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Understanding Social Acceptance of Geothermal Energy: A Case Study from Mt. Lawu, Indonesia

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Abstract. Geothermal energy in Indonesia holds important role in country’s transformations into renewable energy to ensure clean, reliable, and sustainable energy sources. In order to optimize geothermal energy project, it is important to consider the balance of economy, socio-cultural, and environmental aspects. The socio-cultural aspect is critical in the public acceptance of the project and overcome the social resistance. Understanding citizen’s preferences towards the development of geothermal energy leads to the greater understanding of what shapes of strategies and policies should be taken in the project. Based on the interviews with local communities, they reject the construction of geothermal power plants in Mt. Lawu because they think geothermal power plants will give negative impacts to cultural, environmental, economic, and social life aspects in society. This perception may appear because of the lack of understanding of geothermal energy.

1. Introduction

As the largest archipelagic country, possessing tropical rainforest with high biodiversity, and contain various energy and mineral resources, Indonesia plays important role in combatting climate change. However, Indonesia is vulnerable to natural disaster which is exacerbated by climate change, especially on low-lying areas throughout the archipelago. Therefore, according to Indonesia’s First Nationally Determined Contribution [8] [9], Indonesia view comprehensive land and ocean-based climate change adaptation and mitigation efforts as a critical strategy in achieving climate resilience in food, water, and energy. In COP-21 Paris, Indonesia commit to reduce greenhouse gas emissions (GHGs) by 29% on its own efforts (business as usual) and up to 41% with international support in 2030 [3]. Indonesia has taken step to reduce GHGs emission by formulating First NDC which is outlined country’s transition to a low carbon and climate resilience in the future.

According to Government Regulation No. 79/2014 [6], in energy sector, Indonesia is targeting Energy Mix in 2025, whereas new and renewable energy (NRE) contribute at least 23% of total energy mix. This is supported by the huge amount of NREs potential possessed by Indonesia. The renewable energy potential is shown in Table 1.



Table 1. Renewable energy types and its potential in Indonesia. (National Energy Council, 2016)

No	Energy Types	Potential
1	Geothermal	29.544 MWe
2	Hydro	94.476 MWe
3	Bioenergy	32.000 MWe and 200.000 bpd BBN
4	Solar (PV)	207.898 MWe with 4,8 kWh/m ² /day
5	Wind and Hybrid	60.647 MWe with 3-6 m/s
6	Marine energy	61.000 MWe Wave: 1.99 GWe Ocean Thermal: 41 GWe Ocean Wave: 17.98 GWe
7	Shale Gas	574 TSCF
8	Coal Bed Methane	456.7 TSCF

*MWe : Megawatt electric

*TSCF : Trillion Standard Cubic Feet

1.1. Indonesia Geothermal Potential

Indonesia is a country that has big geothermal energy potential because Indonesia lied on the ring of fire. According to MEMR's Geological Agency, Indonesia's geothermal potential is up to 29,215 MW. Indonesia has 27,000 MWe, the 27,000 MWe figure is cited in many World Bank reports and appears to be the basis for claims that Indonesia possesses 40% of the world's geothermal resources [1]. In 2016, energy consumption in Indonesia is up to 59,659.40 MWe (Ministry of Energy and Mineral Resources Republic of Indonesia [2] [7]. Meanwhile, until the end of 2016, the number of capacity installed are up to 1,654 MWe [2] or 2.77% of total energy consumption in Indonesia. So, the capacity installed now is not comparable enough with the total potential we had.

1.2. Lawu Geothermal Potential

Based on SK WKP Nomor 2518 K /30/MEM/2012 dated 13-08-2012 Mt. Lawu is stated as a geothermal exploration area. Mt. Lawu GWA has an area of 60,030 Ha which consists of 5 regions, Karanganyar, Sragen, Wonogiri, Ngawi, and Magetan. The hypothetical resource potential is 137 MWe and the estimated reserves is 195 MWe. Based on SK Izin Pengusahaan Nomor 1/1/IPB/PMDN/2017 dated 30-01-2017 the license holder is PT Pertamina Geothermal Energy Lawu [5] [10]. Target field development plan is 55 MWe in 2022 and 55 MWe in 2024. The conceptual model of Mountain Lawu Geothermal system shown in Figure 1.

Mt. Lawu is part of the Java quadrangle volcano path. The geological structure that controls this area is the crater rim in the peak area. Normal faults-trending E-W, NW-SE, N-S are the possible structures which control the appearance of manifestations. Horizontal faults are also encountered with NE-SW trajectory. The low resistivity distribution that identifies as clay cap lies at a depth of 500-800 m with elevation of top reservoir is 0 m above sea level. Upflow area is estimated at Candradimuka complex with outflow direction to the west spread to southwest at Nglerak-Mangli complex.

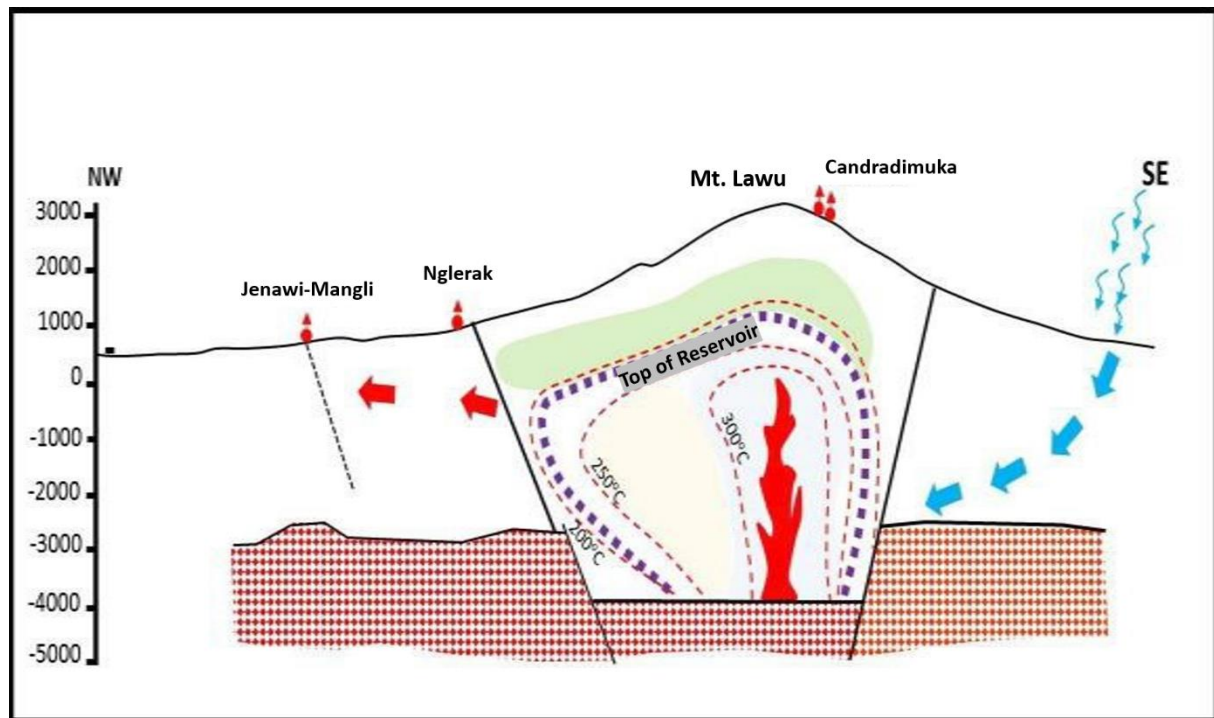


Figure 1. Conceptual Model of Mt. Lawu Geothermal System [5]

2. Methodology

This research aims to optimize geothermal energy project, it is important to consider the balance of culture, environment, economy, regulation, and social aspects. In the form of examine the society's attitude and reaction towards geothermal development in Lawu. It aims to identify factors that influence them and highlights the public understanding of geothermal energy that affect their perception and their preference in the development of geothermal energy. The survey method is face-to-face interview to the community. In order to examine the points above from community briefly, the following question are designed.

The survey starts from 5th January until 16th January 2018. During that time period we got 68 respondents. The respondents are from Sub-district Tawangmangu, Sub-district Ngargoyoso, Sub-district Karangpandan, Karanganyar, and Solo. Respondents from Tawangmangu and Ngargoyoso areas are potentially affected by the development of geothermal energy. Meanwhile, other respondents are from the rejection alliance called "Forum Rakyat Peduli Gunung Lawu". In this survey, the personal data we asked includes name, domicile, educational background, and occupation Table 2.

Table 2. Questions included in survey

No	Questions	Preference
1	Name	
2	RT (Neighborhood)	
3	Occupation	
4	Educational background	
5	Do you know what geothermal is?	A) Know B) Do not know
6	Do you already know that Lawu Mountain has potential of geothermal energy?	A) Know B) Do not know
7	Do you know the utilization of geothermal energy?	A) Know B) Do not know
8	How is your opinion about the development of geothermal energy (to electricity) that will be held here? And mention the reason	A) Agree B) Disagree C) Neutral
9	Do you know what will you get (the rights) if the development of geothermal energy here achieve a success? (this question related to the regulation)	A) Know B) Do not know
10	What kind of sector that can be developed here to improve the citizen's economy?	

3. Result

3.1. Statistic Result

Table 3. Statistic Result

Personal data (persons; %)					
Domicile	Sub-district Tawangmangu	Sub-district Ngargoyoso	Sub-district Karangpandan	Karanganyar	Kota Solo
	(24-35%)	(37-55%)	(2-3%)	(3-4%)	(2-3%)
	Farmer	Breeder	Communication	Midwives	Tailor
	(23-34%)	(2-3%)	(1-2%)	(2-3%)	(1-2%)
	Security	Trash recycler	Teacher	Politic activist	Religious proselytizing activist
Occupation	(1-2%)	(1-2%)	(4-6%)	(3-4%)	(1-2%)
	Environmental volunteer	Cultural observer	Student	Blank data	
	(4-6%)	(1-2%)	(3-4%)	(11-16%)	

Knowledge of geothermal					
Brief explanation what geothermal is	Know (22-32.35%)		Do not know (46-67.65%)		
There is potential on Lawu	Know (42-61.8%)		Do not know (26-38.2%)		
The utilization of geothermal	Know (39-57.35%)		Do not know (29-42.65%)		
	Agree (3-4.4%)		Disagree (52-76.5%)		
Opinion of geothermal development	There is no socialization (11-9.5%)	Environmental damage (30-26%)	Water crisis (26-22.4%)	Pledge of culture (14-12%)	Regulation (1-0.86%)
	Unbelievable toward the human resources (12-10.3%)	Unbelievable toward the government (3-2.6%)	Have no education (3-2.6%)	The extinct of habitat (1-0.86%)	Breathing disturbance (1-0.86%)
	Unilateral of importance (6-5%)	Politics (5-4.3%)	“Activating” Lawu (3-2.6%)		
			Neutral (13-19%)		
Economic sector that can be developed there (persons; %)					
Agriculture (fresh vegetables)	Plantation (coffee or tea)	Goat farm		Cow farm	
(46-51.7%)	(8-9%)	(6-6.74%)		(6-6.74%)	
Herbal meditation	Drying onion	Have no opinion		Tourism	
(1%)	(1%)	(20-22.5%)		(1%)	

3.2. *Community Understanding of Geothermal*

From the statistical results above (Table 3), we can infer that the citizen's understanding of geothermal energy is still very limited, even there is potential in the area. This situation due to low socialization or education to the citizens related to the geothermal potential. Even there are few citizens do not know if there is potential. Some citizens which has better understanding state that they were directly involved in early studies of the potential.

But in the reality, this matter influence the attitude of citizens how they thinking and reacting when there is geothermal energy development that will be held there. They do not have enough knowledge about geothermal, it is related to the utilization, postive and negative impect, also the regulation. They have not been socialized with the government or the energy developer. So, with this situation it is logical if they propose rejecting opinions to the geothermal energy development.

3.3. *Community Point of View*

3.3.1. *Cultural Aspect*

According to the local communities Mt. Lawu is a sacred place which should not be disturbed. The local belief to Mt Lawu is diverse, such as Mt. Lawu is the earth's hub, the hermitage and the former saint's place of his moksha (dissipation). Some people consider the sanctity of Mt. Lawu to be in all areas but some regard only in certain areas.

In Mt. Lawu there are also cultural sites in the form of temples that have appeared or still buried in the ground. Local religious ritual place (treated as religious tourism area) which mostly in the form of holy water pool with spring water from Lawu's hill, like Petilasan Pringgodani. The process of geothermal exploration and exploitation is feared could damage the sites. Agreements to decide areas that may explored and should not be explored are indispensable in this regard.

3.3.2. *Environmental Aspect*

The process of making road for transportation and heavy equipment access to drilling sites is feared will disrupt the preservation of ecosystems. Based on the interviews, public awareness about the function of forests has grown significantly. Various programs such as reforestation were done to preserve the forest. Thus, land clearing for exploration and exploitation transportation access can damage the forest ecosystems that they have already conserved.

Other than that, people argue that the geothermal system is not completely isolated so that fluids can come out and pollute the land. The contamination occurs in area surrounding the drilling wells as well as fluid flow on insulated pipelines on the surface. Community also concerns to the appearance of fractures in Dieng that resulted in the loss of water and also the pipe explosion that cause injuries.

Java tiger is one fauna which is classified as extinct [4]. However, according to some people in the local community, Java Tiger is appeared in Mt. Lawu forest area. Even more in this case, they install cameras at some point in the forest to prove it. The evidence of Java Tiger appearances will be submitted to the UN agency, so that Mt. Lawu to be the conservation of the Java Tiger. Therefore, there will be no exploration and exploitation are allowed in Mt. Lawu.

3.3.3. *Economic Aspect*

The people in community speaks that the benefits of geothermal energy cannot be directly perceived by the local citizens. Even if the developer is gaining employers from local community, some of them think that they will be fired after infrastructure development is over. Meanwhile, the employers required only professionals in geothermal industry once the power plant is already running.

Communities which is mostly work as farming vegetables with intercropping systems depend heavily on water. Thus, the loss of springs became the main fear of people who turned off irrigation of their agriculture land.

3.3.4. *Technical Aspect*

Geothermal utilization which is producing high temperature steam and brine to the surface, is feared by communities that it will cause the ambient temperature increase significantly. This perception appears are estimated due to community lack of knowledge of the isolation in geothermal pipelines.

The people in community also afraid if failures and problems in other energy exploration and exploitation will happen in Mt. Lawu. Technical error and natural events along exploration and exploitation which is causing disaster in other GWA is fearing communities that the same incidents will occur in Mt. Lawu GWA if the project is commenced. In common, respondents take an example in LUSI Mud Volcano, mud eruption and land pollution in Mataloko, also environment pollution, decreasing water quantity, and pipe explosion in Dieng.

By identifying these incidents, it implies that skepticism appears inside the communities to the Indonesian developments, especially to the geothermal development in Mt. Lawu. They also think if human resources in Indonesia is incompetent to run the projects.

3.3.5. *Regulation Aspect*

The public's ignorance of the Minister Regulation of the Environment No. 17/2012 in Guidelines for Community Involvement in the Environmental Impact Analysis (AMDAL) Process and Environmental Permit has made people feel unsafe. Ignorance is caused by the lack of socialization. In addition, in some cases these documents are formed without involving the community.

3.3.6. *Social Aspect*

The majority of community work as farmers. They fear of the negative impacts that may occur in Mt. Lawu. They depend heavily on water springs throughout Mt. Lawu. If the project causes the decreasing in water quantity that they cannot irrigate their field, they feared that they will be forced to move the profession other than as a farmer. They also feel that the electricity needs are already met, so the community considers that the construction of a power plant is not needed. Some people even willing to die to cancel geothermal development.

Some communities are also traumatized against the government program. First, due to the fraud program in the form of geothermal investment in the 1980s. Second, agricultural development program in the form of fertilizer and injections of agricultural crops. The second point even turn off the local agricultural potential of tangerines.

The existence of socialization is carried out by some parties who are not balanced from different points of view. The substance of the socialization is not comprehensive from various aspects of the study. In fact, individuals who are not experts in the field also express opinions. Therefore, the socialization resulted in negative perceptions in society that led to the "rejection". As the community have not really understood the relation with the geothermal utilization directly and indirectly, they think program is only beneficial to some parties without benefiting the local community, even local community potential to bear negative impact from the project.

4. **Conclusions**

1. The majority of the people in community reject the construction of geothermal power plants in Mt. Lawu. They argue that the construction of geothermal power plants gives negative impact. These impacts include the cultural, environmental, economic, and social life aspects in society.

2. People in community are already skepticism against government development programs, especially in geothermal development in Mt. Lawu. They think program is only beneficial to some parties without benefiting the local community, even local community potential to bear negative impact of the project.
3. Community negative perception towards geothermal energy may appear because of the lack of understanding in geothermal energy as they have not received any brief socialization and education from the government and/or the developer.
4. However, some people in communities are asking to the government and developer to resolve the problems in other geothermal areas. After that, geothermal exploration and exploitation in Mt. Lawu can be commenced with better planning.

5. Recommendation

1. The Developer and Government need to conduct brief socialization and education to the communities related to basic geothermal concepts, regulations, development process, and potential impacts, which could be accepted by all elements in community.
2. The field development does not necessary cross or take place in religious and cultural sites. The developer (as project executor), government and local communities (as project supervisor) should know the detailed location data of the sites, so the field development does not ruin the sites.
3. The developer should take responsibility of land restoration due to land clearing for transportation access.
4. The Developer should work based on the standard operational procedure when drilling, production, and other field management in the development of the geothermal field.
5. The Developer should ensure the community recognition and community participation in the Environmental Impact Analysis and Environmental Monitoring Effort-Environmental Management Effort (EIA-EME or AMDAL/UPL-UKL) through public consultation in accordance with in Governmental Regulation No. 27 Year 2012 about the process of arranging and assessment of EIA-EME.
6. The Developer should conduct the environmental management program well to minimize the development impact to community's agricultural land.
7. The Developer and Government should conduct the community empowerment program which the benefits can be directly perceived by the local community, such as direct use utilization for the community surrounding the GWA.

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References

- [1] Asian Development Bank and The World Bank 2015 *Unlocking Indonesia's Geothermal Potential* (Mandaluyong: Ceative Commons Attribution 3.0 IGO) ADB Open Access p 2
- [2] Directorate General of Renewable Energy and Energy Conservation 2017 *Doing Business in Geothermal* (Jakarta: MEMR) p 10
- [3] DPR RI 2015 Komitmen Indonesia pada COP21 – UNFCCC *Info Singkat : Hubungan Internasional* Vol VII No 23/P3DI/Desember/2015. (Indonesian)
- [4] Jackson P & Nowell K 2008 *Panthera Tigris ssp sondaica The IUCN Red List of Threatened Species* e.T41681A10509194
- [5] Geothermal Directorate 2017 *Potensi Panas Bumi Indonesia Jilid 1* (Jakarta:Geothermal Directorate) p 681 (Indonesian)
- [6] Government Regulation No.79/2014 2014 *National Energy Policy* (Indonesian)
- [7] Ministry of Energy and Mineral Resources Republic of Indonesia 2017 *Handbook of Energy &*

- Economic Statistics of Indonesia 2017* (Jakarta: MEMR)
- [8] Indonesian Government 2016 *First Nationally Determined Contribution Republic of Indonesia* (Indonesia: Indonesian Government) p 1
 - [9] National Energy Council 2016 *Indonesia Energy Outlook 2016* (Jakarta: National Energy Council) p 28
 - [10] SK Izin Pengusahaan Nomor 1/1/IPB/PMDN/2017 dated 30-01-2017