Journal of Mechanical Engineering and Vocational Education (JoMEVE)
Jurnal Homepage: https://jurnal.uns.ac.id/jomeve

PUBLIC ACCEPTANCE IN GEOTHERMAL ENERGY

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KEYWORDS

Public acceptance, public engagement, geothermal energy

ABSTRACT

Society is an essential consideration which has a very important role in helping to overcome problems and concerns in the field of technology. Community involvement and participation has become research for technology assessment. From this involvement came two views, namely acceptance and rejection of the community. This study aims to determine public acceptance and engagement about renewable geothermal energy in the world. In this literature review, the research method used is System Literature Review (SLR). This method consists of six stages, research questions (RQ), search strategy design, study selection, quality assessment, data extraction, and data synthesis. Based on the results of research that has been done it is known that the lack of community involvement causes the rejection of energy projects in general. It also resulted in the emergence of distrust of information from the company to the public. The public, industry, stakeholders and the media have a very important role and a very close relationship to increase public acceptance and engagement of geothermal energy. Therefore, both from the industry itself (internal) as well as from the public and stakeholders (external) must be involved in increasing public acceptance of geothermal energy.

INTRODUCTION

Energy availability is one of the most important aspects for the development of society in the world. At present, providing affordable and sustainable energy is a priority and the main strategy for future energy. Renewable energy is the main driver in the decarbonation of energy systems. It also aims to spur and improve energy efficiency and world energy security.

One of renewable energy is geothermal energy. Geothermal energy is green and renewable energy that utilizes thermal energy stored in the earth's core. This energy comes from the natural process of decay of radioactive material that is below the surface of the earth (Bayer, Rybach, Blum, & Brauchler, 2013). The great potential of geothermal resources as a future energy supply in energy conversion and emission reduction has been assessed and recognized by countries around the world. The total source of geothermal energy in the world reaches 12.7GW (Bertani, 2016). At present, the total geothermal capacity installed throughout the world as a power plant reaches 12,729MW in 24 countries and is estimated to be 21,443MW by 2020 (Bertani, 2016). This is a fairly rapid development of geothermal energy.

Although the geothermal industry has recently experienced innovative growth and increased capacity in all aspects. However, in its development there are various challenges. In addition to economic, technical, and environmental challenges, this development has a significant social dimension (Schumacher, Krones, McKenna, & Schultmann, 2019). This dimension relates to involvement between factories and the community (Kortsch,

e-ISSN : 2615-5699
https://doi.org/10.20961/jomeve.v3i2.38574

Society is an essential consideration. In addition, it is important to understand that the world of technology, society and governance are interrelated entities. Community involvement and participation has become research for technology assessment. From this involvement came two views, namely acceptance and rejection of the community.

As a party that will develop geothermal energy technology, community acceptance provides a very important role in helping to overcome the problems and concerns that stakeholders may have. By involving the community in technology acceptance and understanding, it aims to find out whether a technology is accepted by the community, how technology and the risks it will cause. If the community considers the risks to be too large, the industry or stakeholders can delay, or stop adopting new technologies.

Based on research that has been done, shows that many people who reject geothermal renewable energy. Such as rejection of geothermal development that occurred in several areas, namely Mount Rajabasa and Tangkuban Perahu in 2013, Sorik Merapi in 2014, Mount Lawu in 2016, Mount Talang, Baturaden, and Sokaria in 2017 (Adiyatama et al., 2018).

In addition, the lack of community acceptance has been manifested in protests against large-scale renewable energy projects. But on the other hand, there is increasing community support and involvement in renewable energy projects, especially in the context of community energy. This support, because the factory involves the community and stakeholders along the value chain and are mutually benefiting (Walker, 2008; Walker, Devine-Wright, Hunter, High, & Evans, 2010). Therefore, this study aims to take a broader view of community involvement in geothermal energy technology innovation, taking into account issues such as social trust that play an important role in community and social acceptance of technology development (Bell, Gray, & Haggett, 2005; Greenberg, 2014; Gross, 2007).

RESEARCH METHOD

This study uses the Systematic Literature Review (SLR) method (B. Kitchenham & Charters, 2007). This method consists of six stages. There are research questions (RQ), search strategy design, study selection, quality assessment, data extraction, and data synthesis.

First, researchers formulate question research and adapt it to the objectives of this method. After that, the search strategy design aims to find out studies that are relevant to the question research. At this stage, it involves searching for terms and selecting sources of literature used. The next step is the study selection. Here the researcher chooses the study criteria that will be used to identify relevant studies so that they can answer the research questions that have been submitted. The next step after getting relevant studies is quality assessment. This stage is done by compiling quality data. The fifth stage is data extraction. At this stage, it is done by forming data extraction and refining it through the pilot. The last stage of data synthesis is done by determining the appropriate methodology to analyze data extraction based on the type of data and research questions.

2.1 Research Questions

The research questions that will be discussed in this review literature are

1. How to exploit geothermal energy?
   RQ1 aims to find out what challenges and obstacles are experienced in the exploitation of geothermal energy.
2. How is the community's acceptance of geothermal energy?
   RQ2 aims to determine the level of community acceptance of geothermal energy.

2.2 Research Strategy

The research strategy consists of several stages, the search terms, sources of literature, and the search process, which are detailed one by one as follows

1. Search Item
   Some steps to create a search item as follows (B. A. Kitchenham, Mendes, & Travassos, 2007)
   a. Derive the main terms from the proposed RQ
   b. Identify alternative spellings and synonyms in the main terms
   c. Check keywords in relevant literature
   d. Use Boolean OR to combine alternative spellings and synonyms.
   e. Use Boolean AND to connect the main terms
2. Literature Resource
   Literature sources used to find primary studies are sourced from ScienceDirect, Web of Science and Google Scholar.
3. Search Process

The SLR method requires a comprehensive search of all relevant sources. Therefore, the search process is divided into two stages:

a. Look for literature related to public acceptance of geothermal energy.
b. Scan the reference list from the relevant literature then add to the set.

In this Search process, Mendeley Software is used to store and manage search results.

2.3 Study Selection

Study selection is carried out in two phases:

Selection phase 1: Using inclusion and exclusion criteria, i.e. selecting studies by reading the title, abstract, or full text (defined below).

Selection stage 2: Apply quality assessment criteria (defined in the next section) to relevant papers so that they can choose papers of acceptable quality, which are ultimately used for data extraction.

2.4 Study Quality Assessment

Study Quality Assessment is carried out by asking the following questions

1. What is the purpose of the research?
2. What research questions are explained in the article?
3. Are the methods used well defined?
4. How is the experimental design used?
5. Are the findings of the study clearly stated and reported?
6. Are the limitations of the study explicitly analyzed?
7. Does the study carried out add value to academics or the industrial community?

2.5 Data Extraction

Data extraction used here is based on

1. Source
2. Article Title
3. Year of publication
4. Author's name
5. Type of Study (experiment, case study, or survey)

2.6 Data Synthesis

The sole data of the purpose of data synthesis is to gather evidence from selected studies to answer research questions. A little evidence may have little evidence strength, but the aggregation of many of them can make the points stronger (Pfleeger, 2005). This review includes quantitative data and qualitative data.

Title Journal	Journal	Year of Pub.	Authors	Vol. (Issue), Pages
A review of geothermal energy resources in Australia: Current status and prospects.	Renewable and Sustainable Energy Reviews	2013	Bahadori, A., Zendehboudi, S., & Zahedi, G.	21, 29–34
Review on life cycle environmental effects of geothermal power generation.	Renewable and Sustainable Energy Reviews	2013	Bayer, P., Rybach, L., Blum, P., & Brauchler, R.	26, 446–463
The “social gap” in wind farm siting decisions: Explanations and policy responses.	Environmental Politics	2005	Bell, D., Gray, T., & Haggett, C.	14(4), 460–477
Geothermal power generation in the world 2005-2010 update report.	Geothermics	2012	Bertani, R.	41(2012), 1–29
Geothermal power generation in the world 2010-2014 update report.	Geothermics	2016	Bertani, R.	60, 31–43
Geothermal Energy Use, Country Update for Italy (2010-2015).	European Geothermal Congress 2016	2016	Conti, P., Cei, M., & Razzano, F.	(September), 1–17
Energy policy and research: The underappreciation of trust.	Energy Research and Social Science	2014	Greenberg, M. R.	1, 152–160

Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance.	Energy Policy	2007	Gross, C.	35(5), 2727–2736
Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework.	Renewable and Sustainable Energy Reviews	2012	Huijts, N. M. A., Molin, E. J. E., & Steg, L.	16(1), 525–531
Cross versus within-company cost estimation studies: A systematic review.	IEEE Transactions on Software Engineering	2007	Kitchenham, B. A., Mendes, E., & Travassos, G. H.	33(5), 316–329
Guidelines for performing Systematic Literature Reviews in SE.		2007	Kitchenham, B., & Charters, S.	1–44
Acceptance of biomass plants - Results of a longitudinal study in the bioenergy-region Altmark.	Renewable Energy	2015	Kortsch, T., Hildebrand, J., & Schweizer-Ries, P.	83, 690–697
Public attitudes toward emerging technologies: Examining the interactive effects of cognitions and affect on public attitudes toward nanotechnology.	Science Communication	2005	Lee, C. J., Scheufele, D. A., & Lewenstein, B. V.	27(2), 240–267
The Role of Societal Acceptance in Renewable Energy Innovations´BreakthroughInnovations´Breakthrough in the Case of Deep Geothermal Technology.	Proceedings World Geothermal Congress	2010	Leucht, M., Kölbel, T., Laborgne, P., & Khomenko, N.	(April), 25–29
Direct utilization of geothermal energy 2010 worldwide review.	Geothermics	2011	Lund, J. W., Freeston, D. H., & Boyd, T. L.	40(3), 159–180
Environmental and social aspects of geothermal energy in Italy.	Geothermics	2018	Manzella, A., Bonciani, R., Allansdottir, A., Botteghi, S., Donato, A., Giamberini, S., … Scrocca, D.	72(December 2017), 232–248
Communicating climate change: Why frames matter for public engagement.	Environment	2009	Nisbet, M.	51(2), 12–25
Framing Science: The Stem Cell Controversy in an Age of Press/Politics.	The International Journal of Press/Politics	2003	Nisbet, M. C., Brossard, D., & Kroepsch, A.	8(2), 36–70
Exploring public engagement with geothermal energy in southern Italy: A case study.	Energy Policy	2015	Pellizzone, A., Allansdottir, A., De Franco, R., Muttoni, G., & Manzella, A.	85(2015), 1–11
Geothermal energy and the public: A case study on deliberative citizens' engagement in central Italy.	Energy Policy	2017	Pellizzone, A., Allansdottir, A., De Franco, R., Muttoni, G., & Manzella, A.	101(May 2016), 561–570
Soup or art? The role of evidential force in empirical software engineering.	IEEE Software	2005	Pfleeger, S. L.	22(1), 66–73

Societal acceptance of an emerging energy technology : How is geothermal energy portrayed in Australian media ?	Renewable and Sustainable Energy Reviews	2015	Romanach, L., Carr-cornish, S., & Muriuki, G.	42, 1143–1150
The public and nanotechnology: How citizens make sense of emerging technologies	Journal of Nanoparticle Research,	2005	Scheufele, D. A., & Lewenstein, B. V.	7(6), 659–667
Public acceptance of renewable energies and energy autonomy: A comparative study in the French, German and Swiss Upper Rhine region.	Energy Policy	2019	Schumacher, K., Krones, F., McKenna, R., & Schultmann, F.	(November), 315–332
Understanding social acceptance of geothermal energy: Case study for Araucanía region, Chile.	Geothermics	2018	Vargas Payera, S.	
What are the barriers and incentives for community-owned means of energy production and use?	Energy Policy	2008	Walker, G.	36(12), 4401–4405
Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy	Energy Policy	2010	Walker, G., Devine-Wright, P., Hunter, S., High, H., & Evans, B.	38(6), 2655–2663
Farmers, open houses, and technical knowledge: Public outreach in aquistore	Energy Procedia	2014	Young, A., & Sacuta, N.	63, 7043–7046

RESULT AND DISCUSSION

Based on the results of searches that have been carried out to search for literature using the SLR method above, we obtain as many as 20 relevant papers. From the paper, an analysis based on question research was then divided into two, the first concerning the development of geothermal energy and the second about public acceptance of geothermal energy.

Geothermal Energy Exploitation

The first country in the world to produce electricity from geothermal energy was Italy. The country also has the best geothermal energy generation in Europe, the sixth in the world (Bertani, 2016). In Central Italy, there are 34 geothermal power plants. Precisely located in Tuscany, in the "historical" area of Larderello-Travale and Mount Amiata. In this country, geothermal energy production is increasing continuously. This is because geothermal resources that are here are managed effectively.

The use of geothermal energy has been regulated in various laws in Italy. However, there are several obstacles to the exploitation process. In 2010, there was research liberalization, geothermal exploitation, and it was intensively applied to be used as a renewable energy source. This led to the emergence of new players who tried to enter the market. With this incident, some of the proposed geothermal projects can complete exploration, experiencing many environmental problems (Manzella et al., 2018).

In 2013, "Green Certificates" were replaced by "Incentive Costs". The net kWh value generated from the new geothermal power plant from around 13.7 Eurocent / kWh with the "Green Certificate" will be 9.9 or 8.5 Eurocent / kWh with the new "Incentive Fee". This is for units with an installed capacity of less than or above 20 MWe each (Conti, Cei, & Razzano, 2016).

In addition, another obstacle originates from the problem of social acceptance from several local communities who care about environmental issues. In July 2016, national laws defined environmental issues related to geothermal exploitation. This rule has described the best practices that must be applied by geothermal projects, particularly with regard to power plants and those requiring deep good drilling (MISE-MATTM, 2016).

The State of Chile defines geothermal energy as one of the most unknown energy sources. On the other hand, this country has extraordinary geological characteristics for the development of geothermal energy. Geothermal exploration began in the 1920s (Tocchi and Tatio, 1923) However, the law on geothermal was only implemented 16 years ago. The country has almost no high enthalpy geothermal production (Bertani, 2015). When viewed from high enthalpy geothermal energy in Chile, the geothermal concession market is at its peak in 2012 with 76 exploration concessions. However, in 2016, the number decreased (Sernageomin, 2017). he first geothermal

project in the country of Chile is located in Cerro Pabellón, precisely in the Antofagasta area. The project began in 2017 and is operated by ENEL Latin America (Chile) and the Chilean National Oil Company (ENAP). The project is expected to have a capacity of 48 MWe (ENEL, 2012).

On the other hand, low enthalpy geothermal production in Chile experienced quite serious problems. So far, there is no national registration regarding the direct use of geothermal energy projects. However, the data shows that the installed thermal capacity is 19.91 MWt (Lund and Boyd, 2015). This capacity is mostly used for recreational purposes, spa and swimming pool. It is also used for heating in the public school Voipir Ñancul in the city of Villarrica.

In 2009 there was the El Tatio Well incident which succeeded in attracting the attention of the mass media. The emergence of this incident resulted in negative perceptions about geothermal energy. which was originally not known to be a well-known energy source (Otero, 2015). For 27 days, a very strong steam leak occurred, reaching a height of 60 m in a well in El Tatio Field. Here is an area that has great geothermal potential, but it is also an important tourist attraction located in indigenous territories. The Chilean Ministry of Environment then reported internationally that the possible effects of the incident were not from the geysers. The report also highlights the information gap between companies and geysers, this research is responsible for the UN Development Program (PNUD). Since then, geothermal energy has continued to face opposition in Chile. As Hornig (1993) points out, public attention is influenced by media attention, and media coverage shapes perceptions and opinions.

In Australia, geothermal energy technology is relatively immature and unknown. This country has a history of using geothermal energy for direct use, namely for spas and swimming pools. However, this country only has one small geothermal project, a capacity of 80 kW. This project is in the remote town of Birdsville in Queensland.

In the world, in 2010, there were an estimated 24 countries, including the United States, Indonesia, Italy, Mexico, and the Philippines, which have generated electricity from geothermal resources (Bertani, 2012). This geothermal energy source has a significant share of the total electricity produced in various countries, including Iceland (25%), El Salvador (22%), Kenya and the Philippines (17% each) and Costa Rica (13%). In addition, geothermal energy is also used through direct use applications in 78 countries, which include geothermal heat pumps for heating and cooling, water heating in pools and spas (26%), and space heating (15%) (Lund, Freeston, & Boyd, 2011).

Australia has significant geothermal energy potential for heat applications and hot sedimentary rock heat sediments (Bahadori, Zendehboudi, & Zahedi, 2013). At present, there are several large projects at the feasibility study and approval stages in Victoria and South Australia. Geothermal energy is expected to reach 8% of total electricity generation in Australia by 2050. However, such an increase will cause Australians to be exposed to more geothermal energy technology than ever before (Romanach, Carr-cornish, & Muriuki, 2015).

Public Acceptance of Geothermal Energy

Case studies conducted in the Province of Palermo (Sicily, Southern Italy) in the autumn of 2012 (Pellizzone, Allansdottir, De Franco, Muttoni, & Manzella, 2015) and Viterbo (Latium, Italy in Tenga), in the spring of 2014 (Pellizzone, Allansdottir, De Franco, Muttoni, & Manzella, 2017) about the social context in shaping social acceptance of geothermal development. This research shows that there is a low level of knowledge, but the level of respondents who have heard about geothermal energy increased by 17% in Palermo and 42% in Viterbo. Knowledge and opinions about energy sources are very different depending on technology (Manzella et al., 2018).

Other research on geothermal social acceptance in Italy was also conducted by Anna (Pellizzone et al., 2017) This study shows data as much as 22% of respondents said they would be very worried or very worried, 24% were worried, and 36% were not at all or slightly worried The level of uncertainty (the answer I don't know) was 19% of geothermal power plants. In addition, the data also shows that the use of geothermal heat pumps is slightly lower than concerns about geothermal power plants (20% will be very worried or very worried), but the uncertainty (the "I don't know" answer) is higher (25%).

These concerns about geothermal power installations arise related to technological or scientific problems. Such as emissions, environmental impacts, micro-seismic risks, hazards to aquifers or lack of trust (transparency of public institutions and private sector speculation). The main reason for concern found in the survey was the lack of transparency of public institutions (32% were very worried and 36% were worried), followed by risks to aquifers (31% were very worried and 31% were worried). The results of focus groups on the possibility of geothermal exploitation are closely related to trust in developers, politicians and investors.

Therefore, energy management requires public involvement for risk evaluation and ethical considerations. Both of these aspects find the appropriate element in the dichotomization of trust into the trust. Associated with competence, and become social beliefs associated with values (Greenberg, 2014). Trust is an important thing that should not be underestimated. Based on research that has been done shows that the nature of the decision-making

process can greatly influence social acceptance and that opposition to a single facility can be determined by the perception of an unfair and technocratic decision-making process (Bell, 2005, Gross, 2007).

Apart from the knowledge and understanding of the community, community involvement in the exploitation of renewable energy is also very influential. As Vargas research (Vargas Payera, 2018) shows that participants from local communities show that they have not been involved in the decision-making process related to energy projects to date. It also claims that communication about the project has been removed from the top-down; in other words, "the company started communication when the project was approved or even years later," said members of the local non-native community. During that time, members of the Mapuche community stated that "[they] felt vulnerable as neighbours because energy companies approached community after months of working in [their] area. It's too late, people's trust has been destroyed. In this situation, participants show an interest in knowing more about geothermal energy, especially about direct use.

The lack of risk of community involvement results in not only the rejection of energy projects in general but also distrust of information provided by the company to the community. In this context, several members of the local community mentioned that they sought information about the projects through social and local media. Participants who live in rural areas also said the same thing. Regarding this, the participants recognized local community leaders as a reliable source of information. Mapuche communities, and young professionals, who promote environmental protection among non-native rural communities.

Public acceptance is very important for the development of new energy technologies (Leucht, Kölbel, Laborgne, & Khomenko, 2010) with previous research that confirms that the media also plays an influential role in reflecting public sentiments from emerging science and technology (M. Nisbet, 2009; M. C. Nisbet, Brossard, & Kroepsch, 2003). It also explores people's acceptance of the complex and evolving technology through the media.

As in Australia, geothermal energy technology is very important. This is because the general public is not actively seeking information about every complex technology that arises but is more likely to be influenced by media reporting (M. Nisbet, 2009)(Scheufele & Lewenstein, 2005). In the research carried out to consider the two most influential factors that characterize the acceptance of energy technology (Huijts, Molin, & Steg, 2012). These factors are the benefits and risks of geothermal energy.

Based on the analysis of the media on technology it is known that the media will report benefits and risks. The risks reported are economic and scientific (Lee, Scheufele, & Lewenstein, 2005). This research shows that geothermal projects in Australia are the same as geothermal projects in other countries (Huijts et al., 2012).

Economic and technological uncertainties dominate the media from initial research and development. However, other interest groups and social actors, such as communities and environmental organizations, tend to join the discourse if technology enters large-scale developments. This is especially so if these developments are brought closer to the community. When new social actors join the emerging technological discourse, then the community will tend to bring alternative perspectives on that technology. This can reshape the technology profile from a public perspective (Scheufele & Lewenstein, 2005). However, with increasing uncertainty about Australia's Renewable Energy Targets and the economic challenges of advancing geothermal technology in Australia, it is likely that media reporting on geothermal technology in Australia will continue to be a limited profile and focus on the economic viability of technology (Romanach et al., 2015).

Community Involvement/ Awareness in Geothermal Energy

The public, industry, stakeholders and the media have a very close and interrelated relationship to increase public acceptance, public engagement and public awareness about geothermal energy. Each party has a very important role in the development of geothermal energy.

Like previous research conducted on the Aquistore project (Young & Sacuta, 2014). Aquistore intends to show that storing liquid carbon dioxide (CO2) deep underground (in saltwater and sandstone formations), is a safe solution and can be applied to reduce greenhouse gases.

Aquistore is the first special CO2 storage project in Canada and is an integral component of the SaskPower Boundary Carbon Capture and Storage Demonstration (CCS) project. In its development, outreach and strategic involvement is needed to ensure the CCS project is supported. Even when CCS awareness is high, many CCS projects - success and failure - have received attention. The Aquistore communication program was designed with best practices in mind and focused on public involvement and education.

Aquistore conducts public outreach by holding open houses and hosting communities. In April 2012, the project hosted its first open house. The project also received support from various parties such as project members and researchers, this open house is a large-scale effort to involve local communities. The results of this activity, have shown considerable improvement. More than 75 interested citizens and local people attended the event and

learned about the project. In addition to the open house, Aquistore also sends door-to-door invitations to the public so they can participate in this activity. Thus, the holding of this event is an example of the industry's openness to the local community, and after the event was held, community involvement became wider (Young & Sacuta, 2014).

CONCLUSION

Community acceptance is very important for the development of energy technology. Besides, community involvement in the development of renewable energy is also very influential.

Based on the studies that have been stated above, it can be concluded that as an industry party to increase public acceptance of geothermal energy, it is necessary to have the involvement of all elements, both from the industry itself (internal) as well as from the public and stakeholders (external).

However, how research can be successful as has been done by Aquistore (Young & Sacuta, 2014) it is necessary to do further research on the involvement of the Geothermal Power Industry industry to increase public acceptance of geothermal energy. This research will focus on the involvement of the industry in increasing public acceptance of geothermal energy. So that the relationship between the public and industry can be further known.

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