The Scenario of the Potential Analysis Alternative Energy in Order to Strengthening District’s Energy Resilience
(The Case Study in South Sumatera Province)

Muhammad Ferry Muhrom¹, Tb Ronny Rahman Nitibaskara¹, Herdis Herdiansyah², Ravita Sari³
¹National Resilience Studies, School of Strategic and Global Studies, Universitas Indonesia, Salemba, Indonesia
²School of Environmental Science, Universitas Indonesia, Salemba, Indonesia
³Center of Strategic and Defense Studies, Universitas Indonesia, Salemba, Indonesia
E mail: herdis@ui.ac.id

Abstract: The current development of fossil energy, which is the driving force of the economy in Indonesia, is a non-renewable energy and is in need to know when it will be exhausted so it may be replaced with renewable energy. Many powerplant systems in Indonesia are still using conventional system that utilizes fossil energy as the primary energy in the process of electricity generation. The occurrence of electrical energy crisis is marked by several electricity blackout phenomena in some areas in South Sumatera province alternately, which is the proof that the installed power capacity has exceeded the capacity of generation power. Interconnection among several islands, namely Java Island, Sumatera Island, and Bali Island which has been interconnected with closed loop system through transmission network has not been able to overcome the electrical energy crisis. This paper aims to create alternative energy potential scenarios in the province of South Sumatera in sequence/ranking by using quantitative methods with sequential explanatory model formulated in the determination of alternative energy strategies then analyzed by using Analytical Hierarchy Process (AHP) method. The simulation results from this research indicate that geothermal energy potentials get the highest value so that it becomes the priority of alternative energy strategy in South Sumatera Province.

Keywords: Alternative Energy, Renewable Energy, Energy Security, Resilience, Analytical Hierarchy Process (AHP).

1. Introduction

Indonesia potentially has alternative energy in addition to fossil energy, so far to strengthen the renewal of Indonesia's energy through a policy tool that encourages new energy alternatives by suppressing petroleum subsidies and enabling new energy businesses, the issue of fuel price hike is often used as a political issue [1]. A shock will occur as predicted seeing how vital the role of fuel is in meeting the daily needs of life, as it has happened before, as a result of the increase in fuel triggering inflation against all basic commodities and ultimately will be costly for the people. The influence of energy on people's activities are: (1) As input for fertilizer factory, (2) Influence on farmers, (3) Influence on transportation and communication [2]. Therefore, development on renewable and non-renewable energy sources become important to be researched, and on non-renewable energy is needed to know when it is exhausted so that it can be immediately replaced with renewable energy.

Indonesia possesses “New Energy Source ” which existence is located within the archipelago. This New Energy Source not only associated with amount and capacity, but also with its diversity, so this alternative energy sources could be Primary Energy Source as the replacement of Fossil Energy, to be used optimally in the future [3].

A huge challenge from the energy mix is the high dependence on fossil fuels (especially petroleum), which means the low share of renewable energy utilization. Excessive dependence on fossil fuels also raises questions on the sustainability aspect, and the rise in the price of Fuel Petroleum (BBM) in the country that has been closed with government subsidies, which consequently put the burden on the state budget (Budget Revenue and Expenditure) continues to grow. By 2014, the fuel subsidy burden amount to Rp 199.9 trillion from the budget devoted to energy subsidies, which is equivalent to about 2.5% of GDP and 25% of the total budget [4].

2. Theoretical Review

Alternative energy is spread throughout the region of Indonesia, including the province of South Sumatra, where there is a diversity of potential alternative energy resources. Energy potential in South Sumatra
that can be renewed as an alternative energy source such as Geothermal, Water (micro hydro), Wind, and the Sun is large enough Scattered almost throughout the region of South Sumatra, as an area with the potential of large and varied energy resources, the province of South Sumatra needs an alternative priority energy strategy in managing energy potential to support the national energy security of Indonesia [5].

Furthermore, with the increasing demand for electrical energy in Indonesia currently unbalanced with the availability of electricity supply, or the crisis of electrical energy, it is a problem that cannot be avoided. Phenomenon of the electricity energy crisis such as electricity outages in Java-Bali and blackouts in rotation in some areas in South Sumatera province are signs that the supply of electricity in both the interconnection and conventional systems is no longer able to meet the increasing electricity demand of society and industry [6]. This is because the installed power capacity has exceeded the power generation capacity and this condition is aggravated by the price of fuel oil, which has a high selling price, resulting in power plants in the province of South Sumatra and other provinces in Indonesia that use diesel as primary energy for the process of voltage generation to experience an increase in operational costs. This condition is a challenge to the energy security of the region.

There are two concepts of energy resistance that is 5S and 4A. Indonesia's energy security adheres to the 4A which are availability, accessibility, cost (Affordability), and usage (Acceptability) which then adapted to national conditions and capabilities. Energy security is a condition of ensuring the availability of energy and access to energy at affordable prices in the long term by keeping an eye on the environmental aspect as well [7].

3. Methodology

This paper uses a quantitative method with the Sequential explanatory model [8]. Quantitative method is used in determining the priority for alternative energy strategy. Population in this research is energy stakeholder in South Sumatera Area Energy and Mineral Resources Department of South Sumatera Province, PT. PERTAMINA (Persero) RU3 Palembang, PT. PLN Persero WS2JB Palembang, Ministry of Education and Training, PT. Pusri Palembang, and Academics. The technique for collecting data is by using primary data with resource person expert on energy and secondary data through data from documentation and publication of Ministry of Energy and Mineral Resources, PT. Pertamina (Persero), National Energy Council (DEN), Electronic Media, and relevant print media.

South Sumatera region contained a several potentials of renewable and non-renewable resources that can be the replacement for the fossil fuel energy such as, geothermal energy, coal, natural gas, water, wind, solar and peat, whereas the alternative energy like coal, natural gas, and peat is not a sustainable and environmental friendly. For that matters, in this paper we are only focused on the analysis of the geothermal, water, wind, and solar energy that can be managed and utilized as the source of energy which is sustainable along with the priority of environmental concept in its usage. Analytical Hierarchy Process (AHP) is used to analyze alternative energy potentials that influence the utilization and management of alternative energy potentials of strength, weakness, opportunity and threat factors. [9].
Modeling as shown below:

H1: Goal

H2: Criteria

H3: Sub Criteria

H4: Alternative

Picture 1. AHP Formulation of the Renewable Alternative Energy Strategy

Description: A = Low generating cost, B = No pollution and greenhouse gas emissions, C = Reduced oil imports, D = Ongoing utilization, E = High investment cost, F = inadequate infrastructure, G = localizes utilization, H = Cannot be traded before being converted, I = Increase national resilience, J = The demand of electricity and the growth of electrical energy, K = dependence on the fuel that causes National energy security problem, L = Reduce Co2 emissions, M = Lack of Human Resource particularly in the district, N = Deprivation of the infestation for renewable energy (because the rate of return for the capital investment is quite low and uncertain), O = the possibility of the regulation area which is different in accordance to the central government policy [10].

4. Result and Discussion

South Sumatera Province, which is part of Indonesia territory, has potential in alternative energy sources such as geothermal energy, water energy, wind energy, and solar energy which is immense enough and is spread all over South Sumatera region. The potential of this alternative energy can be utilized as primary energy source in South Sumatera province to strengthen the resilience of regional energy [11].

The AHP analysis uses pairwise comparison matrix based on several criteria [12], with several assumptions such as:

a. Analysis of the power aspects of the renewable energy selection strategy

The sub criteria studied in this aspect include: low cost generation factor (A), least pollution factor and greenhouse gas emissions generated at each plant (B), factors for reducing oil imports (C), and sustainable energy utilization factors (D).

Table 1. Local priority and global aspect of power

| Priority of alternative strategy | A    | B    | C    | D    |
|---------------------------------|------|------|------|------|
| Mass                            | 0.085| 0.140| 0.233| 0.542|
| Geothermal                      | 0.074| 0.066| 0.096| 0.074|
| Water                           | 0.171| 0.150| 0.161| 0.171|
| Wind                            | 0.284| 0.240| 0.277| 0.284|
According to table 1, for low cost generating factors, the alternative strategy chosen is the alternative priority of the solar strategy. The energy priority that produces the lowest pollution is solar energy. Factors that can reduce oil imports are big priority solar energy, while for the use of renewable energy more priority to solar energy. Overall priority of renewable energy strategy alternative based on power aspect is more toward the alternative of solar energy that is equal to 0.480.

b. Analysis of the weakness aspects of renewable energy selection strategy

Sub criteria studied in this aspect include: factors that require expensive investment costs (E), factors lacking adequate infrastructure (F), local utilization factors (G), and non-selling factors before conversion (H).

Table 2. Local priority and global weakness aspect

| Priority of alternative strategy | E   | F   | G   | H   |
|----------------------------------|-----|-----|-----|-----|
| Mass                             | 0.042 | 0.133 | 0.268 | 0.558 |
| Geothermal                       | 0.598 | 0.492 | 0.544 | 0.558 |
| Water                            | 0.209 | 0.309 | 0.240 | 0.259 |
| Wind                             | 0.133 | 0.136 | 0.150 | 0.112 |
| Solar                            | 0.060 | 0.063 | 0.066 | 0.071 |
| Total                            | 1.000 | 1.000 | 1.000 | 1.000 |

| Priority of alternative strategy | E    | F    | G    | H    | Weight |
|----------------------------------|------|------|------|------|--------|
| Geothermal                       | 0.025 | 0.065 | 0.146 | 0.311 | 0.547  |
| Water                            | 0.009 | 0.041 | 0.064 | 0.145 | 0.259  |
| Wind                             | 0.006 | 0.018 | 0.040 | 0.063 | 0.126  |
| Solar                            | 0.002 | 0.008 | 0.018 | 0.039 | 0.068  |
| Total                            | 0.042 | 0.133 | 0.268 | 0.558 | 1.000  |

Based on table 2, the alternative priority which has an expensive investment cost is geothermal energy. Based on the inadequate infrastructure factor that is owned by the province of South Sumatera is geothermal. Utilization of the local area is more geothermal and energy factors that cannot be traded before the conversion is
also a geothermal alternative. Priority strategy to be done on the weakness aspect is an alternative aspect of geothermal strategy.

c. Analysis of opportunity aspect in renewable energy selection strategy

Sub criteria which is reviewed in this aspect is: An increase of national resilience factor (I), Electricity demand and the growth of electrical energy factor (J), Dependence on fuel causing national energy security problems factor (K), and reducing emission CO₂ factor (L).

Table 3. Local priority and Global opportunity aspect

| Priority of alternative strategy | I    | J    | K    | L    | Weight |
|---------------------------------|------|------|------|------|--------|
| Geothermal                      | 0.004| 0.005| 0.022| 0.033| 0.064  |
| Water                           | 0.011| 0.014| 0.036| 0.051| 0.112  |
| Wind                            | 0.017| 0.037| 0.061| 0.114| 0.228  |
| Solar                           | 0.038| 0.057| 0.141| 0.360| 0.596  |
| Total                           | **0.071** | **0.112** | **0.259** | **0.558** | **1.000** |

In table 3, the biggest opportunity based on an increased national resilience is the use of solar energy selection strategy. According to The Demand for electricity and the growth of electrical energy, solar energy alternatives are still a selected priority. Factors dependence on fuel prefer to alternative solar energy strategy alternatives, and to reduce CO₂ emissions, the alternative of preferred energy strategy is solar energy. Overall, based on the opportunities that have been made on the utilization of renewable energy, the alternative strategy chosen is more to the selection of solar energy with a value of 0.596.

d. Analysis of threat aspects on renewable energy selection strategy

The sub criteria studied in this aspect are: the limited factors of human resources, especially in the region (M), the less desirable investment factor of the renewable energy sector (N), and the possible factors for the emergence of local regulations that are out of sync with central government policy (O).

Table 4. Local Priorities and Global Aspects of Threats

| Priority of alternative strategy | M    | N    | O    | Weight |
|---------------------------------|------|------|------|--------|
| Geothermal                      | 0.047| 0.139| 0.347| 0.533  |
| Water                           | 0.021| 0.090| 0.149| 0.260  |
| Wind                            | 0.013| 0.033| 0.089| 0.135  |
| Solar                           | 0.006| 0.013| 0.054| 0.073  |
| Total                           | **0.087** | **0.274** | **0.639** | **1.000** |

Based on table 4, the threat aspect, the biggest threat to human resource constraints is on geothermal energy strategy. Less desirable investment in strategic priorities lies in the use of alternative geothermal strategies, as well as for the threat of emergence of local regulations that does not have synchronization with the central government. The greatest threat posed to the priority of alternative strategies lies in geothermal energy. Overall, among the merging of strengths, weaknesses, opportunities, and threats that exist in the selection of renewable alternative energy can be seen in table 5.

Table 5. The selection of alternative priorities of renewable energy strategy of South Sumatra province

| Priority of alternative strategy | Geothermal | Water | Wind | Solar |
|---------------------------------|------------|-------|------|-------|


The priority matrix of energy alternative strategy above shows that geothermal energy is the main priority with value 1.221, the second alternative energy is solar energy with value 1.216, the third alternative is water energy with value 0.796, alternate to four that is wind energy with value 0.766.

5. Conclusion

According to the result of the analysis, the priority for alternative energy strategy based on the Strength aspect is solar energy with value of 0.480, while the priority for alternative energy strategy based on the weakness aspect is geothermal energy with value of 0.547. Priority on the alternative energy on the opportunity aspect is solar energy with value of 0.596 and on the threat aspect is geothermal energy with value of 0.533. Based on the final weighting, the result for the priority of alternative energy strategy that can be done in South Sumatera, as an added value of strength, weakness, opportunity and threat aspects, is geothermal energy with total value of 1.221.

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