

Energy Security Perspective in Indonesia's Geothermal Energy Development

Abdulloh Ubaid¹, Mila Utami Sari², Danisworo³, and Lailatul Qomariyah⁴

^{1,2,3}Student of Energy Security Program, Republic of Indonesian Defense University, Jakarta

⁴Student of Sensing Technology Program, Republic of Indonesian Defense University, Jakarta

Abstract — This paper examines the development of geothermal energy in Indonesia based on availability, affordability, accessibility, acceptability. Apart from the 4 aspects of energy security, the study focuses on the development of new and renewable energy in various related countries. there are exploration rate and resources location and land use variables in terms of availability, energy price and industrial intensity as variables in terms of affordability, energy carrier and population settlement and distribution as variables in terms of accessibility and cultural effect on the energy system and energy conditions shaping cultural aspect as a variable in terms of acceptability. As for strategic matters and obstacles obtained from related countries in geothermal development, attention must be paid to ensuring the need and availability of national energy.

Keywords — Energy Policy, Energy Security, Geothermal Energy.

I. INTRODUCTION

Energy has become a basic human need. Energy has an impact on accelerating changes in social systems, technological advances, and the quality of human life. Energy is used in various life activities such as physiological needs, security, and self-actualization. Changes in social systems and technological advances have an impact on the level of energy demand and specifications. The level of demand and specifications for global energy consumption under normal conditions has increased. in 2020, there will be a decrease in energy demand due to the covid-19 pandemic. The decline is not expected to affect the overall global primary energy consumption trend. the prediction of growth in primary energy use continues to increase every year in line with the global recovery from the crisis (BP Statistical Review of World Energy, 2021).

Energy has become part of the deficiency needs and growth needs in the hierarchy of needs theory. Deficiency Needs are defined as needs created as a result of a lack of energy needed to survive or related to well-being. While growth or being needs are defined as the energy needs created to carry out self-growth in achieving their life targets. The change in the trend of energy utilization is getting wider with the development of technology and digitalization that reaches all aspects of life, making the dependence on the results of the conversion of energy sources into electrical energy very high. This encourages changes in the social, economic and cultural systems of the community so that an energy transition occurs.

Indonesia as a part of the global energy network must adapt to changing global energy trends. One of the forms is a policy in optimizing the exploration and exploitation

of new and renewable energy sources. This was caused by a decrease in oil and gas production by 5% and 11.7% respectively in the 2014-2019 range as well as an increase in coal production by 33.6% in the 2017-2019 range, while the electricity consumption of MWH per capita increased to 1.08 in 2019 from 1.02 in 2017 (BPS, 2020). Changes in the trend of using energy into electricity must be a concern. this is due to the limitations of the generation compared to the demand for electrical energy and its utilization.

The government responded to the changes in energy use trends by issuing a policy on the National Energy Policy (KEN), which was then followed by the establishment of the General National Energy Plan (RUEN). RUEN is a derivative of KEN in an effort to transition from fossil energy to new and renewable energy. Indonesia's target regarding the renewable energy mix in the RUEN is 23% in 2025 of the total primary energy supply (TPES) and 31% in 2050.

During the energy transition process, Indonesia must ensure the availability of energy and access for the public to energy at affordable prices, with due regard to environmental sustainability. This condition is the definition of energy security. Energy security is determined through 4 criteria including availability, affordability, accessibility, and acceptability (Boedoyo, 2012). The paradigm of energy security and energy independence is based on energy management which includes the principle of benefit, the principle of fair efficiency, the principle of sustainability, the principle of community welfare, the principle of increasing added value, the principle of preserving environmental functions, the principle of integration, and the principle of national resilience.

One of the promising energies and has great potential to be developed is geothermal energy. Geothermal energy is a renewable energy source that produces heat continuously from within the earth with direct or indirect use. direct utilization is the utilization of geothermal energy without converting it, while indirect utilization is the utilization of geothermal energy by converting it into electrical energy. Geothermal energy is one of the new and renewable energies that are encouraged in the energy transition effort in Indonesia.

This paper examines the development of geothermal energy based on 4 aspects of energy security, namely availability, affordability, accessibility, and acceptability. Apart from the 4 aspects of energy security, the study also focuses on looking at the conditions for developing new and renewable energy in various related countries.

II. METHODS

The research method in this paper is a qualitative descriptive method with a Literature Review approach. This paper examines critically the knowledge, ideas, or findings contained in academically oriented literature, as well as formulating theoretical and methodological contributions in the field of new and renewable energy, especially geothermal.

III. RESULT AND DISCUSSION

Geothermal energy is heat energy from geothermal fluid sourced from magma with a temperature of up to 5000°C which can be utilized through direct use or production of electrical energy (Dincer, 2018). Indonesia, the United States, the Philippines, Mexico, New Zealand, Italy, Iceland, Turkey, Kenya, and Japan are the countries with the most potential to develop geothermal energy. This is because the country is part of the ring of fire.

Especially regarding geothermal in Indonesia, the potential for development into a long-term national energy base load is very promising. This is in accordance with the large potential for geothermal exploration and exploitation. The greatest potential is on the islands of Sumatra, Java and Sulawesi with total resources and reserves of 9,517, 8,050 and 3,071 MWe. The three islands are 3 large islands with active mountain clusters supported by a large number of people. Currently, Indonesia only has a total capacity of 2130.9 MW. There are 974.1 MWe equivalent to 31.37% proven reserves or 21,635.1 MWe equivalent to 91% of all reserves and resources that can be utilized. This is based on the report issued by the government as follows.



Figure 1: Tectonic plates and global geological activity (Source: Irena Geothermal Power Technology Brief 2017)

Table 1: Indonesia Geothermal Resources and Reserves

No	Location	Total Reserves and Resources (Mwe)
1	Sumatera	9.517
2	Jawa	8.050
3	Bali	335
4	Nusa Tenggara	1.399
5	Kalimantan	175
6	Sulawesi	3.071
7	Maluku	1.144
8	Papua	75

Sources: Handbook of Energy & Economic Statistics of Indonesia (2020).

Table 2: Geothermal power generation and capacity

No	PLTP	Capacity (MW)
1	PLTP Sibayak	12
2	PLTP Sarulla	330
3	PLTP Ulubelu	220
4	PLTP Salak	377
5	PLTP Wayang Windu	227
6	PLTP Patuha	55
7	PLTP Kamojang	235
8	PLTP Darajat	270
9	PLTP Dieng	60
10	PLTP Karaha	30
11	PLTP Matalako	2.5
12	PLTP Ulumbu	10
13	PLTP Lahendong	120
14	PLTP Lumut Balai	55
15	PLTP Marapi Sorik	42.4

16	PLTP Muara Laboh	85
----	------------------	----

Sources: Handbook of Energy & Economic Statistics of Indonesia (2020).

In indirect geothermal utilization, the majority of geothermal conditions in Indonesia have characteristics such as localized, must be converted, high efficiency, high cost, and high risk. The geothermal character is then derived from the aspect of energy security which includes availability, affordability, accessibility, and acceptability (Boedoyo, 2012).

Availability is a critical dimension for energy development. Availability supports economic growth and prosperity and forms the basis of energy production. Availability is related to geothermal potential and location. This is an assessment in determining the geothermal working area. In indirect geothermal utilization, the location and conversion of geothermal energy into electrical energy has an important point in the initial steps of an energy development project so that the exploration rate and resource location are the main points for geothermal development. The location of geothermal working areas in mountainous and forest areas makes land use calculations must be adjusted to environmental conditions. Apart from these two things, there are several other points that must be considered, namely Length of the event, Location of energy source, Extraction and transportation methods.

Affordability is the main downstream dimension for energy development. Affordability has a role as a determinant of energy product uptake. In this case, the equivalence point of affordability is between the cost of producing energy and the ability to buy energy. These factors make the economic price of energy very important which leads to the energy price. On the other hand, the distribution of consumption types, household and industrial, can be part of the energy business model in calculating energy conversion, in which industrial intensity is used to accelerate geothermal development. In addition, there are costs of securing the system, costs of disruption and consumers that can affect geothermal development on a macro basis.

Accessibility is a dimension of connecting upstream and downstream sides for energy development. Accessibility in geothermal energy mostly relies on the availability of physical infrastructure that connects the location of energy production to consumers. In the process, there are 2 important things to focus on, namely energy carriers and population settlement and distribution.

Acceptability is a downstream dimension that relates to consumers individually and in groups in encouraging energy development. If it is based on the energy development team frame, the energy system is based on the cultural effect on the energy system and energy conditions shaping the cultural aspect around the energy source. Apart from these two things, energy development is also measured through Outcomes from energy use, Information availability and Effect of employment rate on energy security.

From the explanation, we can see that geothermal development in Indonesia has its own challenges behind its great potential and many related aspects. If viewed from the study of the development of new and renewable energy in other countries on a macro basis, there are several differences, such as the classification of application areas, development barriers, complexity of energy transition, mapping and ranking of strategic energy.

Kheybari's research classifies application areas to include health, safety and environmental management, hydrology and water management, business and financial management, human resources management, tourism, logistics and supply chain management, design engineering and manufacturing systems energy management (Kheybari, Rezaie, Farazmand, 2020). In terms of obstacles, there are high investment and operational costs, lack of coordination from the government and the private sector and lack of development planning for renewable energy sources (Navarro & Perez, 2018). From the complexity of the energy transition, there is a level of understanding of global energy trends through international policies, adaptation on the domestic side through determining strategic steps to utilize feedback dynamics to promote market transformation without comprehensive international cooperation (Meckling, 2018). In terms of mapping and ranking strategic energy, the most important criterion is the economy while other criteria such as security, human welfare, technology and global effects are supporting criteria (Kabak & Dagdeviren, 2014).

IV. CONCLUSION

considering the large geothermal potential in Indonesia, it can be used as an energy base load with the advantage of being evenly distributed on the potential of the island with a large population. In addition, the changing world energy trends and the urgency of developing new and renewable energy make the geothermal sector a great attraction for investment. For this reason, it is necessary to carry out further mapping based on Indonesia's energy

security as the basis for calculating and planning national energy. In addition, it is necessary to pay attention to several strategic things and obstacles obtained from related countries in geothermal development to ensure the need and availability of national energy.

REFERENCES

- [1] Boedoyo, M. Sidik. (2012). Analisis Ketahanan Energi di Indonesia. Prosiding Seminar dan Peluncuran Buku Outlook Energi Indonesia 2012
- [2] BP P.L.C. (2021). "Statistical Review of World Energy 2021". London: Statistical Review of World Energy, 70th edition
- [3] Gómez-Navarro, Tomás. Ribó-Pérez, David. (2018). Assessing the obstacles to the participation of renewable energy sources in the electricity market of Colombia. *Renewable and Sustainable Energy Reviews* 90 pp 131–141
- [4] Ibrahim Dincer. (2018). *Comprehensive Energy Systems*. Amsterdam: Elsevier
- [5] Kabak, Mehmet. Dagdeviren, Metin. (2014). Prioritization of renewable energy sources for Turkey by using a hybrid MCDM methodology. *Energy Conversion and Management* 79 pp 25–33
- [6] Kheybari, Siamak. Rezaie, Fariba Mahdi., Farazmand, Hadis. (2020). Analytic network process: An overview of applications. *Applied Mathematics and Computation* 367
- [7] Meckling, Jonas. (2018). Governing renewables: Policy feedback in a global energy transition. *Environment and Planning C: Politics and Space* pp 1–21
- [8] Peraturan Pemerintah Republik Indonesia Nomor 79 Tahun 2014 Tentang Kebijakan Energi Nasional
- [9] Peraturan Presiden Republik Indonesia Nomor 22 Tahun 2017 Tentang Rencana Umum Energi Nasional
- [10] Statistik Ketenagalistrikan, Dirjen Ketenagalistrikan, Kementerian ESDM. "Konsumsi Listrik per Kapita (MWH/Kapita), 2017-2019". Retrieved from <https://www.bps.go.id/indicator/7/1156/1/konsumsi-listrik-per-kapita.html>
- [11] Sejati, Sendang. (2018). Hirarki Kebutuhan Menurut Abraham H. Maslow dan Relevansinya Dengan Kebutuhan Anak Usia Dini Dalam Pendidikan Islam. Program Studi Pendidikan Islam Anak Usia Dini. Institut Agama Islam Negeri Bengkulu