Al-Kharaj: Journal of Islamic Economic and Business
Volume 6 (4), 2024: 466 - 478
P-ISSN: 2686-262X; E-ISSN: 2685-9300

SWOT and IFE EFE Analysis in the Development of Geothermal Power Plant in Mount Slamet Area: Ecological and Social Opportunities and Challenges

Ajeng Faizah Nijma Ilma[1]*, Maria Mu'ti Wulandari[2], Baginda Khalid Hidayat Jati[3]

[1] FEB, Jenderal Soedirman University, Indonesia

[2] FH, Jenderal Soedirman University, Indonesia

[3] FH, Jenderal Soedirman University, Indonesia

Email: ajeng.faizah@unsoed.ac.id

Received: 26 March 2024

Revised: 2 November 204

Accepted: 3 December 2024

Abstract

The Geothermal Power Plant (PLTP) development in the Slamet Mountain area aims to provide sustainable energy while facing ecological and social challenges. A SWOT analysis reveals strengths like abundant geothermal resources and strong government support, but also weaknesses such as inadequate infrastructure and high costs. Opportunities include rising public awareness of clean energy and eco-tourism, while threats involve environmental damage and social displacement.

The Internal Factor Evaluation (IFE) score is 3.05, indicating moderate strengths, and the External Factor Evaluation (EFE) score is 3.00, revealing significant opportunities and threats. To achieve sustainable development, a collaborative approach with stakeholders is recommended, focusing on strengthening infrastructure, establishing clear regulations, and fostering community engagement.

Keywords: *Geothermal Power Plant, SWOT and IFE and EFE, ecological impact, social impact*

INTRODUCTION

The development of geothermal energy in Indonesia is very important considering the country has the largest geothermal potential in the world. This renewable energy offers a sustainable solution to meet growing energy needs, while reducing dependence on environmentally damaging fossil energy sources. Mount Slamet, as one of the active volcanoes in Central Java, holds significant geothermal reserves (Bayu Mahendra, 2022). The development of a Geothermal Power Plant (PLTP) in this area becomes very relevant, not only to meet local energy needs but also as a contribution to the fulfillment of sustainable national energy targets. Geothermal power plants can have a positive impact in increasing the availability of electrical energy, reducing carbon emissions, and encouraging local economic growth(Sebestyén, 2021).

The development of a geothermal power plant on Mount Slamet faces a range of complex ecological and social challenges. The project potentially poses risks to local ecosystems, including deforestation that disrupts the habitat of flora and fauna. Geothermal exploration and exploitation activities have impacts on soil and water quality, especially if not managed with strict environmental procedures (Ramadhan, Muslihudin and Effendi, 2021). This uncertainty creates potential resistance from communities, making their involvement in planning and decision-making an important aspect.

Conducting a SWOT analysis in the development of geothermal power plants in Gunung Slamet is essential to identify factors that may affect the success of the project. The analysis revealed strengths such as the huge potential of geothermal energy, but along with weaknesses it

https://doi.org/10.24256/kharaj.v6i4.6341

also revealed poor planning, including limited community consultation and lack of clarity in the environmental impact assessment. The project faces opportunities such as a shift towards clean energy in line with global climate commitments, but also real threats, such as deforestation, water pollution and relocation of wildlife to agricultural land due to land exploration (Biko Nabih Fikri Zufar and Ahmad Fadli Azami, 2021). Understanding these factors allows developers to design mitigation strategies that ensure a balance between ecological sustainability and the well-being of surrounding communities.

The Indonesian government continues to strengthen regulations to support the development of renewable energy, including geothermal. With the enactment of Presidential Regulation No. 112 of 2022, oversight of energy exploration was tightened and the construction of coal-fired power plants was restricted to support the transition to clean energy. In addition, it simplifies the procurement process and sets price caps to ease investment (AHP, 2022). These policies are in line with Indonesia's commitment to reduce dependence on fossil fuels and support national sustainability goals. On the other hand, Government Regulation No. 25 of 2021 replaces Government Regulation No. 7 of 2017 and expands the scope of energy management, emphasizing simplification of procedures, good governance, and environmental sustainability. In the context of Gunung Slamet Geothermal Power Plant, this regulation ensures that exploration and management are carried out responsibly, taking into account environmental sustainability and the involvement of surrounding communities(Hemmati et al., 2024).

The development of a Geothermal Power Plant (PLTP) in the Gunung Slamet area does offer significant potential to meet sustainable energy needs and support the national energy transition. The success of this project relies heavily on a thorough understanding of its strengths, weaknesses, opportunities and threats. SWOT and IFE EFE analysis are important tools in designing strategies that not only maximize the benefits of renewable energy but also minimize negative impacts on the environment and surrounding communities(Smith et al., 2024). With the implementation of strict regulations, such as those stipulated in Presidential Regulation No. 112 of 2022 and PP No. 25 of 2021, it is expected that the management of this project can be more responsible and inclusive, thus ensuring long-term ecological, social, and economic sustainability.

Although great potential exists for the development of geothermal power plants on Mount Slamet, the project faces a range of complex issues. Environmental issues are a major concern, including the risk of ecosystem damage and degradation of soil and water quality(Kjeld et al., 2022). The first issue to be addressed here is what are the strengths and weaknesses of geothermal power plant development in Gunung Slamet, particularly in relation to geothermal energy potential, infrastructure conditions, and local community involvement? This question emphasizes the identification of the internal factors of the project that affect its success, as well as providing insight into the strategic aspects that need to be considered in project planning and implementation.

Second, what mitigation strategies can be designed through SWOT and IFE EFE analysis to minimize risks and optimize ecological, social and economic sustainability? This question encourages the development of concrete solutions based on the strategic analysis, which is particularly relevant in the context of the article to ensure that the project runs with high principles of sustainability and inclusiveness.

This research aims to identify and analyze the strengths and weaknesses in the development of PLTP in Gunung Slamet, including energy potential, infrastructure, and local community involvement. It also aims to design effective mitigation strategies through SWOT and IFE EFE analysis to minimize risks and optimize project sustainability in terms of ecological,

social, and economic aspects. Thus, this research is expected to provide concrete recommendations to support the success and environmental responsibility of geothermal power plant development.

METHODS

This research uses a descriptive qualitative approach to analyze the factors influencing the development of Geothermal Power Plants (PLTP) in the Gunung Slamet Region. This approach allows researchers to explore and understand the social, economic and environmental dynamics associated with geothermal energy development. Thus, SWOT analysis can be conducted in depth, considering the perspectives of various stakeholders. Data sources in this study are divided into two categories:

1. Primary Data:
    a. AMDAL report: An environmental impact assessment document that has been prepared by the developer to understand the potential impacts of the project.
    b. Community Survey: A questionnaire distributed to the surrounding community to gather their opinions and perceptions regarding the geothermal project.
    c. Interviews: In-depth discussions with energy experts, academics, and environmental activists to gain insights into the technical and social aspects of geothermal development.
2. Secondary Data:
    a. Government Documents: Policies related to renewable energy and geothermal development published by the government and related institutions.
    b. Literature Study: Previous research on geothermal power plant development in Indonesia and other countries as references for analysis and comparison.

The data collected will be analyzed through several stages:

1. Data Classification: The data obtained will be categorized into four aspects of SWOT analysis-Strengths, Weaknesses, Opportunities, and Threats. Followed by analysis using the IFE EFE matrix, the IFE-EFE matrix can be used to analyze the competitiveness of the company. The way to use it is to assign weights to each factor, then rank them based on the company's performance. The weighted score is determined by multiplying the weight by the rating.

2. Identification of Findings: Each category will be filled with relevant findings based on the primary and secondary data collected. For example, strengths could include high energy potential, while weaknesses could relate to lack of infrastructure.

3. Linkage Analysis: The relationship between factors within each category will be analyzed to understand how strengths can be leveraged to overcome weaknesses, as well as how opportunities can be strategized against threats.

4. Formulation of Recommendations: Based on the analysis, recommendations for the development of geothermal power plants in the Gunung Slamet area will be developed, focusing on strategies that can maximize benefits while minimizing negative impacts on the environment and society.

With this methodology, the research is expected to provide a comprehensive picture of the potential and challenges faced in the development of PLTP in the region.

RESULTS AND DISCUSSION

1. SWOT Analysis

1.1 Strengths

The development of a Geothermal Power Plant (PLTP) on Mount Slamet has several key strengths. Firstly, the geothermal energy potential in the region is huge, providing a sustainable and reliable source of energy. This allows for stability of electricity supply which is important for regional energy needs. Secondly, it can create local economic opportunities, including job creation during construction and operation, as well as potential revenue generation from renewable energy-related tourism. With community and stakeholder support, geothermal power plants can contribute significantly to local economic development(Ramadhan et al., 2021b).

Mount Slamet, located in Central Java, has great potential as a source of geothermal energy due to its active volcanic activity and unique geological structure. Geothermal manifestations in this area mainly appear on the slopes and base of the volcanic structure of Mount Slamet Tua, following a northwest-southeast oriented fault line. This volcanic area consists of various rock types, such as lava, breccia and volcanic ash, which support the presence of geothermal reservoirs. Field studies have identified eight geothermal manifestation points, including hot springs on the northern and southern slopes, with notable sites such as Pancuran 7 and Pancuran 3 in the Baturaden area. These geothermal features follow fault patterns, suggesting that the permeability of volcanic rocks and fractures favor heat flow and geothermal activity (Widagdo and Setijadi, 2015). The geological composition of Mount Slamet makes it a valuable resource for renewable energy, making it a prospective location for geothermal power plant development that can meet local and national energy needs, as seen in the map in Figure 1.

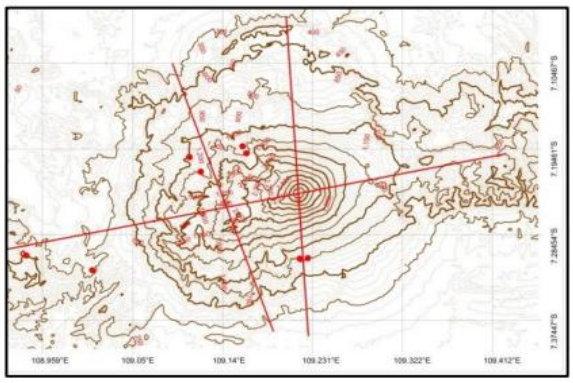

Figure 1: Topographic map of Mount Slamet and various geothermal locations (Widagdo and Setijadi, 2015).

1.2 Weaknesses

Despite their strengths, geothermal projects also face various weaknesses. High initial investment costs are a major challenge, with the development of the necessary infrastructure and technology requiring substantial capital. In addition, impacts on surrounding forests and ecosystems can be a serious issue, including potential deforestation and disruption to local habitats. Technical or geological risks, such as earthquakes or changes in geothermal conditions, can also threaten project viability. These weaknesses require attention and effective mitigation strategies to minimize negative impacts(Nurlathifah & Djafar, n.d.).

1.3 Opportunities

The development of geothermal power plants on Mount Slamet offers a range of opportunities. Government support for renewable energy, including fiscal incentives and policies that encourage investment in the sector, provide good opportunities for project development. In addition, with increasing global awareness of climate change and the need for green energy, the demand for geothermal energy is expected to continue to grow. Technological advances in geothermal exploration and utilization also pave the way for higher efficiency and reduced operating costs in the long run(Nugroho, 2018).

1.4 Threats

However, there are some threats that need to be considered. Adverse environmental impacts, such as pollution and ecosystem disruption, may generate resistance from local communities and environmental activists. Unexpected changes in government policy can also disrupt project viability, especially if renewable energy policies change direction. In addition, the risk of natural disasters, such as earthquakes that can occur in mountainous areas, is a serious threat that needs to be well anticipated(Kusuma et al., 2023).

2. IFE and EFE Analysis

The Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrices for the development of a Geothermal Power Plant (PLTP) on Mount Slamet, with a focus on ecological risks and social risks.

2.1 Internal Factor Evaluation (IFE) Matrix

Strengths:

a. Renewable Energy Potential: Abundant geothermal energy sources.
b. Government Support: Government policies that support renewable energy development.
c. Latest Technology: Access to modern technology for resource management.

Weaknesses:

a. Environmental Risks: Potential air and water pollution due to operational activities.
b. Community Resistance: Opposition from local communities to development.
c. Initial Investment Costs: High investment for infrastructure development.

Table 1. Matriks IFE

Faktor	**Bobot**	**Skor**	**Bobot x Skor**
Potensi Energi	0.25	4	1.00
Dukungan Pemerintah	0.20	4	0.80
Teknologi Terkini	0.15	3	0.45
Risiko Lingkungan	0.20	2	0.40
Resistensi Masyarakat	0.10	1	0.10
Biaya Investasi Awal	0.10	2	0.20
Total	**1.00**		**3.05**

Source: Data processed, 2024

2.2. External Factor Evaluation (EFE) Matrix

Opportunities:

a. Growing Energy Needs: Growing demand for energy in the region.
b. Environmental Awareness: People are increasingly concerned about the use of renewable energy.

c. Investment Support: Investment from international institutions for renewable energy projects.

Threats:

a. Climate Change: Environmental impacts that may affect the stability of operations.

b. Social Conflict: Potential conflicts with communities related to development impacts.

c. Strict Regulations: Policies that may restrict project operations.

Table 2. Matriks EFE

Faktor	**Bobot**	**Skor**	**Bobot x Skor**
Kebutuhan Energi yang Meningkat	0.25	4	1.00
Kesadaran Lingkungan	0.20	3	0.60
Dukungan Investasi	0.15	4	0.60
Perubahan Iklim	0.20	2	0.40
Konflik Sosial	0.10	1	0.10
Regulasi yang Ketat	0.10	2	0.20
Total	**1.00**		**3.00**

Source: Data processed, 2024

3. Results Analysis

• IFE Score: 3.05 (out of a total of 5.00) indicates that internally, there are fairly good strengths despite some weaknesses that need to be addressed.

• EFE Score: 3.00 (out of a total of 5.00) indicates that there are good opportunities, but there are also threats that must be monitored.

DISCUSSION

The interconnection between SWOT elements indicates a complex dynamic in the development of geothermal power plants (PLTP). Strengths such as significant energy potential and government support can be leveraged to address threats, such as community resistance. By involving the community in the planning process and educating them about the benefits of geothermal power plants, the project can gain stronger local support. Additionally, weaknesses

such as high investment costs can be addressed through partnerships with investors who have experience in similar projects, as well as the implementation of new technologies that can reduce costs. A collaborative strategy that integrates strengths and opportunities while addressing weaknesses and threats will be key to the success of the geothermal power plant development in the Gunung Slamet area. The interconnection between SWOT elements illustrates the complexity involved in the development of geothermal power plants. (PLTP). The strengths possessed, such as the significant geothermal energy potential and government support, can be used to face threats, including resistance from the local community. To address this, it is important to involve the community in the project planning process and provide education about the benefits of geothermal power plants (PLTP). This approach is expected to increase support from the local community.

On the other hand, weaknesses such as high investment costs can be addressed by partnering with investors who have experience in similar projects. In this way, financial risks can be minimized. In addition, the implementation of new technologies can also help reduce operational and investment costs. By formulating a collaborative strategy that combines existing strengths and opportunities, while actively addressing weaknesses and threats, the geothermal power plant project in the Mount Slamet area has great potential for success. This approach will ensure that all aspects—be it environmental, social, or economic—are considered in the sustainable development of the project.

1. Potential Development of Geothermal Power Plants at Mount Slamet

The development of Geothermal Power Plants (PLTP) at Mount Slamet has very high potential. As one of the active volcanoes in Indonesia, Mount Slamet holds abundant geothermal resources. This potential can be converted into sustainable electrical energy, making a significant contribution to meeting the continuously increasing national energy needs. In addition, the development of geothermal power plants can create jobs, increase local income, and drive economic development in the surrounding areas. With government policy support for renewable energy, this project can serve as a model for the development of other clean energy sources in Indonesia.

2. Challenges of Developing Geothermal Power Plants at Mount Slamet

Despite the great potential, there are several challenges that must be faced in the development of geothermal power plants in this area:

1. High Investment Costs: The development of the infrastructure and technology required for geothermal power plants necessitates significant initial investment. This can be a barrier for developers with limited capital.

2. Environmental Impact: The construction of geothermal power plants (PLTP) risks causing negative impacts on local ecosystems, including potential water pollution and disruption to biodiversity. The utilization of geothermal resources can also affect the quality of soil and water in the surrounding area.

3. Community Resistance: Uncertainty regarding environmental and social impacts can lead to resistance from local communities, who may be concerned about the changes that will occur to their livelihoods and environment.

4. Technical and Geological Risks: The potential for natural disasters, such as earthquakes, and geological changes in mountainous areas pose threats that need to be considered in project planning and development.

3. Mitigation Steps

To address these challenges, several mitigation steps need to be implemented:

1. Environmental Impact Analysis (AMDAL): Conducting a comprehensive AMDAL study to understand the potential impacts of geothermal power plant development and formulating strategies to mitigate those impacts.

2. Community Participation: Promoting dialogue and community involvement at every stage of the project development. Education about the benefits of geothermal power plants (PLTP) and their impact on the local economy can help build support from the community.

3. Environmentally Friendly Technology: Implementing more efficient and environmentally friendly technology in the exploration and utilization of geothermal resources to minimize the impact on the ecosystem.

4. Strategic Partnerships: Engaging stakeholders, including the government, NGOs, and academics, to create supportive policies and develop environmental conservation programs around the PLTP area.

4. Support for Energy Sustainability

With appropriate mitigation measures, the development of PLTP on Mount Slamet can support energy sustainability with minimal environmental risk. PLTP not only provides a clean energy source that can reduce dependence on fossil fuels, but also offers an opportunity to involve the community in the sustainable management of natural resources. Efforts to maintain the balance between energy development and environmental preservation are crucial to ensure that this project can provide long-term benefits for the community and the environment, as well as contribute to Indonesia's transition towards more sustainable renewable energy(Marliana et al., 2022).

CONCLUSION

The results of the SWOT analysis show that the development of the Geothermal Power Plant (PLTP) in Gunung Slamet has a strategic position. The main strength of this project lies in the large geothermal energy potential and government support, which can be utilized to meet the increasing energy demand. However, this project also faces significant challenges, including high investment costs and resistance from the community due to potential environmental impacts.

Based on the IFE and EFE analysis, the development of the geothermal power plant at Mount Slamet shows good potential. Internal strengths and external opportunities balance the existing weaknesses and threats. However, ecological risks need to be a primary concern. The results of the IFE and EFE analyses show that although there are challenges and risks associated with the construction of the geothermal power plant on Mount Slamet, there are also many strengths and opportunities that can be leveraged to ensure the project's success. Therefore, it is important to plan mitigation strategies to address the existing weaknesses and threats. On the other hand, the opportunities for the development of geothermal power plants (PLTP) are very promising, especially with the increasing global awareness of renewable energy and technological advancements that can reduce operational costs. However, threats that need to be considered, such as adverse environmental impacts and the risk of natural disasters, remain important issues that must be addressed.

From the perspective of IFE and EFE as well as SWOT, the construction of a geothermal power plant at Gunung Slamet is considered feasible, provided that the right strategies are implemented to minimize weaknesses and address threats. Community involvement and collaboration with experienced investors are key to the success of this project. The implications for the future of renewable energy in Indonesia are very positive; the development of the geothermal power plant (PLTP) can serve as a good example of integrating clean energy and social sustainability, as well as providing a boost for other renewable energy projects across the country. With careful planning and the involvement of all stakeholders, the geothermal power plant at Mount Slamet can significantly contribute to Indonesia's transition towards more sustainable energy.

Recommendations

1. Suggestions for the Government:

o Supportive Policy Formulation: The government needs to formulate policies that more effectively support the development of renewable energy, including fiscal incentives and regulations that simplify the permitting process for geothermal power plant projects.

o Education and Socialization Programs: Conduct educational campaigns for the community regarding the benefits and potential of geothermal energy, as well as its positive impacts on the environment and local economy.

o Monitoring and Evaluation: Establish a special agency or team to periodically monitor and evaluate the environmental and social impacts of geothermal power plant projects, ensuring that the projects proceed as planned and meet sustainability standards.

2. Recommendations for Development Companies:

o Community Involvement: Prioritize community participation in every stage of project planning and development. Open and transparent dialogue will build trust and support from the local community.

o Investment in Environmentally Friendly Technology: Prioritizing the use of technology with minimal environmental impact in the development of geothermal power plants, such as efficient water monitoring and management systems.

o Partnerships with Experienced Investors: Building strategic partnerships with investors who have experience in similar projects to support the management of financial and technical risks.

3. Suggestions for Local Stakeholders:

o Dialogue and Collaboration: Initiating discussion forums involving the community, government, and development companies to address concerns and aspirations related to the geothermal power plant project, creating space for collaboration.

o Community Empowerment Program Development: Encouraging the development of programs that empower local communities, such as skills training and business opportunities related to the geothermal power plant project, to enhance economic benefits for the community.

o Environmental Conservation: Promoting environmental preservation initiatives around the project area to ensure that biodiversity and ecosystems are maintained, while also improving the quality of life for the community.

4. Environmental Study: Conducting a comprehensive environmental impact study.

5. Community Engagement: Enhancing communication and community involvement in project planning.

6. Mitigation Plan: Developing a plan to reduce negative environmental and social impacts.

With these steps, it is expected that the development of the Geothermal Power Plant at Mount Slamet can be carried out sustainably and responsively to the needs of the community and the environment, optimizing energy potential, and minimizing risks, while thoroughly considering social and ecological aspects.

Acknowledment

We extend our gratitude to LPPM Unsoed for funding this research, allowing it to be completed successfully.

REFERENCE

AHP (2022) Presidential Regulation 112: Indonesia's Commitment to Renewable Energy, Assegaf Hamzah & Partners. Available at: https://www.ahp.id/presidential-regulation-112-indonesias-commitment-to-renewable-energy/.

Bayu Mahendra, H.S. (2022) 'Deforestasi Hutan Lindung dalam Proyek Pembangunan PembangkitListrik Tenaga Panas Bumi Baturraden di Kawasan Lereng Gunung Slamet dan Ancaman Terhadap Human Security Masyarakat di Sekitarnya', Journal of International Relations, 8(3), pp. 462–470. Available at: http://ejournal-s1.undip.ac.id/index.php/jihi.

Biko Nabih Fikri Zufar and Ahmad Fadli Azami (2021) 'Is Geothermal Power Plant (PLTP) on Mount Slamet Necessary?', Indonesian Journal of Innovation and Applied Sciences (IJIAS), 1(1), pp. 12–18. Available at: https://doi.org/10.47540/ijias.v1i1.161.

Hemmati, M., Bayati, N., & Ebel, T. (2024). Life Cycle Sustainability Assessment of Waste-to-Electricity Plants for 2030 Power Generation Development Scenarios in Western Lombok, Indonesia under Multi-Criteria Decision-Making Approach. Journal of Building Engineering, 95. https://doi.org/10.1016/j.jobe.2024.110335

Kjeld, A., Bjarnadottir, H. J., & Olafsdottir, R. (2022). Life cycle assessment of the Theistareykir geothermal power plant in Iceland. Geothermics, 105. https://doi.org/10.1016/j.geothermics.2022.102530

Kusuma, A., Bintarsari, ✉ Nuriyeni, & Diryat, N. (2023). Journal of Humanities and Social Sciences Studies Gender, Geothermal Energy, and Environment: The Impact of Baturraden Geothermal Power Plant Exploration on Women and Environment in Banyumas, Indonesia. https://doi.org/10.32996/jhsss

Li, J., Gallego-Schmid, A., & Stamford, L. (2024). Integrated sustainability assessment of repurposing onshore abandoned wells for geothermal power generation. Applied Energy, 359. https://doi.org/10.1016/j.apenergy.2024.122670

Marliana, A. I., Sarjanti, E., & Sutomo, S. (2022). Kajian Tingkat Kesesuaian Penggunaan Lahan Terhadap Rencana Tata Ruang Wilayah dalam Upaya Mitigasi Bencana di Kecamatan Baturraden Kabupaten Banyumas. Proceedings Series on Social Sciences & Humanities, 6, 105–110. https://doi.org/10.30595/pssh.v6i.449

Nugroho, A. (2018). PENGEMBANGAN MODEL PEMBELAJARAN MITIGASI BENCANA GUNUNG MELETUS DI SEKOLAH DASAR LERENG GUNUNG SLAMET. Jurnal Pengabdian Masyarakat Multidisiplin, 1(2), 131–137. https://doi.org/10.36341/jpm.v1i2.413

Nurlathifah, W. A., & Djafar, A. (n.d.). Intensitas Erosi Kerucut Sinder Gunung Slamet Berdasarkan Pembagian Kelas Morfometri Kerucut Erosion Intensity of Slamet Cinder Cones Based on Cone Morphometric Classification Ministry of Energy and Mineral Resources. http://jlbg.geologi.esdm.go.id/index.php/jlbg

Ramadhan, M. F., Muslihudin, M., & Effendi, M. (2021a). Analisis Dampak Sosial Ekonomi Budaya Kegiatan Eksplorasi Panasbumi di WKP Baturraden (Studi Kasus di Desa Karangtengah,

Kecamatan Cilongok, Kabupaten Banyumas). Jurnal Ilmu Lingkungan, 19(1), 117–126. https://doi.org/10.14710/jil.19.1.117-126

Ramadhan, M. F., Muslihudin, M., & Effendi, M. (2021b). Analisis Dampak Sosial Ekonomi Budaya Kegiatan Eksplorasi Panasbumi di WKP Baturraden (Studi Kasus di Desa Karangtengah, Kecamatan Cilongok, Kabupaten Banyumas). Jurnal Ilmu Lingkungan, 19(1), 117–126. https://doi.org/10.14710/jil.19.1.117-126

Sauni, H., Fernando, Z.J. and Candra, S. (2022) 'Energi Geothermal Dalam Aturan, Masalah Lingkungan Hidup Dan Solusi Penyelesaian Konflik Di Masyarakat', Jurnal Rechts Vinding: Media Pembinaan Hukum Nasional, 11(3).

Sebestyén, V. (2021). Renewable and Sustainable Energy Reviews: Environmental impact networks of renewable energy power plants. Renewable and Sustainable Energy Reviews, 151. https://doi.org/10.1016/j.rser.2021.111626

Smith, T., Awolayo, A. N., Grasby, S. E., & Tutolo, B. M. (2024). Investigation of geochemically induced permeability alteration in geothermal reservoirs and its implications for sustainable geothermal energy production. Applied Geochemistry, 175, 106193. https://doi.org/10.1016/j.apgeochem.2024.106193

Sutriani, W. and Wijayanto, B. (2020) 'Strategi Pengembangan Industri Energi Terbarukan Geothermal di Kabupaten Pasaman', Geosee: Geography Science Education Explored Journal, 1(1), pp. 1–5.

Vaccari, M., Pannocchia, G., Tognotti, L., & Paci, M. (2023). Rigorous simulation of geothermal power plants to evaluate environmental performance of alternative configurations. Renewable Energy, 207, 471–483. https://doi.org/10.1016/j.renene.2023.03.038

Widagdo, A. and Setijadi, R. (2015) 'Geological Disaster Potential of Gold And Clay Mining At Cihonje Village Gumelar Sub-District Banyumas Regency', Dinamika Rekayasa, 11(1), pp. 11–15.