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Review Article

A Mini Review on The Biomass Energy Implementation from Economic Perspective in Indonesia

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Abstract. The economically feasible study has become an important factor in today's societies due to achieve the well-being of people. The study analyzed the economic perspective of biomass energy from several secondary data locally and globally. The main target of this study aims to explore the economic perspective of biomass energy in Indonesia. The purpose of this study evaluates from many several economic advantages of the utilization of biomass energy such as economic sustainability, and job creation, and the last one is achieving sustainable development goals. Intensive exposure to several analysis factors of the advantages of modern biomass energy that is leading to economically feasible sustainability for the environment and local people in Indonesia. Moreover, it was found that the relationship between biomass energy and sustainable development significantly related to and supported the achievement of United Nation – Sustainable Development Goals (UN SDGs). Based on analyzing the biomass energy and economic strong effect on social development. After this, found significant benefits of biomass energy by creating local income, health care, school, and transportation as well as agriculture. These conclusions are discussed from many literature predictions about the future perspective of the relationship between biomass energy and economics. Recommendations encourage to government, investors, and stakeholders to involve biomass energy which is aim to achieve renewable energy targets. This research will provide more understanding of the several benefits of biomass energy and also to policymakers and investors to the intention of economic growth of biomass energy.

Keywords: biomass energy; economics; opportunities; sustainable development goals; local people

1. Introduction

Carbon Dioxide (CO_2) Emissions are increased by human activities such as industrialization. Global warming and climate change are the results of GHG emissions, which have harmful effects on the environment. Energy use for everyday activities such as transportation, heating, cooking, and electricity generation is one of the sources of greenhouse gas emissions (Kumar et al., 2022). Energy is required to conduct our everyday activities efficiently, and individuals utilize a great deal of energy to reach their objectives. Receiving sufficient energy is crucial to the growth of a nation capable of expanding economic activity with high energy demands.

Two categories of energy sources exist (Benti et al., 2021). Renewable energy sources, such as biomass energy, solar energy, wind energy, hydropower, and geothermal, etc., are regarded a gift from nature since they can be continuously supplied and used. Nonrenewable energy, which includes fossil fuels comprising coal, oil, and gas, is now the most used energy source. These kinds cannot be regenerated in a lifetime and have negative impacts on the environment due to greenhouse gas emissions from the combustion of fossil fuels for energy production.

To combat climate change caused by greenhouse gas emissions, the worldwide community is attempting to move to new and renewable energy sources today. These organizations, such as the United Nations Environment Program,

G20 Indonesia, ASEAN Center for Energy (ACE), and others, are attempting to advance RE via various events, including the World energy conference and seminars (ASEAN Center for Energy, 2022). The shift to renewable energy may not be instantaneous, therefore it will need a great deal of time, study, and effort, which will be significant obstacles. Biomass energy is expected to become one of the world's fastest-growing energy sources by around 30% between 2018 and 2023, and it will play a significant role in meeting global energy goals (IEA, 2022). The generation of biomass energy becomes one of the potential resources and significantly contributes to a country's sustainable development (Bilgili et al., 2017).

Biomass is a renewable energy resource that can be derived from a variety of organic wastes and raw materials, including dedicated energy crops (e.g., agriculture resources copra, castor seed, sesame, groundnut kernel, jatropha, rapeseed, palm kernel, mustard seed, sunflower, palm fruit, soybean, and cottonseed), agricultural crop residue (e.g., rice straw, wheat straw, rice husk, and corn stover), and forest residues (Yang et al., 2021).

Biomass energy is classified into two major categories: traditional biomass energy, which has been used in impoverished nations for a very long period, and contemporary biomass energy, which is a combination of newly created chemicals and modern technology (Benti et al., 2021). For cooking and heating reasons, traditional biomass energy is derived from the direct burning of agricultural wastes such as wood, animal wastes, and home wastes. However, contemporary biomass energy comprises waste processing technologies that generate biogas, biofuel, and bioelectricity (Yang et al., 2021).

Traditional biomass energy has several physiological, environmental, and social implications, particularly for pregnant women, since the smoke from the combustion of biomass causes major ailments in infants and adults (Weldu, 2019). Health consequences may be assessed by two primary factors: 1) pollution from burning stoves and heat, and 2) pollution from the environment caused by cooking and heating with wood (Kong et al., 2022). As a consequence of ineffective forest conservation policies, getting firewood from the forest for burning has a disproportionately negative effect on the ecosystem. Due to the traditional biomass used by the lone woman in a family for cooking and heating, illnesses are likely to have social consequences (Preethi et al., 2021).

Utilization of modern biomass energy can result in numerous benefits, such as reduced environmental impact (e.g., less garbage in landfills, carbon natural, organic material), economic opportunities (e.g., biomass products can be more profitable and less expensive than fossil fuels), and social gains (cleaner air and healthier people as a result of fossil fuels' less harmful emissions) (Aydin, 2019; McFarland, 2019; Bilgili et al., 2017; Wang et al., 2020). On the other hand, there are disadvantages such as requiring a lot of space (e.g. the use of biomass energy, which requires many facilities, tools, and workforce, may create large space and storage), being expensive (e.g. running biomass power plants can cost a lot of money for facilities, tools, and workforce), deforestation (Cutting forests for biomass products may lead to deforestation and biodiversity loss), and not producing enough energy (e.g. biomass energy still produces a low amount of Importantly, the price and cost rely on the investor's capital investment in the equipment and facility. If the cost of the equipment and facility is average, the rate charged to customers will be average; otherwise, the rate would be excessive.

Biomass energy generation is essential and one of the most popular alternatives in our contemporary world since it has the potential for numerous environmental and social benefits (Seidel, 2022). Not only may biomass energy be used in rich nations, but also in poor nations. It is mostly used in developed nations such as the United States, Finland, Sweden, and Austria, as well as in emerging nations like as India, China, and Indonesia (Association, 2022). There are still individuals who use biomass energy and those who do not use it; thus, it is both difficult and necessary to analyze the public's acceptance of attitudes, norms, and control over biomass energy.

Indonesia is one of the biggest nations in ASEAN, with a land area of 1.86 million square kilometers and a population of over 270 million, according to 2021 estimates (ASEAN Center for Energy, 2022) As one of the leading nations towards the largest economy in ASEAN, Indonesia requires high-demand energy due to its economy's vast energy consumption. The government of Indonesia plans to accomplish the objective for upper-middle-income households via economic development in 2045 (ASEAN Investment, 2021). Demand for power in Indonesia declined by 15% in 2020 as a result of the COVID - 19 epidemic, the most challenging year for the energy industry. However, the government safeguarded the 31 million homes most susceptible to energy poverty and lack of access to power (ASEAN Center for Energy, 2022). After almost recovering from the COVID-19 pandemic in 2021, the energy industry is projected to regain its pre-pandemic level of growth in 2022, resulting in increased energy output and a boost to the national economy (ASEAN Investment, 2021).

In addition, the Indonesian government has goals and objectives for reducing carbon dioxide (CO_2) emissions; by 2025, investment in clean energy infrastructure is one of the goals to attain. The Indonesian government will utilize the G20 summit to emphasize the significance of the country's 2060 or earlier Net Zero Emissions ambition (Pribadi, 2022). According to Ministry of Energy and Mineral Resources (EMR) Regulation, renewable energy generation for electricity is governed by MEMR (Draps, 2021). National Grand Energy has a renewable energy target of 100% energy mix by 2060

and is expected to increase capacity by 587 Gigawatts (GW), which includes not only biomass energy but also solar power plants that will produce 365 GW, nuclear power that will produce 35 GW, hydropower plants that will produce 83 GW, and biomass that will produce 13.4 GW (Enerdata, 2022). The government implements many goals to achieve, including a short goal for 2025, a medium goal for 2045, and a long goal for 2060 (ASEAN Center for Energy, 2022).

According to Indonesia's 2014 National Energy Policy, the country's goal is to get 23% additional renewable energy by 2025 (Widyaparaga et al., 2020). According to Worldometer, Indonesia utilizes 87% nonrenewable energy and just 13% renewable energy in 2016 (Pirard et al., 2016). The development of a biomass energy power plant not only employs a large number of people in the surrounding village, but also raises the living conditions of the villagers, particularly in regions of Indonesia, a rapidly growing nation with several islands (Abdullah, 2003). Therefore, it is vital to expand renewable energy biomass power plants. The advantages of adopting biomass energy may minimize the import of fossil fuels from other nations, boost the biomass energy electrical sector, and lower the prices of petroleum imports and electricity supply from other nations (Sugiyono & Nurrohim, 2007).

In this study, the researcher emphasizes (1) the significance of biomass energy in terms of employment opportunities and the potential for economic growth in Indonesia, as well as (2) the relationship between biomass energy and sustainable development objectives, drawing from a variety of literature reviews.

2. Biomass Potential in Indonesia

In 2022 and 2023, Indonesia's GDP will rise by 5.1% and 5.3%, respectively (World Bank, 2022). As infrastructure expands, so will energy usage. Therefore, it is cost-effective for the economy and the nation if a biomass power plant, which uses renewable energy, creates electricity for industries and businesses. Indonesia has greater biomass energy resources, which consist mostly of agricultural and residential leftovers from the cities of Kalimantan, Sumatera, Papua, and Sulawesi (Zafar, 2022). It generated 146,7 million tons of biomass for various applications, including power generation, biofuel, and biogas production, among others (Zafar, 2022). Biomass energy has the ability to generate 32,6 GW and 200,000 barrels per day if the biomass plant operates and is maintained properly (BP, 2019). Indonesia is a major provider of raw materials for the bioenergy and biomass industry, including Palm Oil, Sugar Cane, Paddy, Corn, Cassava, and Wood-waste (Directorate General for Agriculture Based Industry, 2012).

The Indonesian government's presidential regulation number 5/2006 from the National Energy Policy for biomass energy development governs biomass energy policy. The biomass energy potential in Indonesia is around 49,807,43 MW, according to a study (Wibawa, 2018). The Indonesian government expects to contribute 5–10% of the entire energy mix by 2025. (Wibawa, 2018). Indonesia is one of the world's richest sources of biomass energy, and its high-level exploitation of biomass energy may contribute to the production of sustainable energy (News-Details, 2021). Energy is closely tied to the living standards and lifestyles of a nation's citizens (News-Details, 2021). If biomass power plants are constructed with advanced technology, they can create energy for many places with inadequate electrical service (Abdurrahman, 2021). There are several motivations to increase biomass energy since it offers numerous prospects, including domestic energy security, wealth creation for individuals, and economic development for nations (Nandimandalam et al., 2022).

Biomass energy is highly anticipated since it will contribute to and answer the present difficulties facing the growth of Indonesia and the rest of the globe. Therefore, biomass energy should be regarded an excellent renewable energy source, since it does not emit emissions like nonrenewable energy. Despite the fact that it creates certain emissions, they are natural emissions that are neither hazardous to the environment nor to human health. Biomass energy generation may benefit nations by increasing employment opportunities for all people based on energy services. The creation of employment may have a good effect on the population, the provision of energy aids the nation's infrastructures, and it can reduce poverty in the nation (Abdurrahman, 2021).

3. Economic Sustainability

The present issue in Indonesia is that the price of gasoline increases annually, while the energy consumption exceeds the requirements. Biomass energy should be regarded as an alternate energy source for both local and global markets. In this research, biomass is deemed highly sustainable owing to its large economic advantages for residents, its ability to provide a variety of employment possibilities, and its contribution to environmental consequences, particularly the decrease of global emissions and air pollution. Biomass energy may be one of Indonesia's economically viable renewable energy sources (Bildirici & Ozaksoy, 2018; Bildirici & Ersin, 2015). In addition, biomass energy sustainability perspectives in Indonesia will be astounding for green economics in the future (Pribadi, 2022). According to the literature analysis and research of biomass in Indonesia, the transition of biomass energy to a green economy has prompted

the nation and investors to take action (Pribadi, 2022). According to this study's findings, biomass energy is connected to human development and the economy (ASEAN Center for Energy, 2022).

To ensure the continued and healthy expansion of biomass energy in Indonesia, it is vital to analyze the cost of biomass energy production and establish an appropriate price for biomass consumers and investors. To successfully commercialize novel technology, notably biomass energy, it is necessary to do a feasibility study to see whether it is economically viable (Bildirici & Ozaksoy, 2018). Consequently, investors and biomass energy businesses should assess the viability of the biomass energy industry (Sobamowo & Ojolo, 2018). According to several research, community and investor acceptance is required to determine the viability of deploying biomass energy.

According to the International Energy Agency (IEA), biomass energy is a kind of green energy. Utilizing and promoting a green economy is the optimal method for enhancing Indonesia's economic stability. Green energy may be defined as the production of energy from renewable sources without harming the environment or people (Brockington & Ponte, 2015). Numerous associations in Indonesia, such as the Indonesian Institute of energy economics, the ASEAN Center for Energy (ACE), and others, are attempting to provide greater incentives for the green economy. The green economy is the incorporation of renewable energy into Indonesia's economy and investment strategies. This concept is based on the fact that Indonesia has rich natural resources for creating renewable energy and the world's largest nickel deposit (ASEAN Center for Energy, 2022). The lithium-ion batteries that are necessary for storing renewable energy include nickel. According to the United Nations Environment Agency (el-Sheikh, 2022), establishing a green economy may cut carbon emissions and greenhouse gas emissions while generating social value (Shahbaz et al., 2016). Raising local and foreign investment may increase the nation's socioeconomic standards by increasing GDP due to a rise in residents' incomes, while simultaneously lowering carbon emissions and environmental deterioration (Aydin, 2019b).

4. Job Opportunities

Consideration of green employment options in Indonesia is a recent phenomenon (Singh & Setiawan, 2013). Environmental and green energy groups may collaborate to provide employment possibilities with minimal carbon footprints. Due to their huge population in Southeast Asia, Indonesia has unemployment and underemployment problems (Bildirici & Ozaksoy, 2018). In other words, steady development may occur in Indonesia if green employment possibilities are created, resulting in the expansion of the country's green economy and a consistent income for the people (Bildirici & Ozaksoy, 2018). Similarly, South Africa and Southeast Asia are emerging nations with significant unemployment rates (Benti et al., 2021). In the meanwhile, the worldwide pandemic COVID-19 has significantly impacted economic activity, causing certain nations to experience economic decline. The Renewable Energy Division of Indonesia State Electricity Company (PLN) provides comprehensive data on the biomass green energy potential in Indonesia (Green Biomass Energy Indonesia, 2022).

5. Economic Opportunities

The rise of a variety of employment possibilities as a result of economic expansion is one of the most obvious economic benefits of biomass energy generation in Indonesia. In a tiny economy, there may be 30 skilled employees who have the opportunity to find employment (Urbanchuk, 2001). As a result of the economy's fast expansion, there is also a demand for unskilled employees such as vehicle drivers, security personnel, engineers, local trainees, specialists, and many others involved in biomass energy production. Indonesian biomass power facilities are surrounded by several cities and villages. The biomass power plant might provide several employment possibilities for the local people, which would be to the nation's great advantage. It is anticipated that Kalimantan would implement biomass energy in Indonesia. The biomass power plant also faces several technical maintenance issues and constraints. Implementing biomass power plants, for example, requires extensive land tracts. Thus, the local who sold the property for biomass energy bene-fits both the local populace and the biomass power plant's investors.

The hamlet around the biomass power plant will get advantages for local schools, inexpensive electricity, and healthcare, as well as improved infrastructures including buildings, roads, and agriculture. According to the example of Myanmar, communities around hydropower plants have improved chances, such as easy access to agricultural irrigation, employment in hydropower plant operations, and the emergence of new employment prospects as a result of the development of hydropower plants. What is the model for future implementation of biomass power plants in Indonesia’s economic and human development?

6. Biomass Energy and Sustainable Development Goals (SDGs)

In 2015, the United Nations (UN) began emphasizing the significance of the Sustainable Development Goals (SDGs) declaration by all UN member states in order to achieve the UN's 2030 Agenda for all nations to attain SDGs (Department of Economic and Social Affairs Sustainable Development, 2015). The idea seeks to provide a more inclusive framework for national and international development that will aid in tackling environmental, economic, and social challenges. Moreover, the United Nations works to provide opportunity for all citizens of UN member states. Utilization of biomass energy is necessary for sustainable development owing to the fundamental needs of a nation, such as transportation, building, manufacturing, industry, and many other locations, which may have both good and bad effects on the environment, society, and economy. There are a number of evaluations and investigations concerning the deployment of biomass energy systems and the sustainability of the supply chain between SDGs and biomass energy supply chains, such as the ones listed below (forest, agriculture residue, waste, crop, and animals) (IEA, 2022). The IEA outlined the significance that biomass energy supply chains may play in achieving the SDGs. Researchers from several disciplines evaluate the SDGs in relation to biomass energy and social, environmental, and economic development (Destek et al., 2021).

7. What is Important in The Development of Biomass Energy?

Even if biomass power facilities are less harmful to the environment than fossil fuel power plants, only broad use of biomass energy accelerates the transition to clean energy. Public acceptability is a recognized component that contributes to the goal of increasing the proportion of renewable energy in many nations (Wüstenhagen et al., 2007). Public acceptability is essential for the development of new product and service delivery ventures. Public acceptance is essential for establishing early confidence with clients, organizations, and businesses (Shimizu et al., 2021). Although biomass is a kind of renewable energy supported by the government and scientific community, public acceptance or resistance may exist (Liu et al., 2013). When individuals have faith in the benefits of new ventures, there will be widespread acceptance. However, if the public does not believe that a new initiative would be helpful and safe for them, resistance may result. A number of studies shown that the community rejected a number of biomass initiatives (Upreti & van der Horst, 2004). Public acceptability of biomass energy is lower than that of other problematic renewable energy sources in Indonesia and the rest of the globe (ASEAN Investment, 2021). If people embrace new technology initiatives such as biomass power plants in large numbers, there is a good possibility that the biomass energy promotion goal will be met. If individuals reject biomass initiatives, these renewable biomass projects may quickly collapse (Segreto et al., 2020).

8. Conclusion

Indonesia is a country in Southeast Asia with abundant natural resources and the potential to produce biomass energy. The Indonesian government also has some strategies and policies in place to implement biomass energy, but it must develop more effective policies, the appropriate application, and sustainable perspectives. The most difficult obstacles to enhancing biomass energy financing, specialists, and technology, and location. Indonesia is the world's largest island-based nation. There is a greater reliance on biomass energy in remote regions, such as Papua New Guinea and Sulawesi, since it may be difficult to extend the national grid statewide. The Indonesian government expected expanding its relationships with New and Renewable Energy and Energy Conservation stakeholders.

Energy is crucial for a nation's economic prosperity in the contemporary day. Globally constrained access to non-renewable energy and severe weather events associated with GHG emissions from the energy sector result in an increase in the usage of renewable energy globally and in Indonesia. The annual increase in the electricity demand rate is 9.6%. It increased from around 107 TWh in 2005 to 1,070 TWh in 2030. Indonesia depends heavily on fossil fuels and coal as its principal energy sources since they are inexpensive and readily accessible. Indonesia must invest more in renewable energy, particularly biomass energy, which has the greatest potential to fulfill the increased power demand, in order to satisfy the increased energy demand.

Importantly, government policy and regulations must be enforced on green energy plans in Indonesia in order to increase prospects for power production from biomass energy. As a result of biomass energy's ability to provide more employment possibilities and contribute to the nation's economic growth, the unemployment rate in Indonesia decreases, and poverty is alleviated. Consideration of how to use biomass energy in Indonesia will result in several

advantages for Indonesia, including a decreased reliance on fossil fuels, an increase in electricity investors, a decrease in the cost of power supply, and a decrease in environmental consequences. Future study is anticipated to examine the economic implementation of biomass in Indonesia, and then the biomass energy policy between stakeholders and the government.

In the past, traditional biomass energy was the most desirable source of energy in Indonesia, but thanks to advances in energy research, people are now informed about biomass energy and how to convert it to contemporary biomass energy using chemicals. Recently, biomass has replaced fossil fuels, but energy generation capacity remains low owing to evolving technology and poor investment. Bioenergy may create power both directly via biomass and indirectly through biofuel. Education programs and training offered by government and commercial energy organizations and businesses should equip the public with cutting-edge research-based information and technology.

Numerous stakeholders and scholars have taken a keen interest in the link between biomass energy and economic development. When the researcher examines the link between bioenergy and economic development in Indonesia, he or she will compare the two variables. Specifically, they discovered (1) a strong positive correlation between the economy and biomass energy. (2) Biomass energy generation has the ability to increase the nation's economic development. The improvement of biomass energy will benefit social, economic, and environmental factors, and it will contribute to a nation's sustainable development. Countries such as Indonesia and Myanmar have significant potential for biomass energy, which may entice investors in biomass energy production, while the framework of economic sustainability can safeguard the environment and energy security. In addition, local community education and awareness-raising efforts should be developed to promote the use of biomass energy. As biomass energy may significantly contribute to economic prosperity, biomass energy facilities should be distributed nationwide.

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