SOCIAL PERCEPTION AND ACCEPTANCE OF GEOTHERMAL SYSTEMS

DOI: https://doi.org/10.18485/arh_pt.2024.8.ch62

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ABSTRACT

Social acceptance is considered as one of the barriers for implementation of modern technologies. Considering that geothermal systems do not have a prominent level of acceptance by the public compared to solar or wind technologies, this paper aims to investigate the issues and possibilities for their broader social acceptance. We aim to examine public views and social attitudes for the use of geothermal energy. Also, we investigate recent development of geothermal systems and their environmental implications in South-East Europe. This paper identifies various social barriers and categorises them in main groups, such as, environmental, economic, social, political and project management categories. Further, the findings show that for achieving social acceptance inclusive, transparent, and participatory process between all stakeholders is required. The present study aims to establish a framework based on project management methodologies in order to ensure larger social acceptance of geothermal systems by the general public. The authors would like to acknowledge the support of the CA 18219 Geothermal-DHC Cost Action for the excellent research and networking possibilities.

KEYWORDS _ *social acceptance, geothermal systems, social barriers, participatory process, project management*.

INTRODUCTION

The contemporary society demands carbon-free technologies in all industries. In the domain of heating/cooling of buildings the geothermal power production has significant role in mitigating carbon emissions and contributing towards a green and sustainable future. However, social acceptance is considered as a strong prerequisite for successful implementation of geothermal power production projects (Karytsas et al. 2019).

It is noted that, "social acceptability is attained if the project activities do not result in drastic changes from the regular conditions of the area and if the affected sectors can see some advantages issuing from the project" (de Jesus 1995). Further, as stated, it is difficult to have social acceptance for project if the specifics of the local environment are not analysed and it there are not properly designed organizational, technical, economic, and other solutions in order to remove the negative opinions (Popovski 2003).

This paper aims to perform a state-of-the-art literature review regarding the social acceptance of geothermal technologies by the public. The social acceptance was investigated relative to the local context and the specific issues that might arise. Within this research, the findings on the social barriers were grouped in several categories, such as: environmental, economic, social and political barriers. Also, an analysis is preformed regarding the current state of geothermal power use in the Western Balkans.

SOCIAL ACCEPTANCE

Social acceptance can divided in three categories: sociopolitical (acceptance of the technology by stakeholders, the public, and policymakers); community (relating to procedural justice and trust among stakeholders) and market (the relationship between consumers, investors, and firms) (Wüstenhagen et al. 2007). The public is often dubbed as the key stakeholder in the acceptance process. In the literature there are ten categories of the public, such as: consumer, service user, financial investor, local beneficiary, technology host, energy producer, project participant, protesters and supporters (Walker and Cass 2007). Also, authors highlight the need for strong political acceptance in order to realize any significant geothermal development (Popovski 2003). Regarding the social acceptance of geothermal energy, it is noted that this technology does not have a high level of acceptance by the general public, as compared to solar or wind technology, and also has a rather weak political acceptance.

From the literature review, different social barriers on acceptance of geothermal technology have been identified whose presence vary with the local context. Within this research a framework was made and the social barriers were grouped in several categories, such as:

- environmental - citizens afraid from risk of pollution of the environment, afraid of seismic activity, afraid of disturbing/polluting the local land, disturbing volcanic activity etc. (Farghali et al. 2023; Kelly 2011; Kubota et al. 2013; Soltani et al. 2021; Yasukawa et al. 2018),
- economic - citizens afraid of high cost and low benefit, creation of benefits for local communities by directly granting money to local authorities, conducting local development programs (improving infrastructure, environment protection, strengthening local economy and entrepreneurship, promotion of and sports etc.), authorities higher upfront investment, some citizens saw value in increase of their property value etc. (Barbier 2002; Codrea and Călburean 2013; Farghali et al. 2023; Soltani et al. 2021),
- social - limited public knowledge about the technology, lack of accepting novel technologies, lack of general knowledge on how the technology works and its benefits, citizens have had bad experience with former industrial sites in the area from their pollution, negative impact on

tourism if geothermal district plants are build near tourist sites, religious aspects, experiential aspects, visual pollution of the area etc. (Barbier 2002; Cataldi 2001; Dowd et al. 2011; Farghali et al. 2023; Kubota et al. 2013; Pasqualetti 2011; Soltani et al. 2021; Wüstenhagen et al. 2007),

- political barriers - lack of political support on a local/central level, corruption etc.(Peterson et al. 2015; Popovski 2003; Zamfir et al. 2016),
- project management - untransparent project not involving all stakeholders and/nor the public, not properly managed project, lack of communication plan with the public, unfavourable/lack of media coverage, low levels of community participation in consultation processes and in the project development etc. (Kelly 2011; Kubota et al. 2013; Vargas Payera 2018)

PROJECT MANAGEMENT FOR IMPLEMENTING SOCIAL ACCEPTANCE PROJECTS

In order to overcome social barriers of geothermal projects, researchers propose implementing adequate project management methodology. Hence with the research the ISO 21500 (International Standardization Organization 2021) project management standard and the PMBOK project management methodology were considered (Project Management Institute 2013). They are consisted mainly out of 10 categories, such as: stakeholder integration, risk management, time management etc.

As a mean for overcoming social barriers, several authors propose performing a risk communication plan which as a democratization concept encourages active dialogue among stakeholders and stimulates positive social attitudes toward geothermal energy (Kelly 2011; Kubota et al. 2013; Vargas Payera 2018). Risk communication is described as a network or interactive exchange of information among individuals, groups and institutions, which promotes a fair process and mutual understanding among the interested parties. It allows trust building among stakeholders, enabling well-informed decisions and empowering local communities (Carr-Cornish and Romanach 2014; Salter 1999).

It is noted that the public often has high expectations from geothermal power technology and therefore, the developers and local governments need to inform the public regarding the risk-benefit and technical characteristics of geothermal energy in an understandable way. Several authors state that it is required to provide appropriate information to the stakeholders and to increase their understanding of the technology (Dowd et al. 2011; Peterson et al. 2015; Vargas Payera 2018; Yasukawa et al. 2018).

Surveys from various countries show that the public strongly agrees on the direct use of hot springs for geothermal energy utilization, energy saving by using geothermal heat pumps, using small scale geothermal power plants, development of new geothermal power outside of national parks etc.(Baek et al. 2021; Carr-Cornish and Romanach 2014; Kim et al. 2022). Regarding the public information needs for informed decision making include: data on power supplying capability, countermeasures for safety management, impact on electricity price, CO2 reduction contribution to climate change mitigation, upgrading energy self-sufficiency and stable energy supply, increasing local employment etc.

GEOTHERMAL PROJECTS IN WESTERN BALKANS

Further, several geothermal developments in the Western Balkans are investigated, with a focus on Romania, which is among the top four countires in Europe with geothermal energy potential. In Romania currently there is an exploration of the potential for geothermal application on 24 sites (Balgaranov 2023; Codrea and Călburean 2013; GeoEnergy 2020; Todorović 2023). The investigation has uncovered over 200 wells with temperatures of up to 120°C, where as the optimal level for heating of buildings is 90°C. Romania has public plans to invest 150 million euros for the construction and/or modernisation of district heating generation and distribution networks up to a total 60 MW of heat equivalent. With this plan it is expected to contribute to a decrease in greenhouse gas emissions by up to 48,000 tonnes of CO2. For example, in the area in Banat, the commune of Sandra with 3,000 inhabitants, has two boreholes and a distribution system for a school, kindergarten etc.

Most geothermal resources in Romania are used for heating, with the small geothermal power generation unit in Oradea as exception. The binary plant in Oradea is constructed in 2012 and has an installed capacity of 50 kW. The depth of the wells is between 2,700-5,000 m and the water temperature (at wellhead) is approx. 160°C and the estimated production is with a flow around 40 l/s and the estimated lifetime is more than 50 years. During summer, when the heat depleted geothermal water has a constant low temperature, it is partly used for public swimming pool, while the rest is reinjected. The geothermal heatplant was designed to supply the secondary fluid (treated water) with a temperature of 102°C , which can provide 80% of the heat demand for space heating at the design value of -15°C outer temperature , and 100% for house hot water. The peak load for space heating is supplied by two natural gas fired boilers, which increase the supply temperature of the secondary fluid up to 110°C, thus providing heating to 300 flats, i.e., 8000 people. The operating temperature of the DH is 90°C and the temperature of the geothermal resource is 104°C. The production of heating and/ or cooling is 24GWh/a. In 2021, the city announced a photovoltaic car park of 1,500 solar panels that will offset 80% of the total operational energy consumption of the geothermal plant which requires a total of 1.1 MW to operational energy. Since 2005 a geothermal heating plant has been operating in the city's Iosia district, replacing 115.000 GJ/year of lignite and natural gas which is used at the existing CHP (Nádor 2014).

Also, a geothermal project to heat public buildings has been announced in 2023 in the town of Santana in Arad County, city of 11.000 inhabitants in Romania for a cost of 5.7 million euros. It will involve the drilling of a borehole to a depth of 1200 m and of 2.7 km of pipes. In the same county there is another GHS, in Pecica, with two wells in 2022 and geothermal heat is expected to be supplied to 13 buildings. In the town Pecica the water source is at 47°C, at 730 meters adequate for heating 13 public buildings. Also, I Calimanesti, there is a geothermal heating system from a source of a depth of over 3,000 m.

In the region of Southeast Europe, studies show that ihe geothermal energy potential is primarily characterised by a relatively low-enthalpy resource base, which is more appropriate for non-power applications. As of 2020, the planned geothermal power development was at 20 MW. Binary plants allowing cooler geothermal reservoirs used for electricity generation are considered as feasible and provide potential of up to 690 MW. It is noted that the geothermal electricity potential could be deployed mainly in Romania and, to a certain extent, in Bulgaria, Croatia and Slovenia, while in the other SEE this potential is considered as marginal and uncertain.

INVESTIGATION ON SOCIAL BARRIERS FOR GEOTHERMAL PROJECTS

In order to understand social barriers related to geothermal projects a semi-structured survey was prepared and conducted among 20 experts from Macedonia and Romania. The interviewed experts are involved in sustainability assessment of buildings and are energy consultants are open for acceptance of geothermal generation.

The findings provided important understanding on recent geothermal development in Romania as well as better understanding of social barriers of geothermal projects. Several important social aspects were identified which need to be disseminated with the public in order to stimulate broader use of GHCs and increase awareness such as: the public need access to key information about geothermal energy, improved knowledge on the GHC benefits, how they operate and their general use, the cost-benefit of GHC, sound risk management plan of geothermal projects etc.

The semi-structured interview needs to be expanded towards other stakeholder groups, such as government representatives, non-governmental organizations and to a larger sample group in order to have statistically more significant results and to have an insight how different stakeholders have different viewpoints, needs and interests.

MEASURES FOR OVERCOMING SOCIAL ACCEPTANCE BARRIERS

One of the main pre-requisites for social acceptance is the prevention and minimization of undesirable effects on the environment and people. From the literature review several activities are identified for overcoming social barriers, such as: development of an environmental action plan focusing on measures necessary to avoid or minimize any undesirable effects; appropriate environmental management and design practices; procedures for ensuring compliance with health, safety and environmental standards; creation of an environmental guarantee fund (in cases of rehabilitation and compensation for damages due to the project); organization of environmental actions, (afforestation of affected, preservation of the ecosystem etc.); plan to preserve cultural sites etc. Engagement activities involving local communities are of major importance for achieving social acceptance of a geothermal power plant project, as they enhance trust. In order to achieve these objectives, the implementation of a comprehensive action plan is essential.

A socio-economic study of the area during the early stages of the project's development can contribute to overcome social barriers. Such study should include issues such as administrative boundaries, land uses and forms of ownership, population, natural resources, infrastructure, public services, sources of income, transport, cultural attractions, historical sites, energy use and demand, identification of stakeholders and their views on geothermal energy, benefits that are valued by local communities.

Engagement activities should be a fundamental step in the overall development process of a geothermal project. It is highly important to create a group of stakeholders with participation of local government, representatives from all local communities, environmental protection groups, representatives of the agricultural and business sector, etc. and all involved stakeholders should be addressed as equal. Such group should be effectively managed, with focused discussions, detailed information on geothermal energy, the project under development, as well as the opportunities and risks that accompany it. Implementation of information activities targeting all different stakeholders, i.e., local administrative bodies, government agencies, local residents, nongovernmental organizations, local organizations (consumers, residents, etc.), private enterprises, etc. It is stated that It is not possible to successfully conduct a project if the specifics of the local context which can influence its social acceptance are not identified, if there are not proper organizational, technical, economic and other solutions in order to resolve the negative opinions. Issues about the project addressed using a publicly understandable language for clear, effective and accurate communication among all associated parties. A designated project participant should be designated to communicate with all stakeholders. Careless practices should be avoided, especially at the beginning of a geothermal project, as they can lead to the creation of an initial negative view from the part of the local communities. The activities should be monitored by a group composed of local government representatives, local communities, etc., pointing out the company's willingness to run transparent operations. Successful communication strategy requires three components: carefully structured and prepared—factual information; organising a dialogue forum and providing opportunity to comprehend the level of risk in relation to the task or problem, as means of creating and sustaining trust.

ENVIRONMENTAL IMPACT OF GEOTHERMAL PROJECTS

Regarding the environmental impact, geothermal power plants (GPPs) were compared to conventional electricity generation systems according seven life cycle environmental impact indicators (global warming, acidification, eutrophication, human toxicity, ozone depletion, photochemical oxidation, and cumulative energy demand). For example, the GWP of GPPs in Turkey is, on average 60 g CO2 eq./kWh, significantly lower than lignite (1060 g CO2 eq./kWh), hard coal (1130 g CO2 eq./kWh), and natural gas (500 g CO2eq./kWh). In general the LCAs are often based on a specific location and power cycle affecting their comparability. According to a plant´s lifespan for different studies, the GWP impact varied between maintenance (80%) and construction (20%) for a life-cycle of 100 years. In the GWP emissions, about 50% is related to the manufacture of the piping system (water and steam transporting pipes, and the well production liners), and 25% comes from the fossil fuel consumption for the construction of new wells and other 20% due to the initial construction phase (i.e., piping system and the well construction). The contribution from drilling dominates the estimated GWP, ranging on one hand from 60% to 95%. The analysis of these shows that the main environmental impact comes from the construction stage and the drilling activities required to dig wells. Overall the ratio of GWP from construction to maintenance is 80% with 20% respectively, and the ratio of construction to operation is 80% to 20% respectively.

CONCLUSIONS

The results showed that the societal acceptance of geothermal power by local stakeholders was the fundamental barrier because it affected almost all other issues, such as financial, technical, and political risks. The fundamental causes of opposition were identified as follows; conservative values and beliefs, a particular risk perception of the reversibility and predictability of underground structures, and a variety of frameworks for geothermal energy utilization (Vargas Payera 2018). Promoting mutual understanding of risk management options is essential, such as risk reduction and risk transfer at times of unexpected problems, even if the risk is low (Vargas).

Another key challenge is gathering a critical mass of acceptance in the political system to introduce effective renewable energy policies. It is also relevant to combine work on socio-political acceptance with work on market acceptance. For example, gaining investor acceptance for renewable energy policies is key if these policies are to result in effective market growth (Wüstenhagen et al. 2007).

The findings suggest even when the majority of participants are agreed with geothermal project, concerns about the potential risks of the technology are present. Therefore, for overcoming the issues of social acceptance of geothermal projects it is highly important to implement successful project management plan, transparency and participatory approach, risk management strategy, as well as effective communication and dissemination plan.

ACKNOWLEDGMENT

The authors would like to acknowledge the support of the CA 18219 (Geothermal-DHC) Cost Action for the excellent research and networking possibilities.

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