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Analysis of Biomass Energy Potential in North Sumatra Using LEAP

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Abstract− *This research aims to evaluate the biomass energy potential in North Sumatra using the Long-range Energy Alternatives Planning (LEAP) system. North Sumatra, a region rich in agricultural and forestry resources, presents significant opportunities for biomass energy development. The LEAP model, a widely used tool for energy policy analysis and climate change mitigation assessment, was employed to simulate and analyze various scenarios of biomass energy utilization in the region. Key biomass resources in North Sumatra, such as palm oil residues, rice husks, and wood waste, were identified and quantified. The study involved the collection of data on biomass availability, current usage patterns, and technological options for biomass energy conversion. By integrating these data into the LEAP model, different scenarios were developed to explore the potential contributions of biomass energy to the regional energy mix and greenhouse gas (GHG) emissions reduction. The analysis results show that in 2028, the significant potential for new and renewable energy in North Sumatra includes water energy, wind energy and biomass energy. The potential biomass energy produced is 27.0 MW.*

Keywords: Potential, Biomass Energy, LEAP

1. INTRODUCTION

Utilization of renewable energy, such as biomass energy, is increasingly becoming a major focus in global efforts to reduce dependence on fossil energy sources and minimize negative impacts on the environment. In Indonesia, North Sumatra is one of the regions that has great potential in developing biomass energy, thanks to its abundant natural resources such as agricultural waste, palm oil mill waste and wood waste from the forestry sector.

The use of biomass energy is not only promising as an environmentally friendly alternative but can also be a solution to increase regional energy security and make a positive contribution to local economic development. However, to optimize this potential, an in-depth analysis is needed that covers various technical, economic, social and environmental aspects.

In this context, LEAP (Long-range Energy Alternatives Planning system) software becomes a very useful tool. LEAP enables comprehensive long-term energy system simulations, allowing decision makers to explore various biomass energy development scenarios by considering a wide range of relevant variables.

The aim of this analysis is to identify the real potential of biomass energy in North Sumatra, evaluate appropriate policies and strategies to encourage the development of this energy sector, and develop recommendations for sustainable decision making. Thus, analyzing the energy potential of biomass using LEAP in North Sumatra It is hoped that it can make a significant contribution to efforts to achieve national and global renewable energy targets and reduce greenhouse gas emissions.

This introduction highlights the importance of this research in a global and national context and explains LEAP's role as an important tool for strategic analysis and planning in biomass energy development in North Sumatra.

2. RESEARCH METHODS

A. Biomass Energy

In simple terms, sustainable energy is energy that can be renewed (inexhaustible) such as sunlight, water, geothermal heat and wind. Sustainable energy sources do not damage ecosystems, do not pollute the environment, and do not contribute to climate change and atmospheric damage like other conventional energy sources. This is the main reason why sustainable energy is closely linked to environmental issues according to many people. Environmentally friendly energy in Indonesia includes energy based on sun, wind, biomass, water, geothermal, and others. Solar energy in Indonesia uses solar panels to convert sunlight directly into electricity. The potential for wind energy in Indonesia is very large, especially in coastal areas. Biomass is energy obtained from organic materials such as animal waste and plant residues, especially from the sugar, palm oil and wood industries. Water energy also has great potential, but fluctuations in water discharge make production unstable. Indonesia's geothermal potential reaches 29 GW (the largest in the world), but currently only 1,341 MW (4.6%) is utilized. This great potential exists because Indonesia is on the volcanic belt (ring of fire). If the use of new and renewable energy is optimal, then its contribution to the national energy supply can reach 100%. Biomass is an alternative energy source in Indonesia can be used as an energy source, the amount is very abundant and Indonesia’s biomass potential is 146.7 million tons per year temporary the potential for biomass originating from Waste for 2020 is estimated as much as 53.7 million tons

B. Long-range Energy Alternative Planning System(LEAP)

The Long-range Energy Alternative Planning System, or LEAP as it is commonly shortened, employs a bookkeeping system approach combined with a display-based technique. Building energy system models with this design is beneficial since it takes into account a number of aspects, including costs, actual ecological impacts, and energy system representation. In addition to helping create a sustainable energy market strategy, LEAP may be used to comprehend the effects of putting energy policies into practice. In order to meet predefined goals, this bookkeeping system can also be used as a tool to illustrate the effects of different scenarios or energy sources. Exploring significant energy sources can also be done with LEAP using this accounting system approach. It is necessary to take into account the social costs and ecological repercussions of different solutions. The following are some advantages of the bookkeeping structure:
Direct, clear and easy to adapt, and only requires important relevant information.

1. The simulation is not carried out with the assumption of ideal competition.
2. Useful for examining innovation or cost options in energy system development.
3. Very useful in boundary building applications.

The accounting structure is not appropriate for more complex systems where lowest cost estimates are necessary due to a number of other problems, one of which is that it does not naturally differentiate the lowest cost framework. The energy supply design may not align with the projected energy demand due to the unreliability of the cost estimates provided. Conversely, LEAP can be viewed as a semi-analytic model that incorporates improvement, accounting, and simulation components. LEAP runs in two stages in order to be a semi-analytic model. Initially, LEAP functions as a specialized basic bookkeeping tool, and users of LEAP can incorporate simulation models based on the outcomes. In LEAP, a facility for progress estimation is presently being created. Estimated enhancements allow the lowest possible cost framework to be found. While LEAP is not directly utilized to find the lowest cost framework, its output is sent into the Open Source Energy Modelling System's (OSeMOSYS) improvement module. Following that, LEAP receives the OSeMOSYS improvement computation findings and displays them as the lowest cost framework results.

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3. RESULTS AND DISCUSSION

A. Research Data

Research data obtained from the Indonesian Central Statistics Agency for North Sumatra Province can be seen in table 1.

Table 1. Population and Economic Growth Data for North Sumatra

Growth Data	Total
Population	12,98 Milion
GDB	118.51 Billion Rupiah
Income Per Capita	9.13 Milion
Income Growth	6.10%
Growth Rate	1,28%

B. Renewable Energy Potential in North Sumatra

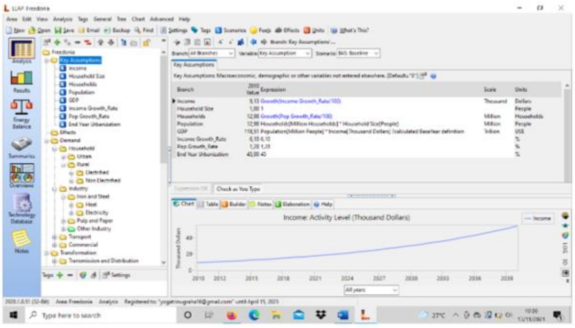

Figure 2. Entering data on population, per capita income and economic growth rate for North Sumatra in 2010

The data on GDP, population, and rates of both economic and population growth are displayed in Figure 3 by the LEAP software. This software will then show North Sumatra's population and economic growth. Additional details are displayed in Figures 3 and 4.

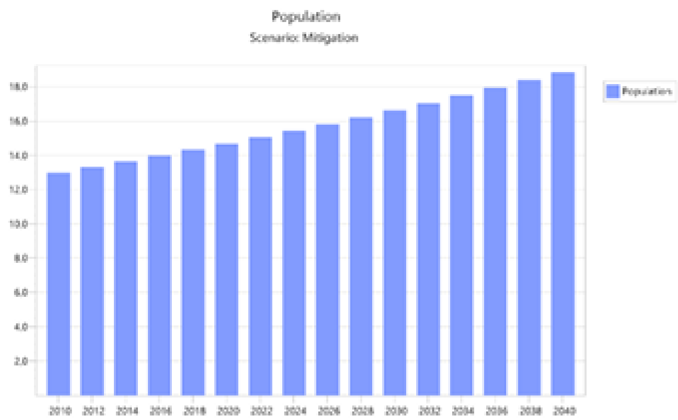

Figure 3. Population Growth of North Sumatra Province 2010-2028

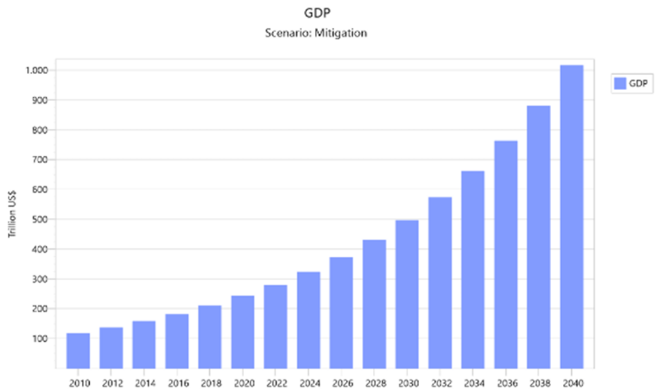

Figure 4. GDP Economic Growth of North Sumatra Province 2010-2028

The purpose of processing this data is to determine North Sumatra's potential for biomass. Figure 5 displays the data processing outcomes.

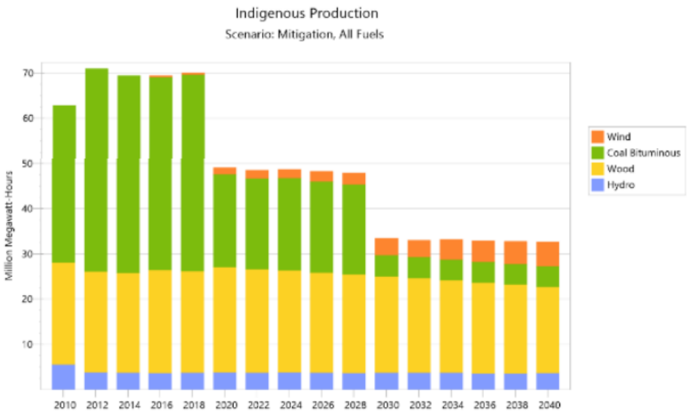

Figure 5. Results of Biomass Potential in North Sumatra

According to the LEAP software's conclusions, biomass energy is one of the renewable energy sources that North Sumatra Province may be able to use in 2028. Table 2 shows the potential for biomass energy in North Sumatra Province in 2028.

Table 2. Final Results of Biomass Energy Potential in North Sumatra Province (MW)

Year	Energy Biomass (MW)
2010	22,6
2011	22,8
2012	22,8
2013	23,1
2014	23,2
2015	24,5
2016	24,6
2017	24,8
2018	24,9
2019	25,1
2020	26,3
2021	26,4
2022	26,5

2023	26,6
2024	26,7
2025	26,8
2026	26,9
2027	27,0
2028	27,0

4. CONCLUSION

This research shows that the potential for renewable energy in North Sumatra in 2028 consists of biomass energy. Biomass energy is predicted to have a potential of 27.0 MW based on analysis using LEAP software. The assessment of biomass energy potential in North Sumatra using the *Long-range Energy Alternatives Planning* (LEAP) model reveals significant opportunities for sustainable energy development in the region.

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