Driving Agricultural Sustainability through Geothermal Energy: A CSR Case Study of Program Gemah Karsa by PT PGE Tbk Kamojang Area

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ABSTRACT

This study examines Corporate Social Responsibility as a resource strategy in assisting the sustainability of Kamojang local community agriculture. The research is based on Pertamina Geothermal Energy (PGE) Kamojang Area's GEMAH KARSA programme, which consists of three major efforts: Geothermal Organic Fertiliser (GeO-Fert), Geothermal Farming, and Green Watering. These initiatives aim to emphasise renewable energy through the direct use of geothermal waste to support sustainable agriculture and the creation of environmentally friendly irrigation systems.

This research uses a qualitative method with content analysis and relies on secondary data from PGE's CSR reports and accompanying documents. These include social mapping study documents, programme implementation documents, social return on investment study documents and social innovation documents. This study also conducted a literature review on CSR programmes based on renewable energy companies, especially geothermal, as an effective strategy to support sustainability, especially in agriculture.

The research findings prove that GEMAH KARSA has a two-way positive impact, positively impacting the local economy and environment and helping to make PGE stand out as an innovative green energy leader. CSR is committed to contributing to sustainable resource utilisation, improving community welfare levels, and building strong relationships with stakeholders. In addition to these benefits, challenges related to regulatory compliance and community engagement were also found in this study. For more effective CSR, greater collaboration and sustainable geothermal innovation are essential. This research contributes to the development of CSR strategies in the field of renewable energy and provides insights for companies seeking sustainable development.

1. INTRODUCTION

Corporate Social Responsibility (CSR) is a really big part of any business plan by a company, especially for ensuring sustainability and building up a good reputation (Stuebs & Sun, 2023). In the energy sector, especially geothermal, CSR is not just about checking social and environmental responsibility boxes. It also helps companies to better manage resources sustainably (Us Y, Pimonenko T, & Lyulyo, 2023) One such organization that is indeed doing that is PT Pertamina Geothermal Energy (PGE) Tbk Kamojang Area, which is committed to running a sustainable business with a contribution towards the local community. PT PGE Tbk Kamojang Area runs a series of CSR activities based on sustainability and green energy. These activities include environmental, social, and economic elements, such as empowering the community, conserving nature, and geothermal energy efficiency innovation. These activities not only benefit the environment and society but also improve the image of PGE as a green energy icon in Indonesia.

Amongst the top CSR initiatives of PGE Kamojang is titled GEMAH KARSA that comprises three core components: Geothermal Organic Fertilizer, Geothermal Farming, and Green Watering. Geothermal Organic Fertilizer makes organic fertiliser from agricultural waste and household waste that is processed using geothermal energy and used on vegetable plantations and coffee farms with a wider scope. Geothermal Farming is a program of nurseries for vegetable farms and coffee plantations using a geothermal greenhouse and coffee drying with a geothermal dryhouse, giving faster production of seedlings and drying of good quality coffee. Meanwhile, Green Watering Innovation answers the problem of access to clean water for agriculture and society through revitalisation of water piping, water ultrafiltration devices integrated with solar power plants and community capacity building with cultural elements of 'Ngalokat Sirah Cai' for innovation sustainability.

The GEMAH KARSA program not only contributes to the environment but also boosts the economy at the local level. For example, because of the organic fertilizer, farmers can sell quality crops at a lower cost. Geothermal Farming allows them to adopt more efficient farming methods, while Green Watering takes care of water issues with secure irrigation solutions. This paper analyzes the impact of the GEMAH KARSA program on the business sustainability and reputation of PGE Kamojang. Based on a review of the company's CSR annual report, this research will analyze how the program is a win-win for the company and its stakeholders. It will also determine challenges and opportunities to improve the CSR program in the future.

The objective is to provide a better picture of how CSR can be a useful tool for resource management in the geothermal sector. Not only will this be useful for PGE when they plan for CSR activities in the future, but it could also serve as a model for other energy organizations who want to

incorporate CSR into their sustainability efforts. On a broader scale, this research could help policymakers and corporate leaders develop more responsible business policies.

The success of GEMAH KARSA can even be a good benchmark for other corporations in the energy sector to have their own resource-based CSR program. With all-around and sustainable strategy, programs like this one could improve the company-community relations while improving competitiveness both domestically and internationally. So, this research does not just offer abstract analysis of how CSR is executed within geothermal energy—this research offers lessons in action for stakeholders that want to develop CSR initiatives that make a difference in society and the environment.

2. LITERATURE REVIEW

Geothermal energy and corporate social responsibility (CSR) have been the subject of numerous studies. The research relevant to these topics is explained as follows. Jelena Stjepcevic and Indre Siksnelyte (2017) write about 'Corporate Social Responsibility in the Energy Sector'. Their paper aims to analyze the development of CSR in the energy sector by identifying and characterizing the critical issues of CSR. The result of the paper is that resource-limited availability, climate change, pollution, and employment are some of the societal issues that energy companies deal with. These businesses must practice CSR due to political, social, or economic obligations. The evolution of CSR in the energy sector and the challenges of its implementation are explored in this research.

Destiana and M. Denu Poyo (2023) write about 'Public Relations Strategy of PT Pertamina Geothermal Energy Area Ulubelu in Improving Image Through Media Activities'. Their paper aims to determine PT Pertamina Geothermal's public relations strategy in conducting media activities as a form of responsibility while enhancing the company's image. The result of the research is that the goal of PT Pertamina's public relations strategy is to improve the company's reputation through media campaigns, especially its CSR program. The company provides information to the public, avoids conflicts, responds to complaints, and conducts transparent operations. The implementation of this program has resulted in a positive image and community support.

Chigozie Nweke-Eze (2024) write about 'Infrastructure of Large-Scale Geothermal Energy Project in Kenya: Materialization, Generativity and Socio-Economic Development Linkages'. Their paper examines the materialization and generativity of infrastructure in large-scale projects, their complex linkages to socio-economic development, and their role in delivering infrastructure. The result is that key infrastructure projects become generative, supporting the socio-economic development of local communities. The study emphasizes the difficulty of planning and executing large-scale, sustainable projects in the Global South.

Buturoaga Mioara (2017) writes about 'Corporate Social Responsibility (CSR) Business Practice and Stakeholders Considered Relevant for the Energy Sector: The Case of Romania'. The aim of this paper is to investigate CSR in the energy sector in a European developing country. The study examines CSR trends, stakeholder engagement, and business activities. It suggests that stakeholders are often unidentified and unengaged, highlighting the need for more innovative CSR approaches.

Untung Sumotarto (2018) writes about 'Geothermal Potential of Arjuno and Welirang Volcanoes Area, East Java, Indonesia'. This paper evaluates 2016 research on geothermal potential, suggesting further exploration. The result is that in the Arjuno-Welirang area, geothermal manifestations include rock alteration and hot springs. Renewable resources could be integrated with the region's geothermal potential.

Yana, Tetyana, and Oleksii (2023) write about 'Corporate Social Responsibility and Renewable Energy Development for the Green Brand within SDGs: A Meta-Analytic Review'. The study analyzed global publications on CSR and renewable energy to understand their impact on green brand development within the SDGs. The result shows that the first publication was in 2005, driven by the Kyoto Protocol. The research identifies five main themes: renewable energy, environmental impact, energy utilization, sustainable development, and alternative energy.

Hadi Setiawan (2014) writes about 'Geothermal Energy Development in Indonesia: Progress, Challenges and Prospect'. This paper discusses Indonesia's geothermal development progress, government policy, regulatory framework, and prospects. The result is that Indonesia's vast geothermal potential is expected to develop significantly within the next five years, due to new laws, regulations, and public awareness.

Badareu, Doran, Puiu, Bădîrcea, and Manta (2023) write about 'Is the Relationship between Corporate Social Responsibility, Environment, and Energy Sufficiently Debated Nowadays?'. This review examines the literature on the connection between CSR, environment, and energy, pointing out areas that need improvement. The result is that the relationship between CSR, environment, and energy is an active area of research, but further studies are needed.

Shuke Fu, Mengxia Tian, Yingchen Ge, Tingting Yao, and Jiali Tian (2024) write about 'Influencing Factors and Mechanisms of Corporate Social Responsibility Reputation under Green and Low-Carbon Transition: Evidence from Chinese Listed Companies'. Their paper creates a comprehensive index system for CSR reputation in Chinese listed companies, finding that public environmental concern and enterprise scale positively impact CSR reputation, while a higher proportion of female managers inhibits it.

The present research is different from the previous studies because it focuses on GEMAH KARSA, the CSR program run by PGE Kamojang, which includes Geothermal Organic Fertilizer, Geothermal Farming, and Green Watering. The main goal is to provide direct benefits to the environment and surrounding communities. This research also differs from Stjepcevic and Siksnelyte's study, which focuses on global CSR challenges, or Destiana and M. Denu Poyo's research, which examines public relations strategies. In contrast, this study shows how CSR can be used as a tool to manage resources sustainably. Furthermore, this research approach is

different from Nweke-Eze's study on large energy projects and socio-economic development, or Badareu et al.'s theoretical study on CSR. The main focus of this research is on how geothermal CSR programs can be managed as sustainable business strategy while building a positive company reputation.

3. METHODOLOGY

This research uses a qualitative method because the data are taken from the company's annual report and the report on geothermal empowerment for maximizing agriculture through the Kamojang responsible and sustainable farming program (GEMAH KARSA). The object of this research is three CSR programs that utilize geothermal energy: green watering, geothermal organic fertilizer, and geothermal farming.

Hennink, Hutter, and Bailey (2020) explained that qualitative research is an approach that allows for a detailed examination of people's experiences using specific research methods such as in-depth interviews, focus group discussions, observation, content analysis, visual methods, and life histories or biographies. The data collection technique used is secondary data, which Kothari (2004) defined as data already collected by someone else and processed through statistical methods. In this study, content analysis was used to systematically review the contents of GEMAH KARSA's company reports and documentation. These include social mapping study documents, programme implementation documents, social return on investment study documents and social innovation documents.

This method helps identify patterns, themes, and key information related to the implementation of CSR programs and their impact on business sustainability and corporate reputation. By analyzing these reports, the research explores how the three CSR programs—Geothermal Organic Fertilizer, Geothermal Farming, and Green Watering—utilize geothermal resources to increase agricultural productivity while maintaining environmental sustainability. This approach provides a structured way to understand how CSR programs can contribute to a company's long-term goals, especially in resource management and the implementation of sustainable business practices.

To enhance the accuracy and reliability of the research results, data triangulation techniques were applied by comparing various sources, such as sustainability reports and other publicly available company documents. This triangulation helps reduce bias and further informs the analysis. It also provides a clearer picture of how the GEMAH KARSA program supports the company's sustainability goals and its impact on stakeholders. Using secondary data and qualitative analysis methods, this study aims to provide deeper insights into the effectiveness of CSR programs as a strategy for building corporate reputation and ensuring long-term business sustainability.

4. RESULT AND DISCUSSION

4.1 CSR as Driver of Environmental and Community Sustainability in the Geothermal Sector

Corporate social responsibility (CSR) in the geothermal industry is really important for ensuring that the use of natural resources is carried out sustainably. Geothermal energy, as the main source in this industry, must be managed properly so it does not harm the environment while maintaining the balance of the ecosystem (Griebler, C, et al, 2016). With the right approach, companies can optimally utilize resources without compromising the sustainability of the surrounding natural environment.

An essential part of CSR in the geothermal industry is the effort to preserve the environment and maintain biodiversity. Geothermal energy exploration and utilization are often carried out in areas with vulnerable ecosystems (Ng, C, et al, 2020). Therefore, companies need to implement various programs to protect the environment. One example is the GEMAH KARSA program, which includes the Geothermal Organic Fertiliser (GeO-Fert), Geothermal Farming, and Green Watering and makes fertilizer from organic waste/waste from agricultural production, can be significantly reduced to 2.08 tons/month, which has implications for reducing carbon emissions by 4,556.2 tCO2e/year. The same goes for other programs such as the Geothermal Dryhouse. Details can be seen in Table 1 and Table 2.

Table 1: Emission Reduction of Geothermal Dryhouse & GeO-Fert Program

No	Item	Unit	Average Carbon Emissions/ month	Average Carbon Emissions/ year
1	Geothermal Dryhouse Emission Reduction	tCO2e	0,67	8,0048
2	Emission Reduction of Geothermal Organic Fertilizer	tCO2e	0,33	4,0024

Source: Social Return on Investment (SROI) Report, Social Development Center (2024)

Table 2: GeO-Fert & Rangers Application Waste Reduction Program

No	Item	Unit	Amount/moth	Amount/year
1	The amount of organic waste that is used as organic fertilizer (GeO-Fert)	ton	2,08	24,96
2	Inorganic waste from Rangers App	ton	0,46	5,52

Source: Social Return on Investment (SROI) Report, Social Development Center (2024)

CSR does not just focus on the environment but also contributes to the livelihood of the surrounding community (Harahap, L, Rahmawati, S.H & Widagdo, 2022). PT PGE

Tbk Kamojang Area, for instance, runs community empowerment programs by mapping social problems and analyzing existing potential. In recent years, the company has developed environmentally-friendly, technology-based programs to support the surrounding community. Moreover, there are also programs in education, health, environment, social issues, and infrastructure. By involving the community, CSR can create long-term benefits and help local communities become more self-reliant. This is evidenced by acquisition of the Community Satisfaction Index (IKM) a study conducted by the Social Development Studies Center (SODEC) of Gadjah Mada University in 2024. The value obtained from the IKM in 2024 with an index value of 3.83 and a Conversion IKM value of 95.67% which is classified in the "Very Good" category. In addition, through the SROI study, a value of 3.13 was obtained, which shows that every 1 rupiah that the company invests obtains a monetized social impact of 3.13 rupiah.

CSR also plays a role in maintaining good relations between companies and various parties, such as the government, community organizations, academics, and local communities. To avoid conflicts with communities due to geothermal energy exploration and production, companies must be transparent and open in their communication. With this company strategy, the community will better understand the company's goals, and the company can gain more support.

Furthermore, CSR implementation must also follow the regulations and policies that apply, both at national and international standards. Companies need to comply with sustainability standards and ensure that all CSR activities are reported transparently. Following these regulations not only reduces legal risks but also boosts the company's reputation and makes the geothermal industry more competitive on a global level.

Effective CSR programs have also led to increased innovation in the geothermal industry. Companies have started developing more efficient and environmentally-friendly exploitation methods, such as using digital technology for monitoring emissions and better water management systems to reduce environmental impacts. With these innovations, the company can improve operational efficiency while maintaining the balance of the ecosystem around the exploration area.

In addition, CSR focus on community engagement has also created new job opportunities in the renewable energy sector. Many training and education programs are offered to local communities so they can be involved in the geothermal industry's value cycle. Therefore, CSR is not just a social responsibility but also a tool for sustainable economic empowerment for local communities.

The role of CSR in the geothermal industry is also strengthened by the collaboration between companies and academic institutions in the development of new research and technology. This collaboration helps increase workforce capacity and generate innovative solutions in managing geothermal resources more efficiently. With this synergy, the geothermal industry can continue to grow without compromising environmental and social sustainability.

4.2 GEMAH KARSA: A CSR Model for Socio-Environmental Transformation in Agriculture

The GEMAH KARSA program, run by PT Pertamina Geothermal Energy (PGE) Kamojang Area, is an effort to utilize geothermal energy not only as a source of energy but also as a solution to improve agriculture and community welfare. The Kamojang Area faces major challenges due to climate change, such as unpredictable weather and limited water availability, which affect crop yields and the local economy. Through this program, PGE strives to create more sustainable agriculture while still respecting the culture and traditions of the Sundanese people, which uphold the principles of life in harmony with nature.

This program provides significant benefits for society, especially vulnerable groups such as small farmers, the unemployed, pregnant women, children, and the elderly. Some of the innovations implemented in GEMAH KARSA include: organic fertilizer (GeO Fert), the use of geothermal steam in Geo-Farm to maintain a stable temperature in the greenhouse, and the Green Watering system, which helps provide clean water for residents. Through this program, the community not only receives solutions to agricultural problems but also has the opportunity to increase their income and overall well-being.

The success of GEMAH KARSA is also supported by the involvement of the local communities and the government. This program serves as a constructive community learning center, where the public can access free education and training for underprivileged communities. Additionally, local governments are involved in supporting this program by issuing policies that encourage farmers to use organic fertilizers and greenhouse fertilizers from Geo-Farm. With this support, the benefits of GEMAH KARSA are expanding, creating a positive effect on communities in surrounding villages.

Geothermal's status as a source of clean energy also continues to prioritize its utilization maximized for vulnerable groups. In addition, the recognition of external parties both nationally and internationally is also a form of the success of direct use geothermal being able to synergize with community empowerment. Details about the numbers can be seen in Table 8, and the awards for the program can be seen below Table 6.

Table 3: Number of Vulnerable Groups Receiving Direct Benefits

No	Category	Qty (people)	Group
1	Unemployment	42	Direct Use Geothermal
2	Farmer GeO-Fert Manager	58	GeO-Fert
3	Farmer GeO-Farm Manager	32	Geo-Farm
4	Farm Laborer	653	Direct Use Geothermal
5	Elderly (Elderly)	81	Rangers App
6	Pregnant Mom	72	Rangers App
7	Baby	76	Rangers App

Source: PT PGE Tbk Kamojang Area Social Innovation Document (2024)

From an environmental and business perspective, GEMAH KARSA has had a very positive impact. This program is the first sustainable agriculture initiative in Indonesia that

directly utilizes geothermal heat. Besides helping farmers face climate change challenges, this program also reduces soil damage, reduces carbon emissions, and optimizes the use of geothermal energy. This positions PGE as a company that cares about the environment, while also opening up opportunities for broader cooperation in the fields of renewable energy and sustainable agriculture.

Not only does it provide benefits to society and the environment, but GEMAH KARSA also helps change the way farmers view agriculture in a more eco-friendly manner. Through mentorship and training, society has begun shifting from conventional farming that relies on chemical fertilizers to organic farming, which is healthier and more sustainable. This program proves that business sustainability can be achieved by integrating social and environmental concerns, while strengthening PGE's reputation as a company that is not only profit-driven but also contributes to society and nature.

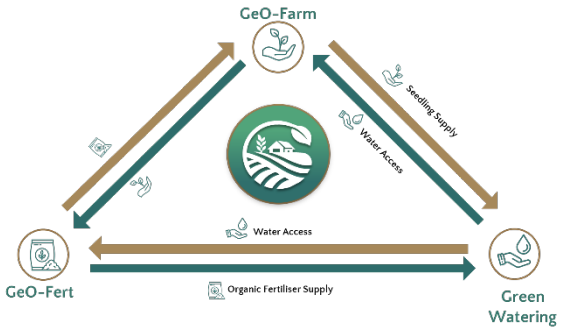
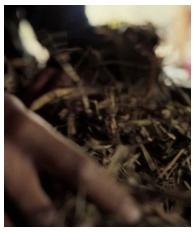


Figure 1: Gemah Karsa – Social Innovation Shared Value

4.2.1. Geothermal Organic Fertilizer

One of the big innovations in the GEMAH KARSA program is creating organic fertilizer by using geothermal energy. Organic waste from the community and industries is processed through fermentation, using geothermal heat as an eco-friendly energy source. This organic fertilizer has been proven to boost soil fertility and crop yields, reduce farmers' dependence on chemical fertilizers, and support more sustainable organic farming practices.

A major issue for communities around the company is the limited access to subsidized fertilizers. Since most of the people work as farmers, fertilizer availability is very important for maintaining agricultural productivity. However, the amounts of subsidized fertilizers are restricted and they are not distributed equally. So, many farmers end up having to buy non-subsidized chemical fertilizers, which cost more. In 2023, each farmer got around 140 kg of subsidized fertilizer, but in 2024, that number dropped significantly to just 80 kg per farmer (GEMAH KARSA, 2024). On top of that, long-term use of chemical fertilizers can damage the soil structure, lower fertility, and reduce crop yields over time.



Products:
Solid Organic Fertiliser (POP) GeO-Fert

Figure 2: Drying Equipment Innovation

To solve this problem, the company came up with an innovative and environmentally friendly solution: Geothermal Organic Fertilizer (GeO-Fert). This idea makes use of local resources, turning agricultural waste like grass, coffee husks, and household waste into organic fertilizer. The process starts with fermenting organic materials, followed by drying using the GeO-Fert machine, which taps into excess steam from Geothermal Power Plants (PLTP). Using geothermal heat makes the process more efficient and serves as a clean and green energy alternative. With GeO-Fert, farmers can maintain soil fertility without having to rely on expensive chemical fertilizers that harm the environment. The Geothermal Organic Fertilizer (GeO-Fert) program, which makes fertilizer from organic waste/waste from agricultural production, can be significantly reduced to 2.08 tons/month, which has implications for reducing carbon emissions by 4,556.2 tCO2e/year. The same goes for other programs such as the Geothermal Dryhouse.

The organic fertilizer produced contains nutrients and microbes that are good for the soil, helping improve soil health and supporting sustainable plant growth. On top of that, this innovation also helps with waste management, since both agricultural and household waste can be turned into fertilizer, which reduces environmental pollution. So overall, GeO-Fert does not just support a greener farming system, but it also boosts farmers' welfare by offering easier and more affordable access to high-quality fertilizer. In addition, GeO-Fert also contributes to the local economy by creating new economic opportunities for farmers. By producing and marketing their own organic fertilizer, farmers can reduce dependency on expensive chemical inputs and generate additional income from fertilizer sales. This added value encourages entrepreneurship at the grassroots level and strengthens the economic resilience of rural communities, especially in areas affected by climate change.

Table 4: Economic Savings of Direct Use Geothermal Program

No	Item	Total (Rupiah)
1	Cost Savings of Organic Fertilizer Trial	2,815,000
2	Electricity Cost Savings (Geothermal Farm) for Nursery and Coffee	10,718,052

3	Gas Cost Savings (Geothermal Farm) for Nursery and Coffee	118,276,667
4	Operational Cost Savings for Coffee Processing	2,200,000
5	Savings in Grass Clearing Costs for Organic Fertilizer Materials	1,870,000
6	Savings in the use of Organic Fertilizer from GeO-Fert	26,000,000

Source: Program Financial Records, 2024

The achievement of this program received appreciation in the form of awards:

- Indonesia Green Award from La Tofi School of CSR for innovation in organic waste management into environmentally friendly fertilizer (National, 2023).
- Proper Gold from the Ministry of Environment and Forestry (KLHK) as recognition of innovative and sustainable environmental management (National, 2023).
- Gold Proper from the Ministry of Environment and Forestry (KLHK) in recognition of innovative and sustainable environmental management (National, 2024).

Figure 3: Geothermal organic fertiliser raw material processing building

4.2.2. Geothermal Farming

As part of efforts to build sustainable agriculture, Geothermal Farming has been working on ways to grow plants by making use of geothermal energy in the growing process. This program uses several techniques, including geothermal greenhouses, which help cut down the use of chemical pesticides and boost both the quality and quantity of harvests. Thanks to this initiative, people living around Kamojang have started seeing real economic benefits, especially through increased income and better welfare. One of the highlights is the diversification of high-value agricultural products, which has added more value to local farming efforts. As a show of commitment to a more sustainable agricultural setup, various steps have been taken to tackle the challenges that local farmers deal with, especially during the plant nursery stage. For example, the Geothermal Dryhouse program is able to increase revenue from geothermal coffee sales up to Rp. 2.6 billion/year. The working baristas also have an increased income of up to Rp. 3,000,000/month, which was previously only Rp. 1,500,000/month. Likewise, economic savings can be felt by coffee farmers with nurseries in the GeO-Farm green house of Rp. 13,500,000 / year. Other programs also felt the same way with the following details in Table 5.

Table 5: Income Increase of Direct Use Geothermal Program

No	Item	Total (Rupiah)
1	Income from Biocomposter Organic Fertilizer Products	96,000
2	Income from Sales of Agricultural Processed Products	600,000
3	Overall Turnover from Sales of Geothermal Coffee (Canaya Geothermal Coffee)	2,656,500,000
4	Barista Fixed Income from Geothermal Coffee Process Group	216,000,000

Source: Program Financial Records, 2024

One of the biggest issues that farmers near the company's area face is the unpredictable weather, which really affects how successful the breeding stage is. Temperature changes, sudden rainfall, and shifts in climate patterns often make it hard for seedlings to grow properly. On top of that, pest attacks during early growth stages are another common problem that leads to lower overall productivity. To deal with these problems, the company came up with an innovative solution—starting with the idea of a Geothermal Dry House. At first, it was only used during the coffee harvest, which happens once a year. But then, realizing its potential, the technology was expanded into the Geo-Farm program, leading to the creation of the Geothermal Greenhouse.

Figure 4: Geothermal Greenhouse, a greenhouse equipped with sprinklers for breeding agricultural seedlings

This Geothermal Greenhouse is a modern farming facility that uses geothermal heat to keep the temperature stable during the seeding process. With this setup, farmers can do their seeding in a more controlled environment, without worrying about what the weather is doing outside. The technology used includes an automatic temperature detection system that adjusts the room temperature in real-time, making sure the conditions stay ideal for seedling growth. Plus, there is also a sprinkler-based automatic watering

system powered by geothermal energy. This helps make irrigation much more efficient and precise, keeping the soil moist without wasting water and ensuring that plants get just the right amount of water.

Figure 5: Geothermal Dryhouse : Increased coffee drying productivity with dryhouse unit 2

In 2024 alone, around 8,400 vegetable seedlings were cultivated in the Geothermal Greenhouse—cabbage being the most popular due to its high demand in the market (GEMAH KARSA, 2024). Once the seedlings are strong enough, they're moved from the greenhouse to community-owned land for further planting.

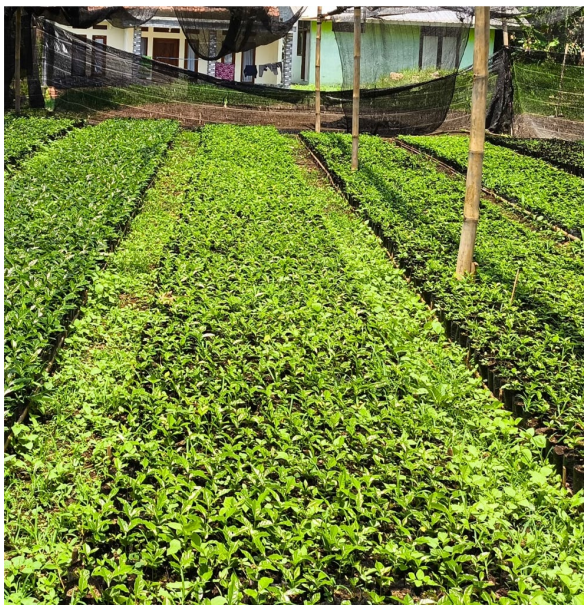


Figure 6: Greenhouse-grown seedlings that are high quality and quick to transplant

One of the key benefits of this greenhouse is that it helps protect seedlings from pests. With its closed and controlled environment, the risk of pest attacks goes down significantly. That means farmers do not need to rely on chemical pesticides, which can harm the environment. This indoor approach creates a much safer and healthier space for plants, producing high-quality seedlings that are ready to plant out once they reach the right level of maturity.

By using the Geothermal Greenhouse, the company is not just helping boost farmer productivity, but is also pushing forward a greener, more eco-friendly and sustainable way of farming. This whole move ties in with the company's long-term vision to create a farming system that is resilient, efficient, and brings positive change to the local community's welfare.

The achievements of this initiative have been recognized through:

- Gold Proper from the Ministry of Environment and Forestry (KLHK) as recognition of innovative and sustainable environmental management (National, 2023).
- Gold Proper from the Ministry of Environment and Forestry (KLHK) in recognition of innovative and sustainable environmental management (National, 2024).

4.2.3. Green Watering

The Green Watering Program is an environmentally friendly irrigation solution that uses geothermal steam as a water source for agriculture. This system is designed to improve the efficiency of water usage on agricultural land around the PT PGE Kamojang Area, especially during the dry season. With this technology, farmers can optimize their agricultural yields without relying on groundwater resources, which are increasingly limited.

Figure 7: Use of HDPE Pipe for Agricultural and Community Water Access

Access to clean water plays a critical role in supporting agricultural and plantation productivity, especially in areas like Legok Pulus, where most of the population depends on agriculture for their livelihood. Currently, local communities face significant challenges in obtaining sufficient water for irrigating their agricultural land. The existing limited water distribution system forces each neighborhood in Legok Pulus to use water alternately, directly impacting crop yields and farmers' work efficiency. Additionally, reliance on

alternative springs whose quality is uncertain can also affect soil health and reduce the quality of agricultural products.

Figure 8: Use of HDPE Pipes for Agricultural and Community Water Access Innovation of Water Ultrafiltration Equipment integrated with Solar Power for Access to Clean Water Ready for Community Consumption

In response to this issue, the Green Watering Program focuses on increasing access to clean water, specifically for the agricultural and plantation sectors. One of the main solutions offered is the construction of a pipeline system that is equally distributed throughout the Legok Pulus area. This system will make water distribution more efficient and structured, and help the farmers to receive a consistent water supply without needing to share usage schedules with other neighborhoods. This is expected to enhance agricultural productivity and maintain the quality of harvests. A stable water supply is also a key factor in plant growth, particularly during critical periods such as planting and harvest seasons.

More than just meeting irrigation needs, this piping system is also designed to improve agricultural land conditions by preventing drought, which is often a major obstacle. Furthermore, wiser water usage can help reduce dependence on unsuitable water sources, ensuring agricultural products remain of high quality and have a higher market value. The benefits of this program will not only be felt by farmers in Legok Pulus but also by the wider community that depends on local agricultural products.

As a further impact, the Green Watering Program also integrates Water Ultrafiltration technology, which aims to provide clean drinking water for the community. This technology allows residents to access potable water without relying on alternative sources with uncertain quality. Although the program's primary focus is increasing water access for the agricultural sector, its effects are felt more widely through the availability of safe drinking water, which ultimately contributes to improving the well-being of the community as a whole.

In addition to infrastructure development, the Green Watering Program emphasizes sustainable community empowerment. Local communities are involved in various stages of water management, from planning, construction, to maintenance of the piping systems and ultrafiltration equipment. Through this approach, Legok Pulus residents are encouraged to actively participate in maintaining sustainable access to clean water in their area. They are also given technical training on how to operate and maintain the piping systems and ultrafiltration equipment, ensuring the program runs effectively in the long term.

This innovation has won various awards, which include:

- Proper Gold from the Ministry of Environment and Forestry (KLHK) as recognition of innovative and sustainable environmental management (National, 2023).
- Gold Proper from the Ministry of Environment and Forestry (KLHK) in recognition of innovative and sustainable environmental management (National, 2024).

4.3 Challenges, Benefits and Sustainability Strategies in GEMAH KARSA Program

Geothermal-based Corporate Social Responsibility (CSR) programs are becoming more popular as a way for companies to genuinely contribute to environmental sustainability and community economic growth. A great example of this is GEMAH KARSA by PT Pertamina Area Kamojang, which brings geothermal technology into sustainable farming. It includes initiatives like producing organic fertilizer using geothermal resources, eco-friendly farming methods, and energy-efficient irrigation systems. The program's goal goes beyond just keeping nature in balance—it also focuses on boosting the well-being of local communities through innovation and responsible resource use. Still, to keep things running long-term, there are several challenges that need to be taken on with the right strategies.

One of the biggest issues is dealing with government regulations and policies, which keep evolving. Companies have to adjust their CSR programs to stay aligned with sustainability standards, environmental laws, and licensing requirements. If they do not handle these changes well, it could seriously impact the program's continuity. Then there is the matter of funding and financial stability—CSR programs need long-term investment to keep making a real difference. Without strong financial support, there is a risk the program could stall or even stop altogether.

Community involvement is another key challenge. Not everyone is quick to accept new methods, especially when they differ from traditional farming practices. When people do not fully understand the long-term benefits of things like geothermal farming or green irrigation, they may be hesitant to join in. That is why an effective educational approach is so important—so communities do not just receive benefits but actually take part in making the program work. There are also technical and operational hurdles, since implementing geothermal technology and producing organic fertilizer requires skilled workers and solid infrastructure. Without both, the program's effectiveness could be diminished.

Even with those challenges, geothermal-based CSR programs offer great value—to companies, to communities, and to the environment. For companies, a successful program helps build a strong sustainability image, fosters good relationships with stakeholders, and enhances their competitive edge globally. For the community, it can create

new job opportunities, increase farmer income, and improve overall welfare. Environmentally, geothermal technology helps shift farming toward more eco-conscious practices by cutting down on chemical fertilizers and making irrigation more efficient.

Considering the future, GEMAH KARSA has real potential to grow, not just in terms of environmental impact, but also in driving sustainable community development. One strategic move could be the commercialization of geothermal organic fertilizer. By marketing fertilizer made from geothermal by-products more widely—and involving the community in this—there is a chance to boost local farmer income and support the long-term sustainability of the program through a self-sufficient business model.

Another smart step is expanding access to direct-use geothermal benefits to more communities beyond the current beneficiaries. This way, more people can experience the advantages of clean, renewable energy. It would also increase awareness of geothermal potential and encourage greater public participation in adopting it. Plus, this kind of access could open up new economic opportunities in agriculture, fisheries, and small businesses based on clean energy.

Tying the program in with the Independent Energy Village (DEB) initiative is also a great move. DEB focuses on helping villages become energy-independent using local renewable sources, including geothermal. With the right synergy between GEMAH KARSA and DEB, villages could grow into economically and energy self-reliant communities that embrace sustainable agriculture.

All in all, with the right strategy, these challenges can be managed, and geothermal-based CSR programs like GEMAH KARSA can continue to grow and deliver broader benefits. Through innovation, community collaboration, and cutting-edge technology, this kind of program has the potential to be a true model for sustainability—one that not only helps the environment but also sparks real local economic development.

5. CONCLUSION

This study takes a closer look at how the GEMAH KARSA Corporate Social Responsibility (CSR) program affects business sustainability and corporate reputation at PGE Kamojang Area. It turns out, CSR efforts that tap into geothermal energy don't just help the environment — they also improve the social and economic well-being of local communities. Through innovations like Geothermal Organic Fertilizer (GeO-Fert), Geothermal Farming (Geo-Farm), and Green Watering, the GEMAH KARSA program helps farmers adopt more eco-friendly and efficient farming practices. Thanks to organic fertilizers sourced from geothermal processes, farmers can boost crop yields at lower costs, and the geothermal-powered irrigation systems offer real solutions for agricultural water issues.

Beyond just helping the community, this study shows that CSR in the geothermal sector plays a big role in preserving ecosystems and promoting sustainable resource use. Environmental programs like GEMAH KARSA help protect local flora and fauna, while its social side builds stronger ties between the company, government, and local people, promotes transparency, and encourages green innovation. By carrying out CSR effectively, companies can run sustainably, minimize environmental damage, and empower the local economy.

From a business point of view, the study points out that CSR isn't just a box to check — it is actually a smart strategy for managing resources and building a strong reputation. When done right, CSR can position a company as a leader in clean and sustainable energy, giving it a competitive edge both nationally and globally. The GEMAH KARSA program is a great example of how well-planned CSR can help with food security, climate change mitigation, and improving community welfare in the long run.

That said, the study is not without its limitations. For one, it mainly relies on the company's annual CSR reports, so there is no direct input from the community or other stakeholders. To get a fuller picture, future research could use interviews or surveys to understand how the community really feels about the program. Another limitation is that the study only focuses on PGE Kamojang, and so the findings might not reflect the whole geothermal industry. To fill that gap, comparative studies across different companies and regions could offer more complete insights.

Considering the future, the success of GEMAH KARSA could totally work as a case study for other energy companies wanting to create their own resource-based CSR programs. With a more comprehensive and long-term approach, programs like this could strengthen ties with local communities, boost competitiveness, and contribute to the Sustainable Development Goals. Plus, exploring the long-term impacts of CSR — socially, economically, and environmentally — could be a valuable focus for future research. All in all, this study not only gives insight into CSR practices in the energy world but also shows how these programs can bring about real, lasting benefits for both people and the planet.

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