1) Regulatory integration of green sukuk and Islamic project financing, (2) Capacity building for Islamic financial institutions in assessing renewable energy projects,(3) Development of digital Islamic finance platforms to reach rural markets, and (4) Multi-stakeholder collaboration among energy providers, Islamic NGOs, and financial technology startups. Ultimately, by integrating Islamic finance into the broader architecture of financial services for biogas development, Indonesia can leverage its dual financial system to accelerate the transition toward a clean, just, and inclusive energy future

With these potentials, Islamic finance can become an integral component of Indonesia's financial services architecture strategy in advancing biogas financing. Strengthening synergy among Islamic financial institutions, regulators, renewable energy developers, and community beneficiaries is essential to realize a fair, inclusive, and sustainable energy transition.

Sharia-Compliant Finance: A Paradigm Shift for Biogas and Energy Transition in Indonesia

The future of Indonesia's energy transition is not merely a matter of shifting technologies it is about transforming paradigms. Biogas, as a decentralized, regenerative, and community-powered energy source, is an ideal medium through which a new financial ethic can be tested and realized. In this regard, sharia-compliant financial services are not supplementary tools; they are the philosophical backbone of a new, inclusive energy economy.

Unlike conventional finance that often treats nature as an exploitable asset and profit as the end goal, Islamic finance offers a sacred lens where energy is viewed as a trust (amanah) from God, and financing is a means of restoring balance (mizan) between humans and the environment. In this context, biogas is not simply a renewable fuel—it is a medium of barakah, a way to reconnect spiritual values with economic actions.

This vision requires a complete redesign of the financial ecosystem. Imagine a national biogas endowment fund powered by waqf, where every cow or farm waste unit becomes a source of clean energy for surrounding communities. Picture a zakat-based energy equity model, where surplus wealth from urban Muslim populations finances energy access in off-grid villages—not as charity, but as a right. Envision a biogas sukuk framework where investors seek not only returns, but also spiritual merit (pahala) and environmental justice.

Sharia-compliant institutions—BMTs, Islamic cooperatives, pesantren-based fintechs—can be transformed into energy missionaries, bringing financing and technical support in one integrated value chain. They do not merely fund infrastructure—they nurture ecosystems, build human capital, and empower local ownership.

Regulators and scholars must also be bold. A "Fatwa on Climate Justice", for example, could legitimize the use of zakat or waqf for

renewable energy. Otoritas Jasa Keuangan could create a Green Islamic Finance Sandbox, incubating disruptive models that blend fintech, blockchain, and Islamic principles to support carbon-free villages. Universities and Halal Centers could pioneer Shariah-compliant impact measurement tools that define success beyond ROI—such as reduction in carbon footprint, community wellbeing, and energy sovereignty.

Ultimately, sharia-compliant financial services are not just mechanisms for financing biogas—they are blueprints for an energy civilization rooted in equity, care, and divine accountability. In a world racing toward climate catastrophe, Indonesia has the opportunity to lead not only technologically, but morally. And it begins with reimagining biogas not just as fuel, but as faith in action.

SWOT analysis

Kearns (2006) developed a qualitative approach to analyze external conditions (opportunities and challenges) and internal (strengths and weaknesses). One of the analysis tools that can be used is the Berlian Porter Model (1990), which also applies a descriptive analysis of institutional conditions that can be implemented in the financial services industry to estimate the competitiveness of these institutions in initiating financing in the biogas sector. Institutions can implement this analysis, including the financial services industry in biogas financing in Indonesia (see Table 7).

Table 7. SWOT Identification for PLTBg Industrial Investment

No	Variable	Condition Identification			
		S	**W**	**O**	**T**
Main Factors Condition Factors					
1	Ease for managers of the financial services industry in offering convenience in funding and financing as well as for the biogas industry as an object so that it is easy to receive funding and financing assistance from the financial services industry	v			
2	Criteria for HR managers in the financial services industry who meet managerial needs	v			
3	The health of the financial services industry in accordance with Financial Services Authority Regulation Number 4 /POJK.03/2016 concerning Assessment of the Soundness Level of Commercial Banks and Financial Services Authority Regulation Number 28/POJK.05/2020 Assessment of the Soundness Level of Nonbank Financial Services Institutions	v			
4	*Linkage system*with channeling, executing or joint financing schemes that can be utilized between the financial services industry which can increase funding and financing service capacity and overcome liquidity problems			v	
5	The technology used in the financial services industry is still limited in operational transaction management. So it is necessary to collaborate with external parties, technology companies or universities in forming information systems		v		
6	Physical and non-physical infrastructure as management equipment still has weaknesses that can be developed because it must comply with standards and is still simple		v		
Request Conditions					

1	Realization of operational and service quality from the financial services industry in funding or financing that is in accordance with customer perceptions (compliance, assurance, responsiveness, tangible, empathy, reliability)	v			
2	The characteristics of the new renewable energy sector, especially biogas through PLTBg, generally require a large funding ceiling or financing			v	
3	Procedural or administrative funding or financing with complicated bureaucracy		v		
4	The availability of complete integrated data on funding or financing in the new renewable energy sector, especially biogas through PLTBg, is still limited				v
5	Growth in funding or financing in the new renewable energy sector as a whole or in the biogas sector through PLTBg is still relatively limited when compared to other market shares		v		
Related and Supporting Industries					
1	Relatively good access to funding or financing from the financial services industry through collaboration to strengthen capital with linkage schemes either through channeling, executing or joint financing	v			
2	Proposals related to the Mandate Letter from both the international and multinational financial services industry to accelerate the transition project to the new and renewable energy sector, especially biogas through PLTBg which is being worked on by the company			v	
3	There is no special institution that handles funding or financing of the new renewable energy sector, especially biogas through PLTBg, so this has the potential to create obstacles to funding and financing				v
4	In the energy transformation scenario, investment and efficiency in the new renewable energy sector, especially biogas through PLTBg carried out by the financial services industry, is able to contribute to the macro economy, especially in opening up new jobs		v		
Structure, strategy and competition					
1	Institutional governance (good corporate governance) of the financial services industry in collaboration with insurance and guarantee companies is good in providing funding or financing to the new renewable energy sector, especially biogas through PLTBg	v			
2	Tight business competition because they have the same market segmentation in providing funding or financing services in the new renewable energy sector, especially biogas through PLTBg				v
3	The development of the new renewable energy sector, especially biogas through PLTBg, which requires funding or financing that encourages operations and practices in the financial services industry			v	
Supporting Factors for the Role of Government					
1	The government is encouraging new energy and other low-carbon technologies to create new jobs and restore the economy			v	
2	There needs to be regulatory support to form healthy competition in the financial services industry to and avoid agency problem practices (the emergence of costs related to the behavior of stakeholders and financial institution managers)			v	
3	Ease for the financial services industry in channeling funding or financing through programs proposed by Ministries or institutions for the new renewable energy sector, especially biogas through PLTBg	v			
The Role of Chance					
1	Investments made by the financial services industry in the new renewable energy sector, especially biogas through PLTBg, are aimed at achieving an energy price structure that is economically appropriate so that it is in line			v	

	with people's purchasing power and the availability of energy infrastructure	
2	Opportunities for the financial services industry to invest are open because the development of the new renewable energy sector, especially biogas through PLTBg, is still supported by the APBN structure.	v
3	Improved economic growth will increase the need for the new renewable energy sector, especially biogas through PLTBg, to attract investment in the financial services industry which is needed in the development of the energy sector	v

Program Strategy for Funding or Financing in the New and Renewable Energy Sector, especially Biogas through PLTBg

Based on the SWOT analysis with Porter's Diamond Model, four strategies are obtained: intersections between internal and external factors. The expected output is a strategy compiled from the management aspect of the financial services industry in providing funding or financing in the new renewable energy sector, especially biogas, through PLTBg (see Table 8).

Table 8. Intersection of SWOT Analysis Internal and External Factors with Porter's Diamond Model

Competitive advantage is a condition that describes the ability of the financial services industry to achieve relatively good performance so that the financial services industry can carry out aggressive and expansive movement plans, including::	
Optimization of funding or financing schemes in the new renewable energy sector, especially biogas, through PLTBg (Strategy a)	**Moderate.** The need for new renewable energy, especially biogas through biogas, globally to achieve net zero emissions by 20050 requires a capital requirement of $35-45 trillion (Irena, 2020). So, it is essential to optimize the appropriate funding and financing scheme for the financial services industry within a specific period, according to the feasibility analysis, while also helping to mitigate the economic risks of climate change (Ningrum, Supriyadi, & Zulkarnain, 2019; Rianawati et al., 2021). Generally, the financial services industry provides funds for funding or financing ranging from 65-75 percent of its total investment (Otoritas Jasa Keuangan, 2014)
Creation of an information system for the financial services industry and funding or financing schemes in the new renewable energy sector, especially biogas, through PLTBg (Strategy b)	**Very High. T**he network of the extensive financial services industry is expected to be optimal with the creation of an integrated information system related to funding or financing schemes in the new renewable energy sector, especially biogas through PLTBg to support the physical infrastructure of the financial services industry and the good health conditions of the financial services industry (Elizabeth, & Rusdiana, 2008).
Strengthening cooperation between the financial services industry and other stakeholders (Strategy c)	**Quite high.** Strengthening the cooperative relationship between stakeholders involved in the development, especially biogas through PLTBg, starting from research, preparing Standard Operating Procedures to the evaluation process so that funding or financing from the financial services industry is integrated and sustainable (Emerson, Syarief & Asmara, 2020)
Mobilization is a condition that describes the financial services industry being able to optimize its resources to minimize incoming threats so that the financial services industry can survive incoming threats, including:	
Conducting joint training	**Quite High.** Increasing the capability of human resources owned by

to improve human resources in the financial services industry (Strategy d)	the financial services industry so that they comprehensively understand the business process of PLTBg and key documents used in funding or financing analysis, including the Power Purchase Agreement (PPA)
Conducting risk mitigation and management (Strategy e)	**Quite High.** The financial services industry is expected to be able to design planning in carrying out mitigation and risk management resulting from the funding or financing process in the renewable energy sector, especially biogas through PLTBg, such as credit risk, reputation risk, and legal risk (Winrock International, 2015).
Investment is a situation where the financial services industry is faced with opportunities but resources are unable to realize them because they are faced with weaknesses, so the financial services industry can decide to make long-term investments or decide to let go of existing opportunities, including:	
Cooperation in the implementation of the Tri Dharma of Higher Education in the development of the new renewable energy sector, especially biogas, through PLTBg (Strategy f)	**Moderate.** The development of higher education and the role of the tri dharma of higher education can be utilized to encourage the financial services industry to be involved in funding or financing the new renewable energy sector, especially biogas, through PLTBg. So that sustainable finance is achieved by integrating environmental and social aspects in providing funding or financing (Otoritas Jasa Keuangan, 2014).
Strengthening the managerial structure of the financial services industry (Strategy g)	**Quite High.** Encourage the managerial level to actively participate in providing funding or financing in the renewable energy sector, especially biogas through PLTBg through the financial services industry policy outlined in the determination of capacity and procedures for provision and monitoring (Govender, Thopil & Inglesi-Lotz, 2019). The involvement of the financial gauze industry in the PLTBg project is an opportunity and a contribution to the development of its credit portfolio (Perkumpulan Prakarsa, 2014).
Damage control is a situation where the financial services industry faces weaknesses and threats that are difficult to avoid. Hence, the financial services industry is careful in taking policies that do not threaten the sustainability of its services. Includes:	
Submission of hearing to regulators regarding regulations as a legal umbrella for funding or financing in the new renewable energy sector, especially biogas, through PLTBg (Strategy h)	**Quite High.** The management of the financial services industry is expected to be able to communicate effectively with regulators to produce regulations to support the activeness of the financial services industry in optimal funding or financing in the renewable energy sector, especially biogas through PLTBg, which supports sustainable development (Winrock International, 2015).
Education and socialization related to funding or financing in the new renewable energy sector, especially biogas, through PLTBg (Strategy i)	**Moderate.** Management of the financial services industry is expected to conduct education and socialization related to the funding or financing scheme in the renewable energy sector, especially biogas through PLTBg, so that it can be utilized optimally (Yousuf et al., 2016).

The strategic preference used by the management of the financial services industry is calculated based on the Quantitative Strategic Planning Matrix approach with a range of preference answers ranging from 1-4 with criterion 1 = low; 2 = moderate or moderate; 3 = relatively high; 4 = very high (Rangkuti, 1997, 2003). The preparation of strategic preference calculations is carried out based on priority plans carried out

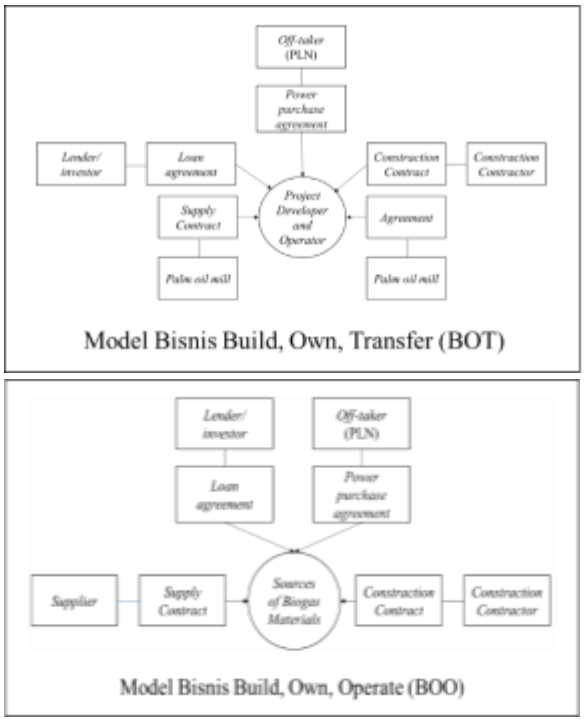
by the financial services industry's management to overcome the SWOT approach (see Table 9).

Table 9. Formation of a Financial Services Industry Strategy for PLTBg Funding

	(Strenghts/ S)	**(Weaknesses/ W)**
(*Opportunities*/ O)	***Competitive advantage***	***Mobilization***
	• Strategy a - S5; S3; O2; O4; O7	• Strategy d - O1; O5; O8; W1; W2
	• Strategy b - S1; S7; O6; O9; O8	• Strategy e - O2; O3; O4; O6; O7; O9; W3; W4; W5
	• Strategi c - S6; S4; S2; O1; O3; O5	
(Threatnesses/ T)	***Investment***	***Damage control***
	• Strategy f - S3; T1; T2	• Strategy h - W1; W3; W4; W5; T3
	• Strategy g - S1; S2; S4; S5; S6; S7; T3	• Strategy i - W2; T1; T2

Technically, the financial services industry has a significant role in society, one of which is contributing to long-term sustainable development through the products and services it provides. One is in the renewable energy sector, which is predicted to be the future industry. Moreover, Indonesia has enormous potential for developing renewable energy (Otoritas Jasa Keuangan, 2014). This is done with the following considerations: (1) clean energy generates economic benefits of three to eight times the initial investment (International Renewable Energy, 2020); (2) the volatility of fossil fuel prices is a global opportunity to accelerate the shift to clean energy (S&P Global, 2022); (3) investment in renewable energy and energy efficiency creates 63 million new jobs (International Renewable Energy Agency, 2020). This tremendous potential needs support from the financial services industry. According to the Otoritas Jasa Keuangan (2014), the fact is that only a small proportion of them fund or finance the new renewable energy sector, especially in the biogas sector through PLTBg, because their knowledge of the energy business model and the resulting risks are relatively high.

Therefore, an approach is needed for the financial services industry so that it is willing and able to be involved in funding or financing PLTBg projects by considering environmental, technical, financial, and legal risks. So, there is a need for strategic collaboration between stakeholders and the financial services industry to design scheme procedures to analyze and monitor the provision of funding or financing for PLTBg projects that have been in effect so far. There are two schemes in the development of biogas, namely (Otoritas Jasa Keuangan, 2014; Basuki & Kartono, 2012; Paulose, 2013; Kanaidi, 2021): (1) the build, own, operate business model a cooperative pattern where the owner of the biogas source builds PLTBg and operating it, this scheme involves external parties such as the financial services industry as investors, contractors, and project operators but all responsibility and ownership of PLTBg lie with the owner of the biogas source who built the PLTBg; (2) the build own transfer business model, a pattern of cooperation by conducting external financing that provides benefits to the government through PLN because the project business risks are fully transferred to the private sector, this scheme is a third party developing and operating a biogas project by the concession period and at the end of the party's period the third is to transfer operations and ownership of PLTBg.



Source: Basuki & Kartono, (2012); Financial Services Authority, (2014)

Figure 7. Biogas Development Business Model

Strategic Architectural Design

Strategic architectural analysis is a strategic map that can be used to achieve the target of initiating the development of biogas financing in Indonesia through the PLTBg project (see Figure 5). This strategy is divided into three stages, which are carried out in the long term in order to achieve the expected end goal, namely: (1) preparation, (2) acceleration (speed), and (3) expansion (expansion). This architectural design can guide the financial services industry in accelerating transition projects in the new renewable energy sector, especially biogas, through PLTBg through a funding or financing scheme. This is done to create new and renewable energy efficiency, especially in the biogas sector, through PLTBg, which is based on the economy, society, and environment. It also creates a business climate and healthy competition to avoid agency problems.

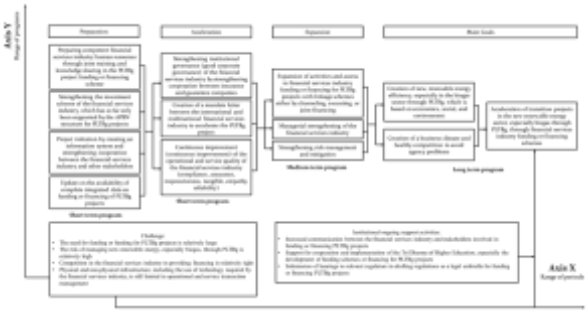


Figure 8. Architectural Strategy for the Financial Services Industry in Indonesia

From an Islamic financial perspective, this strategic approach can be further enhanced by embedding sharia-compliant principles at each stage. In the preparation phase, Islamic finance could provide early-stage funding through crowd-based funding models, such as sukuk (Islamic bonds) or waqf (charitable endowments) to ensure equitable access to energy resources. These structures can gather initial capital while adhering to the principles of risk-sharing (mudarabah) and profit-sharing (musyarakah), which are central to Islamic finance. This ensures that financial benefits are distributed fairly among all participants, preventing exploitation of any party and ensuring ethical development.

During the acceleration phase, sharia-compliant financial institutions, such as Islamic banks or cooperatives (BMTs), can step in with project financing through ijarah (leasing) or murabaha (cost-plus financing), ensuring that financing is structured to be both ethical and efficient. These instruments would align with the goal of boosting renewable energy without falling into the pitfalls of interest-based lending, as conventional financing models often do. The acceleration phase in Islamic finance would also focus on zakat-funded initiatives, where surplus

wealth is channeled to finance sustainable projects, aligning with Islamic obligations to help the less fortunate and ensure economic justice.

In the expansion phase, the long-term growth of PLTBg projects could be supported through the issuance of green sukuk, a form of Islamic bond designed to fund projects that contribute positively to the environment. This phase would integrate Islamic social finance tools, such as waqf, to ensure that biogas plants are not only financially sustainable but also contribute to community welfare. Moreover, shariah-compliant microfinancing solutions can help expand biogas usage to rural areas by offering affordable access to clean energy, which can empower local communities and reduce energy poverty.

In this Islamic finance-driven framework, the PLTBg project can contribute to sustainable development goals (SDGs), with a focus on environmental justice, poverty alleviation, and social equity. Moreover, the use of Islamic finance tools helps ensure that financial flows are ethical, avoid exploitation, and are designed for the benefit of both the individual and the collective, adhering to the core principles of mizan (balance), amanah (trust), and adl (justice) in Islam.

This integrated approach ensures that biogas financing is not only a step towards energy efficiency but also a catalyst for socio-economic justice and environmental stewardship in line with Islamic financial values.

CONCLUSION

The Government of Indonesia has committed to running renewable energy through biofuel as stated in the Presidential Regulation of the Republic of Indonesia Number 22 of 2017 concerning the National Energy General Plan by setting a target of achieving 23 percent of renewable energy utilization in the national energy mix and establishing a biogas digester with a target of 1.7 million households by 2025. Utilizing biogas is one of the targets for developing bioenergy-based renewable energy, as set out in the National Energy General Plan. However, the achievement of biogas utilization is still far from the National Energy General Plan 2025 target. Biogas Power Plants are targeted to reach a capacity of 5.5 gigawatts in 2025, realizing it is only around 1.33 percent.

There are two schemes used in the development of biogas, namely: (1) the build, own, operate business model whereby the owner of the biogas source builds PLTBg and operates it; this scheme involves external parties such as the financial services industry as investors, contractors and the project operator but all responsibility and ownership of the PLTBg lies with the owner of the biogas source who builds the PLTBg; (2) the build own transfer business model, a pattern of cooperation by conducting external financing that provides benefits to the government through PLN because the project business risks are fully transferred to the private sector, this scheme is a third party developing and operating a biogas project by the concession period and at the end of the party's period the third is to transfer operations and ownership of PLTBg.

Strategic architectural analysis is a strategic map that can be used to achieve the target of initiating the development of biogas financing in Indonesia through the PLTBg project (see Figure 5). This strategy is divided into three stages, which are carried out in the long term in order to achieve the expected end goal, namely: (1) preparation, (2) acceleration (speed), and (3) expansion (expansion). This

architectural design can guide the financial services industry in accelerating transition projects in the new renewable energy sector, especially biogas, through PLTBg through a funding or financing scheme. This is done in order to create new and renewable energy efficiency, especially in the biogas sector through PLTBg that is based on the economy, social, and environment, as well as the creation of a business climate and healthy competition to avoid agency problems.

REFERENCES

Ahmad, K., & Darwish, M. (2021). Islamic finance: Principles and practices. *Journal of Islamic Economics*, 28(4), 45-61.

Anwar Muhammad Foundation. (2021). Kajian Akademik Kebijakan Energi Baru Terbarukan dan Konservasi Energi (EBTKE) di Indonesia. Anwar Muhammad Foundation, July, 21st 2021, 10.10 WIB. Available at https://amf.or.id/kajian-akademik-kebijakan-energi-baru-terbarukan-dan-konservasi-energi-ebtke-di-indonesia/, January, 24th 2023

Bakan I, & Doğan F. (2012). "Competitiveness of The Industries Based on The Porter's Diamond Model: An Empirical Study". *International Journal of Recent Research and Applied Studies,* 1 (3): 441-455

Basuki, Y.T., & Kartono, R. (2012). "BOO and BOT is a Strategic Alternatif Solutionto Help Business Sustainability in the Pharmacheutical Indistries for Complying of The CPOB (Cara Pembuatan Obat yang Baik) Indonesia Regulation No. HK. 03.1.33.12.12Year 2012". *Advanced Science Letters*, 21(5): 1154-1157

Bowman, G., Ayed, L., & Burg, V. (2022). Material And Energy Flows Of Industrial Biogas Plants In Switzerland In The Context Of The Circular Economy. *Bioresource Technology Reports*, *20* (101273): 1-9

Bowman, J., & Singh, K. (2022). Circular Economy and Renewable Energy: Bridging the Gap. *International Journal of Renewable Energy*, 47(2), 312-328.

Brienza, C., Sigurnjak, I., Meier, T., Michels, E., Adani, F., Schoumans, O., Vaneeckhaute, C., & Meers, E. (2021). Techno-Economic Assessment At Full Scale of A Biogas Refinery Plant Receiving Nitrogen Rich Feedstock and Producing Renewable Energy and Biobased Fertilisers. *Journal of Cleaner Production*, *308 (*127408): 1-11

Cevik, S. (2022). Climate Change and Energy Security: The Dilemma or Opportunity of the Century?. *IMF Working Papers*, *22* (174), 1-20

Dilisusendi, T. (2022). *Kebijakan Pengembangan Biometana di Indonesia*. Prepared for Bioshare Series 8: Exploring the Future of Biomethane in Indonesia. Bandung 19 Oktober 2022. https://www.youtube.com/watch?v=PZ5DmBQeVx4

Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral, & United Nations Development Programme. (2021). *Pedoman Investasi Pembangkit Listrik Tenaga Bioenergi*. Jakarta: Kementerian Energi dan Sumber Daya Mineral. Available at https://www.ebtke.esdm.go.id/lintas/storage/pedoman_investasi/1648782420-BLlcdr3Ajz.pdf

Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral. (2022). Strategi Pengembangan Biogas Kejar Target Bauran Energi. Jakarta: Kementerian Energi dan Sumber Daya Mineral https://ebtke.esdm.go.id/post/2020/07/06/2579/strategi.pengembangan.biogas.kejar.target.bauran.energi

Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi. (2014). *Indonesia sebagai Lumbung Bioenergi Dunia.*

Kementerian Energi dan Sumber Daya Mineral, March, 15th 2014, 01.01 WIB. Available at https://ebtke.esdm.go.id/post/2011/01/17/70/indonesia.sebagai.lumbung.bioenergi.dunia January, 24th 2023.

Direktorat Jenderal Energi Baru, Terbarukan dan Konservasi Energi. (2020). Strategi Pengembangan Biogas Kejar Target Bauran Energi. Kementerian Energi dan Sumber Daya Mineral, July, 06th 2020, 11.05 WIB. Available at https://ebtke.esdm.go.id/post/2020/07/06/2579/strategi.pengembangan.biogas.kejar.target.bauran.energi January, 24th 2023.

Elizabeth, R., & Rusdiana, S. (2008). "Efektivitas Pemanfaatan Biogas sebagai Sumber Bahan Bakar dalam Mengatasi Biaya Ekonomi Rumah Tangga di Perdesaan". *Pusat Studi Ekonomi*, 220–234.

Emerseon, E., Syarief, R., & Asmara, A. (2020). "Sustainability Strategy to Utilize the Biogas of Tapioca Industry in PD XYZ". *Manajemen IKM*, 15 (1): 84-93

Ferdinand, D.Y.Y. & Tresyanto, C.A. (2020). "Marketing Strategy Using Porters Five Force Model Approach: A Case Study At The Culinary Center In Sidoarjo Regency". *International Journal of Business and Management Invention*, 9 (11): 44-48

Forum Kelapa Sawit Berkelanjutan Indonesia. (2017). *Rencana Aksi Nasional Kelapa Sawit Berkelanjutan Periode 2018-2023*. Jakarta: Forum Kelapa Sawit Berkelanjutan Indonesia

Govender, I., Thopil, G.A., & Inglesi-Lotz, R. (2019). "Financial and Economic Appraisal of a Biogas to Electricity Project". *Journal of Cleaner Production*, 214, 154-165

Gulam, K. (2011). Chapter 11: The Swot Analysis: Process and Basic Components. Jedah, Kingdom of Saudi Arabia: University of Jeddah. https://www.uj.edu.sa/Files/1001210/Subjects/Chapter%2011%20SWOT%20ANALYSIS.pdf

Gürel, E., & Tat, M. (2017). Swot Analysis: A Theoretical Review. *The Journal of International Social Research*, 10 (51): 995-1006

Hamel, G. & Prahalad, C.K. (1996). *Competing For The Future*. Boston: Harvard Business School.

Hassan, M. K., & Choudhury, M. A. (2020). Zakat and its role in sustainable development. *International Journal of Islamic Finance*, 12(3), 188-204.

Hays, K. (2023). The Party's Over: Interest Rates, Inflation, Oversupply Siphon COVID-Fueled Polymer Demand. S&P Global Community Insight, January, 20th, 2023, 09:18 UTC. Available at The party's over: Interest rates, inflation, oversupply siphon COVID-fueled polymer demand | S&P Global Commodity Insights (spglobal.com), January, 24th 2023

Hosseini, S. S., Azadi Tabar, M., Vankelecom, I. F. J., & Denayer, J. F. M. (2023). Progress In High Performance Membrane Materials and Processes For Biogas Production, Upgrading And Conversion. *Separation and Purification Technology*, *310* (123139): 1-50

International Energy Agency (2022a) Renewables 2022 Analysis and forecast to 2027. IEA. Available at https://www.iea.org/reports/renewables-2022/executive-summary

International Energy Agency (2022b) An Energy Sector Roadmap to Net Zero Emissions in Indonesia. IEA. Available at https://www.iea.org/reports/an-energy-sector-roadmap-to-net-zero-emissions-in-indonesia

Internastional Renewable Energy. (2020). *Global Renewables Outlook: Energy transformation 2050*. Abu Dhabi: Internastional Renewable Energy.

Kaniadi. (2021). Pola Kerja sama BUMN. https://www.slideshare.net/KenKanaidi/pola-kerja-sama-bumnksp-bot-boo-dll

Kapoor, R., Ghosh, P., Kumar, M., Sengupta, S., Gupta, A., Kumar, S. S., Vijay, V., Kumar, V., Kumar Vijay, V., & Pant, D. (2020). "Valorization Of Agricultural Waste For

Biogas Based Circular Economy In India: A Research Outlook". *Bioresource Technology, 304* (123036): 1-11

Kearns, K.P. (2006). "From Comparative Advantage to Damage Control: Clarifying Strategic Issues Using SWOT Analysis". *Nonprofit Management and Leadership* 3(1): 3 – 22.

Khan, U, I., Hafiz Dzarfan Othman, M., Hashim, H., Matsuura, T., Ismail, A. F., Rezaei-DashtArzhandi, M., & Wan Azelee, I. (2017). "Biogas As A Renewable Energy Fuel – A Review of Biogas Upgrading, Utilisation and Storage". *Energy Conversion and Management*, *150,* 277–294

Kementerian Energi dan Sumber Daya Mineral (2006). Blueprint Pengelolaan Energi Nasional 2006 – 2025. Jakarta: Kementerian Energi dan Sumber Daya Mineral. Avaliable at https://www.esdm.go.id/assets/media/content/Blueprint_PEN_tgl_10_Nop_2007.pdf

Kementerian Energi dan Sumber Daya Mineral. (2020). *Handbook of Energy & Economic Statistics of Indonesia 2019*. Jakarta: Kementerian Energi Dan Sumber Daya Mineral.

Kementerian Energi dan Sumber Daya Mineral. (2022). *Blueprint Pengelolaan Energi Nasional 2006 – 2025 Sesuai Peraturan Presiden Nomor 5 Tahun 2006*. Jakarta: Kementerian Energi Dan Sumber Daya Mineral.

Kristoferson, L.A. dan V. Bokalders. (1991). *Renewable Energy Technologies: Their Application in Developing Countries*. London: ITDG Publishing

Lembaga Penyelidikan Ekonomi dan Masyarakat, Fakultas Ekonomi dan Bisnis, Universitas Indonesia. (2016). *Analisa dan Monitoring Kredit Untuk Proyek Pembangkit Listrik Tenaga Biogas* (PLTBg). Prepared for Pelatihan Analis Lingkungan Hidup Untuk Lembaga Jasa Keuangan, Belitung 26-28 Oktober 2016.

Mansfield, G.M., Fourie, L.C.H., & Gevers, W.R (2005). "Strategic Architecture As A Concept Towards Explaining The Variation In Performance Of Networked Era Firms". South African Journal of Business Management, 36 (4): 19-31

Ningrum, S., Supriyadi, & Zulkarnain. (2019). "Strategy Analysis of Biogas Development as Domestic Alternative Energy by Utilizing Cow Manure". *Jurnal Penelitian Pertanian Terapan*, 17 (3): 45-57.

Otoritas Jasa Keuangan. (2014). *Buku Pedoman Energi Bersih untuk Lembaga Jasa Keuangan*. Jakarta: Otoritas Jasa Keuangan.

Otoritas Jasa Keuangan. (2019). *Paket Pelatihan Keuangan Berkelanjutan dalam Pembiayaan Energi Bersih: Pembiayaan Pembangkit Listrik Tenaga Biogas*. Jakarta: Otoritas Jasa Keuangan.

Paulose, D. (2013). Risks and Strategies for a Build-Own-Operate International Airport Project in IndiaInternational Energy Agency. (2020). Energy Efficiency And Economic Stimulus: IEA Strategic Considerations For Policy Makers. https://www.iea.org/articles/energy-efficiency-and-economic-stimulus

Perkumpulan Prakarsa. (2014). *Mengawal Green Banking Indonesia dalam Kerangka Pembangunan Berkelanjutan*. Jakarta: Perkumpulan Prakarsa.

Perkumpulan Prakarsa. (2021). *Urgensi Komitmen Bank dalam Akselerasi Pembiayaan Hijau untuk Transisi Energi Bersih*. https://theprakarsa.org/urgensi-komitmen-bank-dalam-akselerasi-pembiayaan-hijau-untuk-transisi-energi-bersih/

Pusat Studi Energi Universitas Gadjah Mada. (2021). Model Bisnis untuk Memperkuat Peran Pemerintah Daerah dalam Pemanfaatan Potensi Energi Terbarukan di Indonesia. Yogyakarta: Universitas Gadjah Mada

Rangkuti, F. (1997). *Analisis SWOT Teknik Membedah Kasus Bisnis*. Jakarta: PT. Gramedia Pustaka Utama Jakarta

Rangkuti, F. (2003). *Bisnis Plan Teknik Membuat Perencanaan Bisnis dan Analisis Kasus*. Jakarta: PT. Gramedia Pustaka Utama Jakarta.

Romanello, M., Di Napoli, C., Drummond, P., Green, C., Kennard, H., Lampard, P., Scamman, D., Arnell, N., Ayeb-Karlsson, S., Ford, L. B., Belesova, K., Bowen, K., Cai, W., Callaghan, M., Campbell-Lendrum, D., Chambers, J., van Daalen, K. R., Dalin, C., Dasandi, N., Costello, A. (2022). "The 2022 Report Of The Lancet Countdown On Health And Climate Change: Health At The Mercy Of Fossil Fuels". *The Lancet*, *400* (10363), 1619–1654.

Rianawati, E., Loeksmanto, I.H., Hilbert, J., Alemmu, S., Mkhize, M., Mohammed, M., Eremed, W.B., & Salie, Y. (2021). *Biogas Financing Options in Argentina, Ethiopia, Ghana, Indonesia, and South Africa*. Jerman: Digital Global Biogas Cooperation

Satpathy, P., Wunder, K., Vaske, M., & Steinigeweg, S. (2022). "Converting Sea Weed To Biogas Energy: Utilization Of Synergism During Co-Digestion With Maize Silage". *Energy Reports*, *8*: 1084–1093.

Sekretaris Jenderal Dewan Energi Nasional. (2019). *Buku Outlook Energi Indonesia 2019*. Jakarta: Sekretaris Jenderal Dewan Energi Nasional.

Setyono, J.S., Mardiansjah, F.H., & Astuti, MF.K. (2019). "Potensi Pengembangan Energi Baru Dan Energi Terbarukan Di Kota Semarang". *Jurnal Riptek*, 13 (2): 177-186

Smit, A.J. (2010). "The Competitive Advantage Of Nations: Is Porter's Diamond Framework A New Theory That Explains The International Competitiveness Of Countries?". *Southern African Business Review*, 14(1): 105-130

Sodagar, M., et al. (2020). Musharakah financing for renewable energy projects: A case study. *International Journal of Islamic Finance*, 15(4), 213-227.

S&P Dow Jones Indices. (2022). Dow Jones U.S. Oil & Gas Index. New York: S&P Dow Jones Indices. Dow Jones U.S. Oil & Gas Index | S&P Dow Jones Indices (spglobal.com)

Takman, J., & Andersson-Sköld, Y. (2021). "A Framework For Barriers, Opportunities, And Potential Solutions For Renewable Energy Diffusion: Exemplified By Liquefied Biogas For Heavy Trucks". *Transport Policy*, *110*, 150–160.

Team Financial Management for Emergencies. (2013). *SWOT Analysis: Strategy Skill*. London: Team Financial Management for Emergencies.

Thamrin, S., Sari, D.A.P., & Setyoningrum, A. (2019). *Energi Baru dan Terbarukan*. Bogor: Universitas Pertahanan.

United States Enviromental Protection Agency. (2020). *Anaerobic Digester/ Biogas System Operator Guidebook: A Guidebook for Operating Anaerobic Digestion/ Biogas Systems on Farms in the United States*. Washington, D.C.: United States Enviromental Protection Agency. Available at https://www.epa.gov/sites/default/files/2020-11/documents/agstar-operator-guidebook.pdf

United Nations Department of Economic and Social Affairs. (2021). *Global Population Growth and Sustainable Development*. Washington, D.C.: United States Enviromental Protection Agency. UN DESA/POP/2021/TR/NO. 2. Available at https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2022_global_population_growth.pdf

Wahyuni, S. (2011). *Menghasilkan Biogas dari Aneka Limbah*. Jakarta: PT Agro Media Pustaka.

Watchravesringkan, K., Karpova, E., Hodges, N.N., & Copeland, R. (2010). "The Competitive Position Of Thailand's Apparel Industry: Challenges And Opportunities For Globalization". *Journal of Fashion Marketing and Management*. 14(4): 597.Winrock International. (2015). *Buku Panduan Konversi POME Menjadi Biogas Pengembangan Proyek di Indonesia*. Virginia: Winrock International.

Yousuf, A., Khan, M.R., Pirozzi, D., & Wahid, Z.A. (2016) "Financial Sustainability Of Biogas Technology: Barriers, Opportunities, and Solutions". *Energy Sources, Part B: Economics, Planning, and Policy*, 11(9) 841-848.

Zito, F, P., Brunetti, A., & Barbieri, G. (2022). Renewable Biomethane Production From Biogas Upgrading Via Membrane Separation: Experimental Analysis And Multistep Configuration Design. *Renewable Energy*, *200*: 777–787.