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Factors Influencing Geothermal Acceptance: Insights from Germany, Switzerland, Japan, and Indonesia

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1 INTRODUCTION

In the context of global efforts towards renewable energies, geothermal energy holds great potential (Barbier 2002; Chakraborty and Mazzanti 2021; Kassem and Moscariello 2025; Smith 2019). Beside the economic, technological, and geological feasibility of a specific geothermal project, the social element of different stakeholder groups in direct and indirect connection to the project proposal can be crucial for its success. The importance of social acceptance gets also in the focus of research, as shown by the increasing number of publications dealing with social acceptance towards geothermal technology (Renoth et al. 2023). Publications in this literature review underline evidence that social acceptance can lead to delays in, or even the cancelation of, geothermal projects (Flechtner et al. 2019; Ibrohim et al. 2019; Karytsas et al. 2019). To combine social acceptance with renewable energy innovations, Wüstenhagen et al. (2007) developed a widely used concept in this field. The dimension of community acceptance, as one of the three dimensions of the concept, focuses on the specific project level and its feasibility (Wüstenhagen et al. 2007). Renoth at al. (2023) used this framework with a focus on community acceptance to identify acceptance categories and acceptance factors in direct relation to geothermal projects. Our goal is to analyse existing research on the community acceptance of geothermal projects in Germany, Switzerland, Japan, and Indonesia for applied research, i.e., four countries with specific differences and similarities in terms of community acceptance. We aim to investigate whether there are country-specific characteristics and, based on our conclusions, to create country acceptance profiles. Those acceptance profiles may provide useful insights into how to address community acceptance in geothermal projects, raise awareness of social expectations and emotional concerns, and help include these aspects into project planning. Germany and Switzerland are comparable European countries which have already gained some experience with the success and failure of geothermal projects. The economy and culture are similar in these two countries with a high standard of living (OECD 2024; OECD 2025). Compared with these two countries, Japan has some similarities regarding the economy and standard of living, but notably differs from Germany and Switzerland in terms of its culture. The fourth country we included in our study is Indonesia. Geologically it is situated, like Japan, on the Pacific Ring of Fire with big geothermal potential (Masum and Ali Akbar 2019). The economy has been strongly developing over the last decades and, therefore, Indonesia's energy demand is also growing (Sukanto et al. 2024). However, the social structure in Indonesia differs from the other three countries as religion plays a more prominent role in daily life (Tamir et al. 2020).

2 METHODS AND RESULTS

2.1 Methods

For our research we used a scoping review to identify different previous research on social acceptance and geothermal technology. We used Web of Science and Scopus as search engines with broad science databases and extended the database of GeoRef by ProQuest to also use a geo-specific database. The search string was 'geoth* AND accept* AND (Japan OR Germany OR Indonesia OR Switzerland)' and limited to the time between 2011 till the end of June in 2025 to collect the most recent publications. The search on all three databases yielded a total number of 167 papers, which is split up into 87 publications in Scopus, 52 papers in Web of Science, and 28 articles in GeoRef. After removing duplicates (n=47) and papers with missing topic references in the published title or abstract (n=82), a total number of 38 publications remained for full text screening. At this stage, nine papers were removed, due to missing topic connection. Furthermore, access to five papers was not possible. This gave 24 papers collected from the databases. Five additional papers were manually added due to their relevance in the field, resulting in a total of 29 scientific papers used for our research. All publications are in English and internationally published. Only papers dealing with at least one of the four countries are included. We used the concept of Wüstenhagen et al. (2007) about social acceptance of renewable energy, which forms

the foundation of our review. To identify the community acceptance research within the selected papers, the scheme of Renoth et al. (2023), with five acceptance categories and over thirty acceptance factors, served as base for the deductive content coding (Kuckartz and Rädiker 2023).

2.2 Results

The distribution of research across the four countries is shown in figure 1. Germany is the country with the least amount of publications in our research. It was addressed in five of the 29 scientific papers. Japan has seven and Switzerland eight publications, respectively. Indonesia is mentioned in ten research papers. Between 2011 and 2025 the research on acceptance and geothermal technology increased, even though there was a gap of two years (2023, 2024) with no publications.

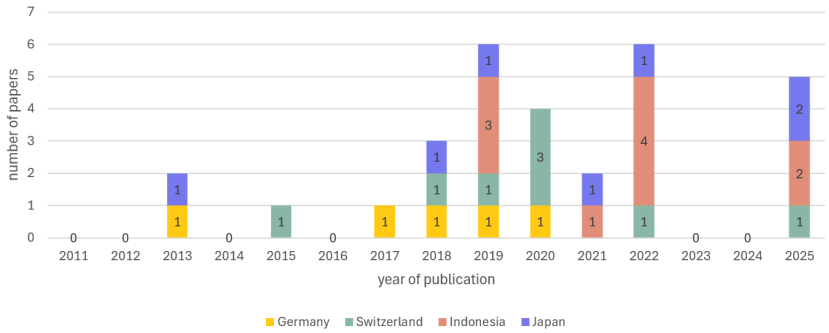


Figure 1. Publications between 2011 and June 2025 regarding acceptance and geothermal technology separated by countries and year of publication.

Overall, Indonesia has the most identified acceptance factors with 70. Papers about Switzerland addressed 42 acceptance factors whereas papers about Japan dealt with 27. Publications about Germany identified 21 acceptance factors. The largest acceptance category is ‘project organization and process’ (49 mentions). The most commonly mentioned acceptance factor is ‘trust in key actors’ (13 mentions), ‘local profits and income’ (11 mentions), and the ‘distribution of benefits and costs between community actors’ (10 mentions). They are observed in all four countries, except ‘local profits and income’, which was not mentioned in any Switzerland paper. The second largest acceptance category is ‘environment’ (36 mentions). The two quantitatively dominant acceptance factors are ‘environmental impact’, which appears in all four countries, and ‘seismicity’, which is not mentioned in publications addressing Japan. The most addressed acceptance factor in the category ‘municipality’ (36 mentions) is ‘general knowledge about geothermal technology’ (10 mentions). Furthermore, ‘socio-cultural values’ (7 mentions) and the ‘agricultural sector’ (5 mentions) play a certain role in Indonesia and Japan, but not so much in Switzerland or Germany. In the category ‘technology’ (20 mentions) the factor ‘maturity of technology’ (8 mentions) played a relevant role over all four countries. The acceptance factor ‘grid infrastructure’ was only observed in Indonesia and Switzerland. ‘Governance’ (19 mentions) is the smallest acceptance category. One associated acceptance factor ‘plans in politics’ (10 mentions) has no appearance in publications dealing with Germany.

3 DISCUSSION AND CONCLUSION

3.1 Discussion

Interest in geothermal energy is rising globally, with notable enthusiasm observed in Indonesia. However, in 2023 and 2024 there were no new articles regarding acceptance and geothermal technology in the four selected countries published. A potential explanation for this gap can be the lingering effects of the COVID-19 pandemic, which may have hindered surveys and resource availability in the preceding years.

Germany demonstrates that project organization and processes are critical acceptance factors Here, the ‘distribution of costs and benefits’, ‘trust in key actors’, and ‘local profits’ play a central role (Borg 2020; Kunze and Hertel 2017; Trevisan et al. 2013; Zaunbrecher et al. 2018). This may relate to the experiences in Germany in the past. Negative events, such as seismic activity and significant damage in Staufen im Breisgau (Sass and Burbaum 2010) and Landau (Heimlich et al. 2015) raise awareness and the demand of an insurance for the worst-case scenario (Kunze and Hertel 2017). Since those events, geothermal technology is negatively connotated with seismicity (Heimlich et al. 2015; Sass and Burbaum 2010). Furthermore, negative experiences of geothermal projects for instance in Puchheim (Flechtner et al. 2019) causing distrust in developer and geothermal project partners. This issue can be addressed with transparent and open communication (Borg 2020). However, in the acceptance factor ‘energy production’ tends to have a positive connotation and is seen

as ‘renewable energy’ with more advantages compared to other renewable energy technologies (Trevisan et al. 2013; Zaunbrecher et al. 2018). It is also stated that’ knowledge about geothermal technology’ is relevant for community acceptance. According to Zaunbrecher et al. (2018) and Borg (2020) many people in Germany have a poor knowledge about geothermal technology (Borg 2020; Zaunbrecher et al. 2018).

In **Switzerland**, environmental concerns emerge are the primary factor that affects acceptance. ‘Seismicity’ (Cousse et al. 2025; Cuppen et al. 2020; Ejderyan et al. 2020; Knoblauch et al. 2019) and ‘environmental impacts’, as caused by fracking (Cuppen et al. 2020; Ejderyan et al. 2020), as well as other negative underground effects (Cousse et al. 2025; Ejderyan et al. 2020) lead to a low level of acceptance. In the category ‘project organization and process’ the focus is on ‘information about the project’. Local information about the project and transparency about associated advantages and disadvantages can reduce concerns (Ejderyan et al. 2020). Furthermore, in this category the ‘distribution of benefits and costs among community actors’ is mentioned as a factor influencing acceptance (Ejderyan et al. 2020; Spampatti et al. 2023; Stauffacher et al. 2015). More specifically, these concerns can be linked to seismic events during geothermal projects in Basel and St. Gallen, causing widespread concerns regarding geothermal projects (Ejderyan et al. 2020; Stauffacher et al. 2015).

For **Japan**, ‘trust in key actors’ is an essential acceptance factor. The continuity of responsible people and companies during a project is favoured for building trust and supporting community acceptance (Hymans 2021). Furthermore, combined with ‘cultural values’, there is a special situation with hot springs and their owners, both of which are deeply rooted in Japanese communities. If the use of geothermal technology affects the hot springs negatively, community acceptance will likely not be in favour of the project (Hymans 2021; Hymans and Uchikoshi 2021; Kubota et al. 2013; Yasukawa et al. 2018). The trust of these stakeholders towards developers and the project itself can highly affect community acceptance (Hymans 2021; Kubota et al. 2013; Shinozaki et al. 2025). In addition, aspects of governance, such as ‘political plans’ and ‘political regulations’, play a key role for the acceptance of geothermal projects. Regional governments, which give the permission for geothermal projects, notably influence the process and opinion about geothermal projects (Kubota et al. 2013; Yasukawa 2019; Yasukawa et al. 2018). Furthermore, governmental laws support hot springs before geothermal projects, which also affects the acceptance of different groups within a community (Hymans and Uchikoshi 2021).

In **Indonesia**, ‘local profits and income’ for the community is a key acceptance factor. There are advantages such as competitive energy prices, which lower the cost indirectly and help the local economy or employment opportunities for the local community (Pambudi et al. 2022). Concerns are, however, that a geothermal project will have a negative effect on the local industry and that only external experts instead of local people are employed (Hariyadi et al. 2019; Ibrohim et al. 2019). This might also relate to the economic situation in Indonesia as a developing country. The ‘general knowledge about geothermal technology’ is rather poor and leads to concerns about the technology (Ibrohim et al. 2019; Pambudi et al. 2022; Siyaranamual and Yusuf 2025; Wahyudi et al. 2019). However, the study of Pambudi et al. (2022) found that high school students had a reasonably good knowledge about geothermal projects. An outstanding factor in community acceptance in Indonesia is ‘agriculture’. The relevance of agriculture is addressed in six of the ten papers and relates to concerns on negative effects to farmland or fishing zones (Hariyadi et al. 2019; Ibrohim et al. 2019). Regarding the ‘grid infrastructure’, geothermal technology is seen as a reliable energy source and an improvement of the local infrastructure (Anggreta et al. 2022; Yudha et al. 2022). ‘Seismicity’ plays a minor role in the research of Indonesia, a country frequently affected by volcanic eruptions and concomitant seismic activity. Only two papers mentioned the fear of seismic events as an acceptance factor (Anggreta et al. 2022; Ibrohim et al. 2019).

3.2 Conclusion

This study reveals commonalities and differences in community acceptance of geothermal technology in Germany, Switzerland, Japan, and Indonesia. Across all four nations the relevance of the category ‘project organization and process acceptance’ is crucial and affects community acceptance, regardless of the country. Information campaigns at early stages with transparent and easily accessible information can support the understanding of, connection with, and trust in geothermal projects. The environmental impact of geothermal projects is similarly relevant. Positive effects, such as the reduction of greenhouse gases, can be found, as are concerns about the negative impact on the surrounding ecosystem, such as deforestation and water shortage. However, there are also country-specific peculiarities that affect community acceptance in the four countries.

In Germany and Switzerland, due to the experience of seismic activities connected to geothermal projects in the past, concerns about new seismic events exist. Also, technical terms like ’fracking‘ negatively influence the acceptance of geothermal projects. To address these concerns, information can help assess the actual risk of seismic event in geothermal projects. In Japan cultural and governance acceptance factors are prominent compared with the other countries. Due to the cultural embedding of hot springs, their owners have a prominent

influence on the community acceptance. This can be addressed by specifically explaining the concept of geothermal technology and possible effects on hot springs. Furthermore, the role of hot springs is also politically empowered due to laws and local governments. This political level also influences the community acceptance and practical implementation of geothermal projects. In Indonesia, the country-specific conditions regarding community acceptance are in the categories of municipality and governance, albeit in a different way compared to Japan. In particular, the economic situation in Indonesia is different, as it is still a developing country. Geothermal projects are seen as an opportunity to improve the local infrastructure and energy supply. However, concerns such as the effects on agriculture, which is one of the basic incomes, or negative effects on spiritual sites, play an important role. This can be addressed by improving knowledge about geothermal technology in general and allowing the local population to participate in a transparent and informative project process.

These differences and commonalities reflect the varying political, cultural, historical, and economic perspectives of the four countries, which all affect community acceptance of geothermal projects and technology. The findings of this analysis indicate a need for further research to better understand the contexts, perspectives, and impacts on acceptance of geothermal projects across different nations. Future studies should consider historical, economical, and cultural factors unique to each country to decode acceptance mechanisms. Considering a country's perspective and its context, country-specific strategies to improve community acceptance can be developed to implement geothermal technologies worldwide.

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