Journal of Renewable Energy, Electrical, and Computer Engineering
Vol. 2, No. 2, September 2022, 84-89
e-ISSN: 2776-0049 DOI: https://doi.org/10.29103/jreece.v2i2.9278
Research Original Article

Modelling Demand for Energy Sources as Alternative Energy in the Province of North Sumatra

Yoga Tri Nugraha✉ **Muhammad Irwanto**
Department of Electrical Engineering, Universitas Prima Indonesia, Medan, 20118, Indonesia
yogatrinugraha@unprimdn.ac.id, muhammadirwanto@unprimdn.ac.id
✉Corresponding Author: **yogatrinugraha@unprimdn.ac.id | Phone: +628116040207**

Abstract
Energy is needed to support daily human activities. Energy usage for the necessities of life is always increasing every year. So far, the energy used comes from fossils, namely coal and oil. Every year fossil energy reserves are decreasing. To overcome these problems, a potential alternative energy source that can replace fossil energy is needed, namely renewable energy. Potential of renewable energy is one of the alternative sources of energy supply and security in the Province of North Sumatra. To ensure the resilience of renewable energy to run sustainably. It is necessary to analyze the potential of renewable energy in North Sumatra by using the Long-range Energy Alternatives Planning System. The results obtained show that North Sumatra has a great potential of energy sources as alternative energy, namely hydro energy and wind energy. It is forecasted that for the year 2027, hydro energy has a potential growth of 3,7 million megawatt-hours and wind energy has a potential growth of 2,2 million megawatt-hours.
Keywords: Modelling; Alternative Energy; LEAP; Energy Management;

Introduction
Energy is needed for human activities, especially for economic, household, industrial, business, and transportation activities. Most of the world's energy supply comes from fossil fuels which are non-renewable energy resources. Energy needs are expected to continue to increase, while sources of oil and coal reserves are dwindling. In addition, the use of fossil fuels as energy contributes to excess carbon in the atmosphere causing global warming. Therefore, it is necessary to supply alternative energy other than oil and coal. Renewable energy is one of the alternative sources of energy supply because, in addition to having a low impact on environmental damage, it also ensures energy sustainability for the future. Renewable energy is energy that comes from nature that can be sustainable. With the decreasing number of conventional fuels nowadays, of course, renewable energy and alternative energy are needed. Meanwhile, the increasing energy demand is increasing. With the decreasing amount of oil or coal, various alternatives have emerged as a substitute for oil or coal energy.

The need for energy in Indonesia in particular and on earth in daily life continues to increase due to population development, monetary development, and examples of the use of energy itself which are always evolving. The contemplation of energy and climate conservation surely expects us to soon have the option to utilize sustainable energy that is accessible effectively and is less harmful to ecosystems including water, geothermal, solar-based, and wind.

Perfect and reasonable energy accessibility has become one of the manageable goals of progress by 2030, where energy management is a worldwide problem and requires the responsibility of central governments and neighboring countries to have an interest in implementing this goal. In Indonesia, the approach to new energy and environmentally friendly energy is contained in the unofficial law no. 79 of 2014 concerning National Energy Policy (KEN). In the archives, new energy and green power are set to reach 23% by 2025, and by 2050 it will reach at least 31%. Then again, dependence on oil and coal is focused on reducing, by 20% and 25%, respectively. To achieve this goal, different efforts and projects are required whose elaboration and implementation are contained in the overall public energy plan (RUEN) and the general energy plan (RUED-P).

Even though the energies of the executives are under the control of a common government, state-run administrations need to recognize the possibility of new and sustainable sources of power in their territories independently. Adapting from the goals of progress that can be supported on energy moderation and maintenance in the 2019-2023 Regional Medium-Term Development Plan (RPJMD), the North Sumatra Provincial Government needs to examine new elective points for energy supply which can be called Renewable Energy (RE) at the provincial level.

To remain and increase the usage of renewable energy in North Sumatra as alternative energy and to support the reduction of energy use using fossil fuels such as coal, a study of renewable energy needs to be conducted in North Sumatra in terms of the potential for water flow velocity and waste production increase. Therefore, this new and renewable energy potential has a very important and fundamental role as a substitute energy for fossil fuels such as coal and supports the security of the electricity supply in North Sumatra.

Literature Review

1. Energy Management

Energy management is a program that is planned and implemented systematically to utilize energy effectively and efficiently by planning, recording, monitoring and evaluating continuously without compromising the quality of production and service. Energy management includes planning and operating energy-related consumption and production units to actively manage efforts to save energy use and reduce energy costs. The goals of energy management are resource-saving, climate protection, and cost savings. For consumers, energy management makes it easier to get access to energy according to what and when they need it. Energy management is concerned with environmental management, production management, logistics, and other business-related functions. Energy management is an activity in an organized company using management principles, with the aim that energy conservation can be carried out so that energy costs as a component of production/operation costs can be reduced as low as possible. Energy conservation itself implies an effort to continue to use energy rationally but still maintain productivity and fulfil the requirements of corporate governance. The rational use of energy includes saving and energy efficiency. So a distinction must be made between energy saving and energy conservation. Energy savings can be done by only reducing the use of energy but comfort and productivity will decrease. Meanwhile, energy conservation is the application of rules in energy management, not only reducing energy consumption but also implementing efficient operating patterns, and installing additional equipment that improves system performance so that energy consumption is lower but does not reduce comfort and productivity. In essence, energy conservation is a guide on how to save energy properly and contains methods and tools that can be used to save energy without reducing productivity and comfort. Meanwhile, energy efficiency means that the comparison between energy use and its production can be comfort, motion and others. So high energy efficiency means low energy consumption but high production. Thus the concept of energy conservation is broader than energy efficiency. The international standard on energy management is the ISO 50001 Energy Management System. ISO (International Standards Organization) is the international organization for standards. This energy management system does not stand alone because it is an amalgamation and harmonization of energy management systems that have been implemented by several countries and regions such as the European Union. Currently, several countries such as Denmark, Ireland, Sweden, US, Thailand, and Korea have their national energy management standards. Meanwhile, the European Union even has a regional energy management standard that has been used.

2. Renewable Energy

In basic terms, sustainable power is characterized as renewable (inexhaustible) energy such as daylight, water, geothermal, and wind. Sustainable resources are not harmful to the ecosystem as energy sources that do not pollute the climate and do not add to harmful environmental changes and atmospheric destruction like other conventional sources. This is the basic justification for why sustainable energy is so closely related to nature and environmental issues according to many people. Environmentally friendly energy in Indonesia consists of solar-oriented energy, wind energy, biomass, hydro, and geothermal energy. Solar-based energy in Indonesia uses solar-powered PV which uses some of the sunlight directly to generate power. Wind speed in Indonesia has tremendous potential, especially in seaside areas. Biomass is the energy obtained from natural sources such as the excreta of living things and plant deposits. This potential comes mainly from the sugar, oil palm, and timber businesses. Water energy also has tremendous potential, but the fluctuating release of water makes the energy produced unhealthy. Indonesia's geothermal potential reaches 29 GW (the largest on the planet) but the limit introduced is still 1,341 W (4.6%). This extraordinary potential is because Indonesia is a volcanic route (ring of fire). Assuming the use of new and environmentally friendly electricity is ideal, the proportion of public shocks can reach 100%.

Materials & Methods

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

A Long-range Energy Alternative Planning System is applied in this research. The concept used by LEAP is a display structure with a bookkeeping system approach. This design can be used to create an energy framework model by factoring in the actual depiction of the energy framework, costs, and ecological effects. Something beyond creating an organic energy market side approach, LEAP can be used to break down the effects of implementing energy regulation. Furthermore, the accounting system is used as an instrument to detail the consequences of implementing several situations of interest or energy supply to achieve predetermined targets. Similarly, LEAP with the accounting system approach can also be used to investigate important energy sources, ecological effects, and social costs arising from selected situations.

In turn, LEAP can be thought of as a half-breed model combining raising, recreation, and bookkeeping. To have the option of working as a half-breed model, LEAP works in two phases, being a specific basic bookkeeping relationship as an attached office, and LEAP clients can add a recreation model of the results obtained by LEAP. The current progress estimation office is being created in LEAP. An estimated increase should be possible to decide on the most minimal spending framework. Indirect jumps were used to determine the least cost framework, but the LEAP results as text were used as contributions to the Open Source Energy Modeling System (OSeMOSYS) enhancement module. The consequences of calculating the OSeMOSYS progress are placed once again into LEAP to show as a side effect of the least expense framework. The process of carrying out this research will be explained in Figure 1.

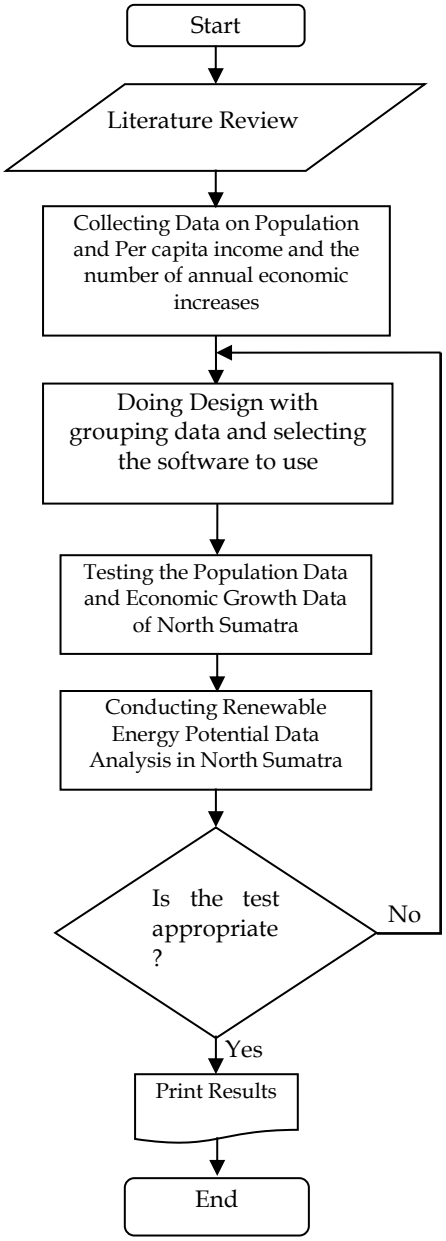


Figure 1. Research Flowchart

Results and Discussion

1. **Research Data**

The research data obtained from the Central Statistics Agency of Indonesia, Province of North Sumatra can be seen in table 1.

Table 1. Population and Economic Growth Data in North Sumatra

Growth Data	Total
Population	12,98 million
GDP	118,51 billion rupiah
Income per capita	9,13 million rupiah
Revenue Growth	6,10 %
Population Growth Rate	1,28 %

2. **Modelling Demand for Energy Sources as Alternative Energy Potential in North Sumatra**

When entering data into the Long-range Energy Alternative Planning System software, it can be seen in Figure 2.

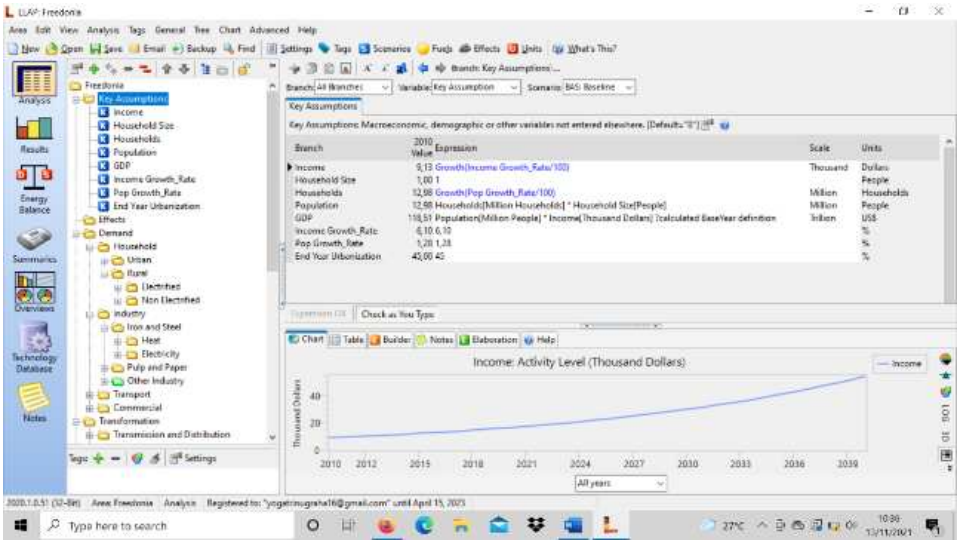
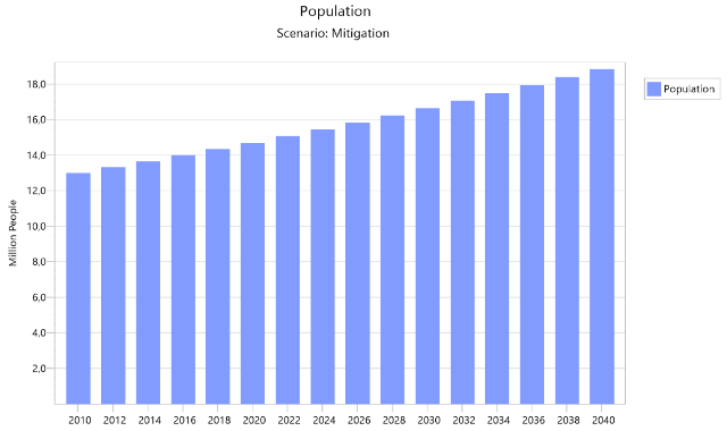


Figure 2. Entering population data, per capita income, and economic growth rate of North Sumatra in 2010

Figure 3 shows the LEAP software display which includes data on population, GDP, and the rate of population growth as well as the growth rate of economic income. After that, it will show the population and economic growth in North Sumatra. It can be seen in Figure 3 and Figure 4.



Fige 3. Population Growth of North Sumatra 2010-2027

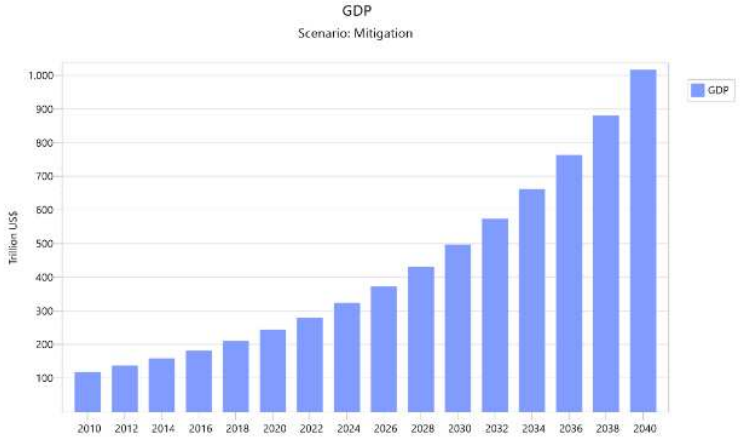


Fig 4. North Sumatra GDP Economic Growth 2010-2027

The data above will be processed to see the results of the modelling deman of alternative energy potential in North Sumatra. The results of the processed data can be seen in Figure 5.

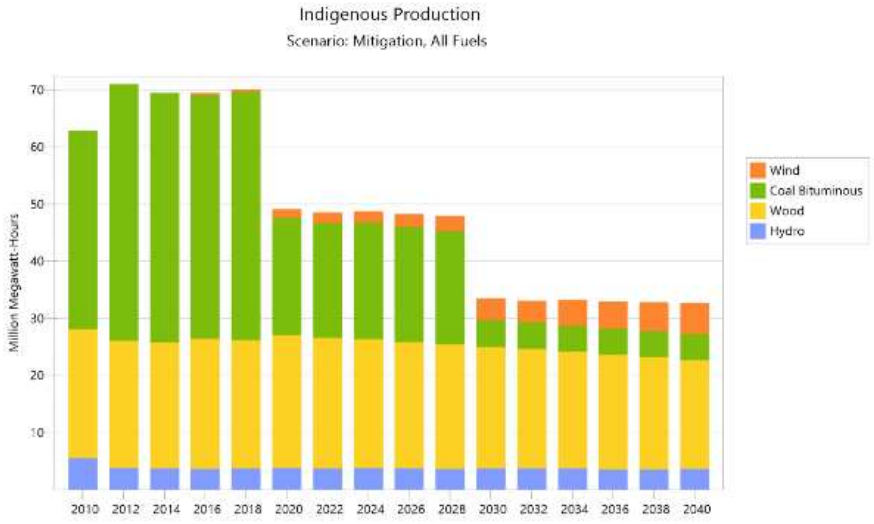


Fig 5. Results of Modelling Demand for Energy Sources as Alternative Energy Potential in Province of North Sumatra in 2027

Based on the results obtained by the LEAP software, the modelling demand for Energy Sources as alternative energy potential in North Sumatra are hydro energy and wind energy. The modelling demand for Energy Sources as alternative energy potential in North Sumatra in 2027 can be seen in table 2.

Table 2. Final Results of Modelling Demand for Energy Sources as Alternative Energy Potential in Province of North Sumatra Province in 2027 (Million Megawatt-hours)

Years	Hydro Energy	Wind Energy
2010	5,5	0
2011	3,8	0
2012	3,8	0
2013	3,7	0
2014	3,7	0
2015	3,6	0
2016	3,6	0,4
2017	3,7	0,4
2018	3,7	0,4
2019	3,7	1,0
2020	3,8	1,5
2021	3,8	1,5
2022	3,7	1,8
2023	3,7	1,8
2024	3,8	1,9
2025	3,7	1,9
2026	3,7	2,2
2027	3,7	2,2

Conclusions

The result is that the modelling demand for energy sources as alternative energy potential in Province North Sumatra are hydro energy and biomass energy. Hydro energy has a potential growth of 3,7 million megawatt-hours in 2027. Meanwhile, wind energy has a potential growth of 2,2 million megawatt-hours in 2027 using the Long-range Energy Alternatives Planning System.

Acknowledgments

This research is to assist the provincial government and PT. PLN (Persero) in finding alternative energy in North Sumatra.

References

D. J. Massaga, G. Kirkil, and E. Çelebi. (2019). "A Comparative Study of Energy Models for Turkish Electricity Market Using LEAP," 2019 16th International Conference on the European Energy Market (EEM), pp. 1-4, DOI: 10.1109/EEM.2019.8916283.

K. Akom, T. Shongwe, M. K. Joseph and S. Padmanaban. (2020). "Energy Framework and Policy Direction Guidelines: Ghana 2017–2050 Perspectives," in IEEE Access, vol. 8, pp. 152851-152869, DOI: 10.1109/ACCESS.2020.3018314.

M. R. Kresnawan, I. A. Safitri and I. Darmawan. (2018). "Long Term Projection of Electricity Generation Sector in East Kalimantan Province: LEAP Model Application," 2018 12th South East Asian Technical University Consortium (SEATUC), pp. 1-5, DOI: 10.1109/SEATUC.2018.8788875.

N. K. Rayaguru, K. Karunanithi, S. S. Dash, P. Chandrasekar, and S. M. Bani. (2021). "Investigations of Capacity Expansion Planning Using LEAP Model," 2021 International Conference in Advances in Power, Signal, and Information Technology (APSIT), pp. 1-4, DOI: 10.1109/APSIT52773.2021.9641203.

A. Bhuvanesh, S. T. J. Christa and S. Kannan. (2017). "Least Cost Electricity Generation Planning for China with Low GHG Emission Using LEAP and EnergyPLAN," 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), pp. 1-5, DOI: 10.1109/ICCIC.2017.8524458.

R. RÍos, M. Quintana, M. RamÍrez, E. Ortigoza, V. Oxilia, and G. Blanco. (2019). "Use of electric vehicles to achieve sustainable development goals in countries with surpluses of hydroelectricity: case of Paraguay," 2019 IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies (CHILE CON), pp. 1-6, DOI: 10.1109/CHILECON47746.2019.8988038.

T. Rudolf, T. Schürmann, S. Schwab and S. Hohmann. (2021). "Toward Holistic Energy Management Strategies for Fuel Cell Hybrid Electric Vehicles in Heavy-Duty Applications," in Proceedings of the IEEE, vol. 109, no. 6, pp. 1094-1114, DOI: 10.1109/JPROC.2021.3055136.

J. A. Nieves, A. J. Aristizábal, I. Dyner, O. Báez and D. Ospina. (2018). "Energy Analysis of the Tertiary Sector of Colombia and Demand Estimation Using LEAP," 2018 ICAI Workshops (ICAIW), pp. 1-6, DOI: 10.1109/ICAIW.2018.8554996.

S. Ejaz, M. Aamir, M. A. Khan, and B. Ashfaq. (2018). "Modeling and analysis of CPEC energy power projects using LEAP model," 2018 International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), pp. 1-8, DOI: 10.1109/ICOMET.2018.8346410.

W. G. Santika, T. Armee, M. Anissuzaman, G. M. Shafiullah, and P. A. Bahri. (2018). "Sustainable energy for all: Impacts of Sustainable Development Goals implementation on household sector energy demand in Indonesia," 2018 International Conference on Smart Green Technology in Electrical and Information Systems (ICSGTEIS), 2018, pp. 13-18, DOI: 10.1109/ICSGTEIS.2018.8709108.

A. Nigam and K. K. Sharma. (2022). "Integration of Hybrid Energy Model with Solar PV, Hydro & Wind Turbine by Using MATLAB/Simulink," 2022 International Conference on Electronics and Renewable Systems (ICEARS), pp. 228-232, DOI: 10.1109/ICEARS53579.2022.9751856.

M. Beken, B. Hangun, and O. Eyecioglu. (2019). "Classification of Turkey among European Countries by Years in Terms of Energy Efficiency, Total Renewable Energy, Energy Consumption, Greenhouse Gas Emission, and Energy Import Dependency by Using Machine Learning," 2019 8th International Conference on Renewable Energy Research and Applications (ICRERA), pp. 951-956, DOI: 10.1109/ICRERA47325.2019.8996583.