



## CROWD THERMAL DELIVERABLE D1.1

# INTERNATIONAL REVIEW OF PUBLIC PERCEPTION STUDIES

### *Summary:*

Energy infrastructures are understood as socio-technical systems, which means beside the technical characteristics of a geothermal project, also the social dynamics on site have to be taken into account. In this respect, to provide knowledge about relevant acceptance factors, a literature analysis was carried out with the focus on the acceptance of geothermal projects, but also referring to experiences from other renewables. The analysis identified project-, process- and context-related factors in different countries and thus sensitises for potential social barriers and the relevance of meaningful participation and communication procedures.

### *Authors:*

Jan Hildebrand, IZES gGmbH, Head of Department Environmental Psychology  
Silke Rühmland, IZES gGmbH, Research Assistant  
Kathrin Klein, IZES gGmbH, Research Assistant

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## 1 EXECUTIVE SUMMARY

Geothermal energy is a promising technology in the category of renewable energies. With its realization, the global decarbonization of energy systems can progress. The implementation process of geothermal energy has revealed that the successful and spacious integration in local energy supply systems depends on both the technological improvement and the wide acceptance of the public, following the understanding of energy infrastructures as a socio-technical system (Stauffacher et al., 2015). To understand why geothermal energy can be controversial, the underlying aspects that influence the acceptance need to be analyzed.

In the literature review existing studies on the acceptance of geothermal projects worldwide and partly also on other renewable energies have been examined and the results on relevant influencing factors have been structured.

The dimensions on which those factors occur can generally be divided into three superordinate categories:

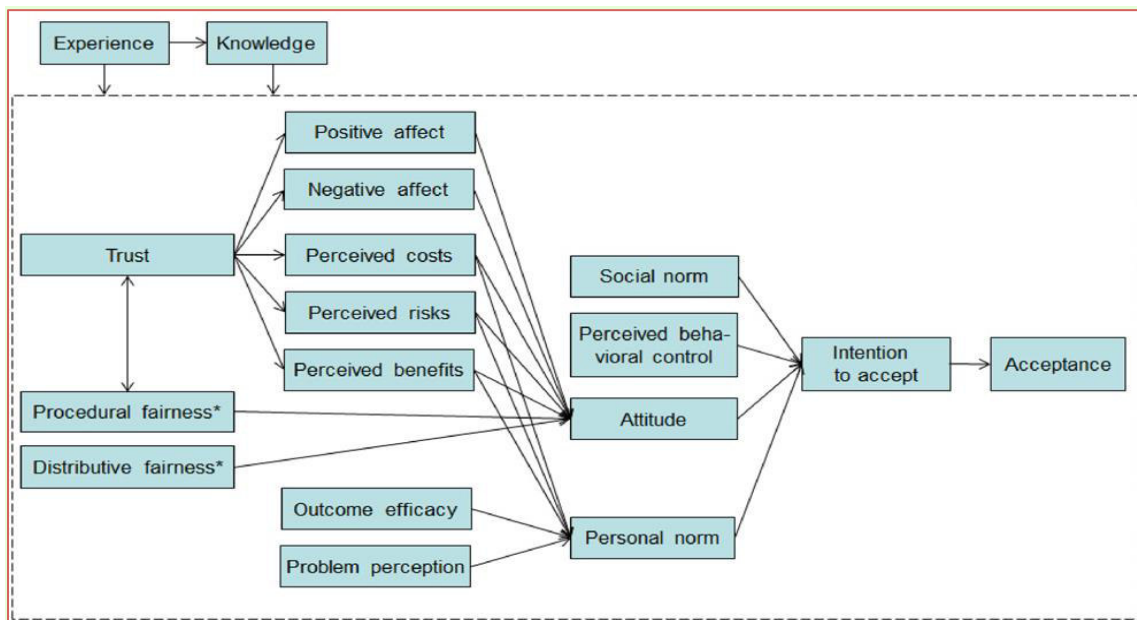
One contains those aspects that are more or less directly related to a geothermal energy project itself and the response from the (local) public in the sense of a subjective perception. Furthermore, the process of planning and permitting and related communication procedures represent a relevant dimension. Especially as the planning process is the time window in which many persons get the first time in contact with the topic and the provided information shapes attitudes and beliefs towards the energy projects, special attention should be paid on this phase. Finally, contextual influences like regional characteristics (e.g. experiences with geothermal or other energy infrastructures) and the political (energy) framework, such as national energy transition concepts are relevant as they build the frame of the respective projects.

The review provides a valuable starting point for the further project tasks, especially regarding the stakeholder and case study analysis in the CROWD THERMAL project's case studies (T1.3), the development of public engagement approaches (T1.4), and the work package "case studies" (WP5).

## 2 INTRODUCTION

New infrastructure projects mean an intervention in the familiar living environment: this applies to motorways, railway lines, as well as to (renewable) power plants. The changes associated with the infrastructure projects can be perceived and evaluated as positive or negative, the reaction depends on personal dispositions and a number of different context and project-specific factors. As projects are often facing conflicts, the question of public acceptance is increasing.

In order to benefit from existing knowledge towards public acceptance connected to geothermal projects, a literature review was carried out. As the literature review is part of the environmental psychological acceptance research within CROWD THERMAL-project, it follows the assumption that human's perceptions and behaviour as a respond to geothermal projects can only be understood by considering the social and contextual systems in which the new technology is meant to be embedded.

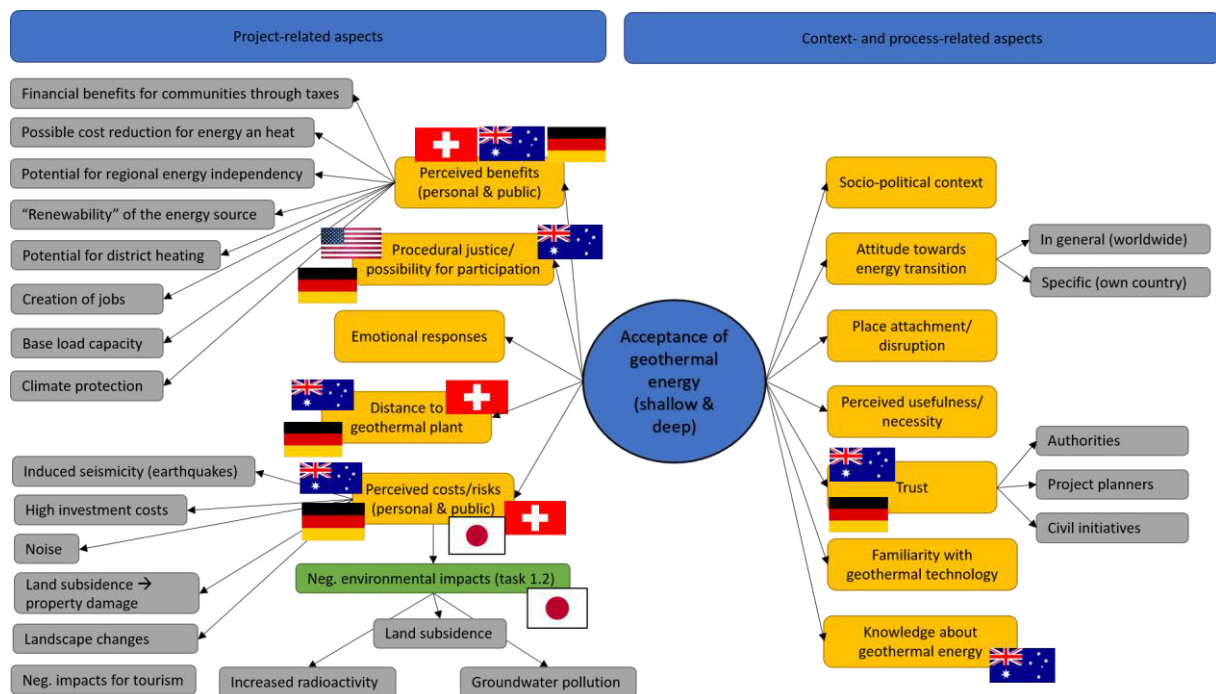


**Figure 1:** Psychological factors influencing sustainable energy technology acceptance (Huijts, Molin, & Steg (2012, S. 530)

The figure illustrates that for all attitude relevant issues like perception and evaluation of risks, cost-benefit considerations or other relevant factors, trust and credibility represent fundamental parameters, as these act as a filter for the cognitive and the affective information relevant here. In this context, the congruence and absence from contradictions between different information sources also play an important role in promoting trust. This stresses the understanding of subjective perceptions and social constructions rather than one objective truth.

### 3 RESULTS

Within the literature review, available studies on the acceptance of geothermal projects have been structured and analysed. Besides the topical focus of the studies, the review shows that a broad range of empirical methods were applied, starting from literature analyses, qualitative interviews and focus groups, standardised polls up to media analyses. Regarding the applied research design it is noticeable that most of the studies used a cross-sectional case study design, only few longitudinal studies are existing. Looking at the countries, it becomes evident that there is already broad experience existing in Australia, Switzerland, and Germany, of course in other countries, e.g. UK, is also acceptance research on geothermal projects undertaken. The following figure gives an impression of topics and studies and their national origin, a structured overview of the most relevant studies is provided in the annexe.



**Figure 2:** Schematic visualisation of studied topics on geothermal projects related to the origin

The results of the literature review illustrate the complexity of the acceptance of geothermal projects. There is not one overarching factor or a monocausal explanation but a broad range of different acceptance factors on different levels.

The dimensions on which those factors occur can generally be divided into three superordinate categories:

One contains those aspects that are more or less directly related to a geothermal energy project itself and the response from the (local) public in the sense of a subjective perception. Furthermore, the process of planning and permitting and related communication procedures represent a relevant dimension. Especially as the planning process is the time window in which many persons get the first time in contact with the topic and the provided information shapes attitudes and beliefs towards the energy projects, special attention should be paid on this phase. Finally, contextual influences like regional characteristics (e.g. experiences with geothermal or other energy infrastructures) and the political (energy) framework, such as national energy transition concepts are relevant as they build the frame of the respective projects.

In the following the chapters, the results of the review regarding relevant acceptance factors on the level of project, process, and context will be presented.

## 3.1 PROJECT-RELATED VARIABLES

### 3.1.1 Perceived Disadvantages and Advantages (cost-benefit ratio)

The social acceptance of geothermal energy is highly influenced by the perception of (material and immaterial) disadvantages and advantages of the technology. The range of costs and benefits is from potential monetary benefits such as regional value added up to perceived risks as possible costs.

Financial costs (Huijts et al., 2012) like high investment costs are to be classified as negative components. Before a geothermal power plant can be built, an appropriate reservoir needs to be found. The drilling and reinjection added, around 50% of total costs are needed for this undertaking. In this context, boreholes can count as a big financial investment (Hirschberg et al., 2015). For the further processing, pipelines and the plant itself need to be set up wherefore approximately 40% of total costs are needed. The remaining 10% of the costs are distributed over different other activities (Barbier, 2002). The financial risk of investing in a geothermal power plant is high. Whether the water extraction rate is sufficient or the temperature of the reservoir is high enough cannot be found out for sure until the first drilling has started (Muratore et al., 2016). Developers of geothermal power plants, especially when being a small or medium-sized enterprise have to take up a high financial risk as well as a long duration between the planning and the actual realization process (Kubota et al., 2013). As a consequence, to make the investment in geothermal energy systems profitable, subsidies might need to be paid during the start-up phase (Huijts et al., 2012).

Generally it is assumed that the higher the costs of geothermal energy are the less positive people are about it. Especially in countries with a lower-income population the economic aspects are the most important in terms of social acceptance of geothermal energy projects (Kepinska & Kasztelewicz, 2015).

Costs that have no direct but an indirect connection with financial issues are another category of disadvantages that come along with geothermal energy projects (Huijts et al., 2012). To individual costs count the loss of value for houses that surround a geothermal energy plant (Ziefle et al., 2015) because of its unpleasant side effects or the investment of a certain effort to understand the geothermal technology system to become able to use it (Huijts et al., 2012). The public costs reach from noise from drilling and production (Benighaus & Bleicher, 2019; Romanach & Carr-Cornish, 2013) to the impact on tourism (Borzoni et al., 2014) because of the uncertain consequences a geothermal energy plant has on the near environment (Vargas Payera, 2018) as well as the non-esthetic look of a power plant (Wallquist & Holenstein, 2015).

In Germany, geothermal energy is perceived as a risky technology (Kunze & Hertel, 2015). It has caused more protesting than wind energy and is thereby probably the most conflictive renewable energy source (Kunze & Hertel, 2017). Thus, the perception of risks is a major aspect in terms of social acceptance. Here, one of the most important factors is the risk of induced seismicity and triggering earthquakes as a consequence of the energy generation procedure (Romanach & Carr-Cornish, 2013; Benighaus & Bleicher, 2019; Çetiner et al., 2016). The seismic events in Swiss Basel 2006 and Germany Landau 2009 (Kunze & Hertel, 2017) have increased the awareness for such incidents. In this context a dreaded side effect of the public is property damage, like damage on buildings (Benighaus & Bleicher, 2019).

Besides seismic events, ground and water pollution can occur if boreholes connect different aquifers or from usage of antifreeze or other aids. Using ground heat to generate energy can lead to an imbalance provoked by temperature changes which has impacts on the prevalent chemistry and bacterial composition in the underground (Borg et al., 2018; Herrmann & Herrmann, 2013).

People are also aware of personal health risks (Shortall et al., 2015). There are certain gases that can be released during the working process on a geothermal energy plant that have the potential to cause health problems as well as environmental risks if they reach a certain level. One example would be CO<sub>2</sub> (Carbon Dioxide) that is contained in geothermal steam (Noorollahi, 1999). The accumulation to a certain concentration leads to health risks in low-lying areas around geothermal plants (Noorollahi, 1999). Still, what needs to be noted in this

regard is that the amount of CO<sub>2</sub> output of a properly functioning geothermal power plant is fundamentally lower than for other forms of energy production.

The release of hot water impacts human health as well. It contains toxic chemicals like aluminum, boron or arsenic (Wetang'ula, 2004).

The negative bearing on the near environment and vegetation is another risk factor of geothermal energy (Borzoni et al., 2014). Locals fear for the safety of ecosystems because the incomplete isolation of a geothermal system can lead to environmental pollution (Ibrohim et al., 2019). The impact on flora and fauna leads to changes in microclimate (Herrmann & Herrmann, 2013). And not to forget, the transportation of heavy equipment that is needed to drilling sites might require the buildup of roads wherefore nature loses ground (Ibrohim et al., 2019).

A lot of research concerning the risk perception of geothermal energy systems has been made. One example are Kluge and colleagues (2015). With the help of an interview with open answer format, the authors wanted to investigate what acceptance-relevant cognitions their participants had. According to the frequency participants (N = 104) mentioned certain disadvantages of geothermal energy systems the most urgent ones were costs, unknown risks and earthquakes. Interestingly, age and gender differences could be found. The group of older participants tended to have a greater perception for the unknown risks whilst the majority of younger participants referred to the costs that come along with the realization of a geothermal energy project, so a noticeable distrust of the economical benefit dominated their perception. Taking a closer look to the distribution of answers women and men were giving, there was one difference worth mentioning. Women put the fear of environmental damage on record whilst men did not (Kluge et al., 2015). Research revealed other general differences concerning sexes and risk perception. German women show a high amount of risk perception and women in general show higher amounts than men (Gustafsd, 1998).

Perceiving the disadvantages of geothermal energy systems supports a negative attitude towards it. As case studies show, if locals and the entire community can derive advantage from the buildup of the geothermal energy project, for example economic opportunities, lifestyle improvements or sharing of property, the acceptance of a deep geothermal plant is higher (Meller et al., 2018). Unsurprisingly, perceiving the benefits that geothermal energy has support a positive attitude towards it. The benefits can be divided into different categories. The potential of district heating (Vargas Payera, 2018), the potential of energy independency (Michelsen & Madlener, 2012; Michelsen & Madlener, 2013; Bleicher & Gross, 2015) the reduction of energy security problems (Huijts et al., 2012) or the creation of jobs (Pellizzzone, 2015) can be attributed to public benefits (Huijts et al., 2012). What needs to be

noted is that the creation of jobs can also come along with the fear of short time employment (Ibrohim et al., 2019) which would then undermine the positivity.

Financial aspects of geothermal energy have already been mentioned in the context of disadvantages, but there are also benefits for consumers. Geothermal energy provides possible cost reductions for energy and heat (Borzoni et al., 2014; Tsagarakis, 2019) amongst others because of increasing fuel prices (e.g. Roy et al., 2008; Hee et al., 2013; Bleicher & Gross, 2015).

Because of the reduction of CO<sub>2</sub> emissions (about 8 – 46 gram per kilowatt-hour) (Hirschberg et al., 2015) geothermal energy has a high climate protection potential (Romanach & Carr-Cornish, 2013; Borzoni et al., 2014; Tsagarakis, 2019). Furthermore obtaining geothermal energy for heating matters would make wood burning unnecessary (Vargas Payera, 2018).

The geothermic energy source is renewable (Romanach & Carr-Cornish, 2013; van Douwe & Kluge, 2014). In contrast to other renewable energy systems like wind or solar energy, geothermal energy is independent of weather conditions and therefore the predictability and reliability of a constant energy supply is given (Hirschberg et al., 2015).

The investigation of Kluge and colleagues (2015) containing 108 participants uncloaked the possibility of general age and gender differences in the perception of benefits. Younger tended to focus on the benefits centering on sustainability, the majority of middle-aged participants mostly referred to its potential to replace fossil fuels whilst the oldest group perceived the local energy supply as especially beneficial. The female attendees focused more on the benefits of the category sustainability and eco-friendliness, on the contrary men mostly referred to economical benefits.

The relation between risk and benefit perception is a widely spread topic in research. There are authors that support the hypothesis that the acceptance and realization of geothermal energy projects relies on the outmatching of the individually perceived risks due to the perception of the technological benefits (Carr-Cornish & Romanach, 2014; Huijts et al., 2012; McComas et al., 2008; Weaver et al., 2009). As an example, a finding that conforms to this hypothesis is that targeting information that contain long-term benefits of geothermal energy system usage have the potential to outweigh high installation costs and therefore result in an increased willingness to pay for geothermal energy systems (Zografakis et al., 2010; Tsagarakis, 2019). Another backing of this hypothesis comes from Kluge and Ziefle (2016) who found the arguments in favor of geothermal energy to have a greater influence on the attitude than the arguments against. Whereas previous models of acceptance research resulted in the benefits of renewable energy sources to be the most predictive factors (Knoblauch et al., 2019), the findings of Knoblauch and colleagues (2019) stated the induced

seismic risks to have the biggest importance. Another investigation by McComas et al. (2016) acknowledges the last-mentioned results. Here, participants responded that regardless of the benefits, induced seismicity would not be tolerated. Thus, when the perception of risks is high, the outweighing of risks through benefits does not fully work (Knoblauch et al., 2019).

### 3.1.2 Project characteristic on site: Distance

While planning to build a geothermal energy plant the decision where it should be sited is one of the first things to do. In this context, the acceptance of the public strongly depends on the distance between the plant and the own residence shaping the feeling of being affected. Pellizzone et al., (2016) disclosed that in the region of Viterbo (Italy) the general attitude towards geothermal energy was positive and it was perceived as a promising energy supply source. However, the positivity of sight declined when plans about building a geothermal plant in their direct environment were schemed (Schively, 2007).

An overview of statistical analyses (Knoblauch et al., 2019) shows that people prefer geothermal energy projects to be constructed in afield areas. More specific, the acceptance increases by locations about five and more kilometers away from their homes (Carr-Cornish & Romanach, 2012; Romanach & Carr-Cornish, 2013). More recent findings of Carr-Cornish & Romanach (2014) reveal that the majority of participants even wished distances from 100 kilometers and more from their homes.

When it comes to the decision where a geothermal system is supposed to be sited, having a look at the tradeoff of benefits, avoided CO<sub>2</sub> emissions and induced seismicity risk is meaningful because it reveals where the geothermal energy production is the most profitable. The advantage of siting a geothermal system in remote areas is the reduction of the risk of induced seismicity to a minimum whereas urban areas have a higher risk of induced seismicity. On the other hand, only urban areas can purposefully use the produced energy for residential district heating. Research of Knoblauch and Trutnevyte (2018) has shown that the most profitable siting area for a large enhanced geothermal system is near a large population, meaning around 10.000 to 100.000 residents. Respecting a reduced risk factor and acceptable sales a medium or large sized geothermal plant near some residential area counting 1.000 to 10.000 people is the most beneficial. Choosing remote areas is the most adverse alternative because a lack of sales would not justify the costs and efforts to build a geothermal power system. To conclude, comparing the preferences of residents with

the best objective site of a geothermal energy plant reveals that the distance the public widely accepts is not corresponding to the optimal siting area.

### 3.1.3 Emotional Responses

Emotions also need to be brought up as a central theme, strongly related to the subjectively perceived risks (see above). In terms of geothermal energy systems, affects can concern the expectation of feelings after decisions have been made (Loewenstein & Lerner, 2003; Huijts et al., 2012) or they occur in the context of thinking about the technology (Midden & Huijts, 2009; Huijts et al., 2012). As an example, Zaunbrecher and colleagues (2018) found a significant correlation between the emotional evaluation of self-drawn pictures depicting geothermal energy associations and the acceptance of this technology. The more positive the emotional rate of the drawing, the more acceptance participants stated. The more negative the drawing was rated, the less acceptance these participants showed for geothermal energy projects. Especially those drawings representing drilling and power stations were rated negatively.

Lavine et al. (1998) pointed out the importance of affects by finding them to dominate the cognitions in forming an attitude. This finding is consistent with the assumption that the feeling of trust is connected to affect and as a consequence the perception of costs, risks and benefits change correspondingly (Montijn-Dorgelo & Midden, 2008; Siegrist et al., 2007; Huijts et al., 2012). Thus more trust leads to a more positive feeling and furthermore to a more positive evaluation of costs, risks and benefits.

The outweighing of cognitions and objective facts through subjectively sensed emotions was found in further analysis. The concluded assumption is when it comes to the decision whether a technology is being accepted, negative and emotional engaged attitudes have a bigger influence than positive arguments that are mostly based on facts (Achterberg et al., 2010; Joffe, 2003; Zaunbrecher et al., 2016; Borg et al., 2018). This could be a possible explanation for the mentioned findings of Knoblauch et al. (2019) where the induced seismic events had the biggest importance for acceptance.

### 3.1.4 Place attachment/Place disruption

A strong emotional connection between a person or a group of people and specific places they live in or come to visit is a phenomenon that is called place attachment. It usually is a positive bond that can cause individuals to act (Devine-Wright & Howes, 2010; Lewicka, 2005; Manzo & Perkins, 2006), for example when it is being disrupted by planned or occurring changes (Devine-Wright & Howes, 2010). Research suggests that the opposing of

a change depends on the intensity the existing bond between an individual and a place has, meaning the stronger the bond, the more negative the attitude (Vorkinn & Riese, 2001). It is important to note that a disruption of place attachment does not always happen when changes occur. It depends on factors like the beauty of nature or the symbolic or historical meaning of the place (Devine-Wright & Howes, 2010). To illustrate, one reason locals of Mount Lawu reject the build-up of geothermal energy plants is because the region is perceived as a sacred place that should not be disturbed (Ibrohim et al., 2019). Free association data of another survey of Devine-Wright and Howes (2010) that themed disruption of place attachment through wind farming reveals a peered place to be interpreted in terms of its beauty and potential of recovery for stimulus overflooded individuals. Participants of the study stated a perceived threatening of the natural beauty and a questionnaire analysis acknowledges the suggestion of the bond's strength to determine the attitude because correlations between the stated amount of place attachment and negative interpretations of outcomes, negative emotional evaluation, negative attitude and oppositional activities were found.

## 3.2 PROCESS-RELATED VARIABLES

### 3.2.1 Procedural Justice – Participation

Besides the risk and benefit perception, the involvement of the public in the process of developing and realizing a geothermal energy project is another major aspect that has an impact on social acceptance (Reith et al., 2013). Information, participation, cooperation and transparency are the main headwords.

Spreading information before concrete planning of geothermal projects in a community and embolden the citizens to participate is needed to alleviate the social acceptance. As case studies from Illkirch-Graffenstaden and Wissembourg show, the discussion and exchange between the operator of the project and the local government lead to an increase of agreement and strengthened the coherence in terms of the project. Thereby the acceptance by the residents was facilitated (Chavot et al., 2018). In Groß-Gerau, Germany, a community engagement process consisting of three different phases was developed. The obtained data supports the assumption that people's trust and acceptance of geothermal projects can be enhanced by making sure they are fairly engaged (Wallquist & Holenstein, 2015). In contrast, cases like La Robertsau and Eckbolsheim have illustrated that imposing a geothermal project

without debating about it has potential to generate fatal misunderstandings between operators, local politicians and inhabitants (Chavot et al., 2018). All of these case studies underline the remarkableness of a fair participation in geothermal energy projects. An analysis of Kluge and Ziefle (2016) revealed that citizens not only wish for an opportunity to participate (Ziefle et al., 2015) but that the own participation is even more important than the assessment of an expert about the project.

The wish of participation is strongly connected to transparency, which was found to be one of two basis aspects in terms of a broad social acceptance of geothermal energy (Ziefle et al., 2015). The trust in the stakeholders and project actors that create transparency are the base for a broad acceptance. Therefore, an early and regular communication as well as officially known unambiguous responsibilities are indispensable for the realization of a geothermal project. Important aspects to implement this are the transfer of information and the active involvement of the residents. Active discussion forums as well as the possibility to participate in decisions help to create a local identity (Ziefle et al., 2015).

Kluge and colleagues (2015) also brought up the topic of transparency. The collection of answers to the question what transparency in communication means to them revealed that most of the people (N = 94) find the disclosure of risks, disadvantages and costs, the information in time as well as attributes like honesty and comprehensibility as very important characteristics. Furthermore they wished for expert reports and an involvement of the public in the development and decision process. Thus, how exactly the siting process is being held has an impact on how fair the entire project is perceived by the public (Krütli et al., 2010; Krütli et al., 2012) and how it reacts to it (Parthasarathy, 2010).

Last but not least, the case study of St. Gallen is a strong evidence for the importance of a transparent communication for the acceptance of a geothermal energy project (Muratore et al., 2016). St. Gallen was the biggest geothermal energy project in Switzerland. The prevailing mood of the residents concerning the geothermal energy project was generally positive, although seismic events during the drilling procedure occurred. Thus taking a look at the communication structure they followed, helpful guidelines for an effective communication in terms of geothermal energy projects can be transpired. The operators made sure the communication was based on the desires and requirements of the public. They emphasized that the released information should be easily accessible, understandable and well-adjusted to the specific needs of the local public. As a survey of local residents revealed, the communication between them and the responsible operators was perceived as elaborated and direct. Freddy Brunner, a project manager also played an important role for the entire communication process. He reacted immediately, held emotionally sweeping speeches and all in one depicted a trustful leading personality. The responsible authors for

the investigation of the case study St. Gallen (Muratore et al., 2016) underlined the importance of an open and honest risk communication without overrating the possible scenarios. To prevent a break out of panic in case a risk scenario becomes reality, methods of resolution could already be presented in advance.

### 3.2.2 Knowledge

Within planning procedures, the role of information in order to create knowledge that enables citizens to gain informed opinions is a relevant task. Generally public shows a poor amount of knowledge for renewable energy systems (Kepinska & Kasztelewicz, 2015) and there are many surveys that can confirm the lack of knowledge for geothermal energy specifically. For example the analysis of Pellizzone (2015) revealed that only 17% of participants knew what geothermal energy is and almost half of the participants were not able to say whether geothermal energy has positive or negative effects on the daily life. There seems to be neither any knowledge what geothermal energy can be used for nor what influence it has on the environment (Çetiner et al., 2016). This condition can cause recognizable problems in terms of a positive attitude towards geothermal energy systems in public because a connection of knowledge and acceptance can be assumed according to researchers like Carr-Cornish and Romanach (2014). They noticed that those participants who disagreed or were unsure about the topic had a greater probability of lower subjective knowledge of the technology whilst participants who agreed with geothermal energy from the beginning of the analysis stated higher amounts of knowledge (also compare Kluge and Ziefle, 2016). Similar results were found by a comparison of a group that was well informed about geothermal energy with a group that was not. They offered a significant difference in behavioral acceptance and attitude towards geothermics, meaning the well informed people showed a higher acceptance, a more positive attitude and more consensus with the positive arguments for geothermal energy whilst the uninformed people were less acceptant, had a more negative attitude and agreed more with the negative arguments (Kowalewski et al., 2014).

A lack of knowledge can hinder acceptance because it leads to insecurity and a skeptical attitude (Renn, 2011; Renn, 2008; Borg et al., 2018). A possible explanation why knowledge is so important for acceptance might be the influence it has on an individual's perceived behavioral control. The more they feel like they have it under control, the less distrust emerges and the less dangerous the risk is being perceived (Kowalewski et al., 2014; Kluge et al., 2015).

### 3.2.3 Trust

Trust, which has already been mentioned in the context of participation, transparency or emotion, is another factor that influences public's acceptance of geothermal energy projects. Unsurprisingly, a lack of trust in individuals that are part of the decision process of geothermal energy projects can pose the base of social conflicts (Pellizzone et al., 2016). To avoid distrust, representatives of public authorities on a national, regional or local level can implement suitable legislative frameworks or take part in building up a social infrastructure so that the frameworks are clear and comprehensible and decisions are transparent (Karytsas et al., 2019).

Sometimes, trust in project planners is unsettled. A consequence of the attempt to achieve community's acceptance is the refined publication of those projects that support an operator's position. However people can obtain information about geothermal projects from diverse sources and are thereby not dependent on the official information a responsible operator hands out, which leads to a loss of trust by the feeling of being fooled (Chavot et al., 2016).

Since the trust in energy companies or national governments can be shattered, the public rates scientists to be more competent and reliable (Pellizzone, 2015) and that they are the most trusted persons to give information about a geothermal energy project (Kluge & Ziefle, 2016).

A German-wide survey that investigated not only the perception and attitude concerning geothermal energy but as well perceived beneficial factors, risk factors, the demand on information, possible reasons for protesting and attributes of a satisfying communication via open answer format revealed trust was – next to transparency – the second basis aspect in terms of a broad social acceptance of geothermal energy (Ziefle et al., 2015). Thus for a successful implementation of a geothermal energy plant in a community, it is important to know how to act to reach resident's trust. For instance, a general advice for all involved parties would be to establish accountability of all activities around geothermal energy projects as well as actually realizing the commitments that have been made (Karytsas et al., 2019).

## 3.3 CONTEXTUAL VARIABLES

### 3.3.1 Regional context: Experience and Familiarity

Worries as well as positive thoughts about aspects of geothermal energy projects are strongly related to former experiences (Pellizzone et al., 2016), thus experience can have an

influence on how people ponder whether they generally have a positive or negative attitude towards something (Huijts et al., 2012; Schuitema et al., 2011). The case studies of Palermo and Viterbo (Pellizzone et al., 2016) serve as an example for negative experience leading to a negative attitude. In Viterbo, citizens were especially alarmed about the risk of water pollution. A link to a past experience of arsenic water contamination in Viterbo could be found. Furthermore, an explanation for locals of Palermo being more pessimistic towards new technologies could be the experience of mafia speculation in this field. Lastly, one of the risks that is perceived to be critical for the acceptance of the technology in Palermo concerns a general skepticism towards the authorities developing, constructing and managing the geothermal energy project, which might have been caused by past incidents of wind farm speculation in the city.

In case there are no former experiences or at least no negative ones, becoming familiar with the geothermal energy technology could be promising for an enhancement of acceptance. This idea of some researchers (e.g. Huijts et al., 2012) has its origin in the mere exposure effect (Zajonc, 1968). The effect describes the procedure of an individual developing a more positive evaluation of an initially neutral stimulus only by being repeatedly confronted with it. There are examples from other theme areas that reveal the positive effect familiarity has on an individual's attitude. For instance the experience with hydrogen vehicles leads to the perception of it being more save and showing a better performance (Martin et al., 2009; Huijts et al., 2012). Another investigation examining a hydrogen bus project revealed that a one year experience led to a more positive evaluation of technology's safety (Saxe et al., 2007). A further fact underlining the potential of familiarity respectively experience is that it can increase knowledge and is therefore related to it (Huijts et al., 2012). An enhanced knowledge - as described above - leads to a more positive attitude.

### 3.3.2 Socio-political context

Publics' acceptance of geothermal energy was found to be on the whole a little lower than for renewable energy sources in general. This might partially be due to the lack of governmental support in the present and the lack of mentioning in existing documents. The comparison with other renewable energy technologies reveals geothermal energy has an a priori disadvantage in these matters (Kepinska & Kasztelewicz, 2015). But from the viewpoint of the socio-political context, whether geothermal energy is accepted or not also depends on the individual environmental policy in a community, its sustainability in economic development and the consistency of local social identity. This leads to the assumption that being against geothermal energy is related to the individual social situation, what sort of

social world they belong to and how they socially identify themselves. The case of Northern Alsace suits as a good example for the listed components. Here, since oil drilling has been done for many years the residents were familiar with it and included the usage of underground resources for energy generation in their social identity. Since the planned geothermal energy project was also coherent with long term environmental policy plans of the region and the level of sustainability in economical issues was compatible with this renewable energy technology, it has been widely accepted by the residents (Chavot et al., 2018).

The role of mass media in a consisting socio-political context also needs to be noted. In case people do not bother informing themselves by own research they receive their information concerning geothermal energy through mass media. Thus media influences the discourse of a society through its role as an information provider (Stauffacher et al., 2015).

While working on a geothermal energy plant, smaller as well as larger seismic events can occur. They usually result in media attention and as a consequence of this to a negative public reaction and sometimes to the shutdown of the project. Journalists attention seems to be more drawn to negative than to positive events, thus negative stories are more discussed (Galtung & Ruge, 1965; Stauffacher et al., 2015). The research of Stauffacher and colleagues (2015) confirms this trend. They analyzed how intense deep geothermal energy has been discussed in mass media in Switzerland. They found articles about geothermal energy to increase when seismic events like the ones in Basel (2006) and St. Gallen (2013) occurred. Not only the amount of articles seems to be complied with big events in geothermal energy, but also the arguments media refers to. In 193 selected articles the quantity of arguments against geothermal energy was with a total of 795 higher than the sum of arguments in favor, counting 555. To compare, before the first big seismic event in Basel happened the number of pro arguments was higher than the ones against geothermal energy (121 versus 34 in a time span between 1997 and 2005). To investigate the frames of geothermal energy in media, the authors clustered all arguments and came to a result of four major frames namely energy transition, risks, technology and costs, whilst energy transition and risks predominated. Interestingly the two different stakeholders of industry and science focused on different aspects of geothermal energy. The industry emphasized the technological potential, scientists however focused on the risk aspects. A German media analysis of Leucht (2012) reveals a comparable alteration of perspectives on geothermal energy in media over the time. First, a positive view with focus on the potentials of the innovation dominated reporting. After the seismic event in Landau 2009 the preponderant technological angle was expanded. The perspective of a possibly dangerous innovation with technological and social risks was taken in. The media of the most recent year the analysis

took account of revealed a mitigation of the negative view point. A more ambivalent atmosphere with focus on social agreeableness dominated.

### 3.3.3 Perceived usefulness/perceived necessity within the energy system

The assumption of a person to which degree the usage of a technology enables accomplishing higher goals or challenges can be termed as perceived usefulness. Whether a technology is viewed as useful or not has a big influence on people's willingness to use it as well as on the final adoption of it (Kardooni et al., 2015; Davis, 1989; Liang & Yeh, 2009). Davis (1989) underlines the importance of the perceived usefulness of geothermal energy which is alongside the perceived ease of use and the general attitude towards using the technology part of his conceived *technology acceptance model* (TAM), an explanation approach for users' motivation. The models' classification of the different factors has found application in further research like the one of Kardooni et al. (2015). The authors posed several hypotheses with regard on perceived usefulness. It was shown that both costs and knowledge positively affected the perceived usefulness of geothermal energy significantly. Furthermore perceived usefulness itself had a positive influence on the perceived ease of use.

Taking a look at other investigations that themed perceived usefulness of geothermal energy might partly explain why public's acceptance of geothermal energy is hindered. To illustrate, Turkish students who took part in a research for assessing public's perception and acceptance of geothermal energy stated with 76.9% that they thought geothermal resources were not necessary (Çetiner et al., 2016). Locals of Mount Lawu Indonesia viewed the demand of electricity in their community was covered whereby the construction of a power plant would not be needed (Ibrohim et al., 2019).

In this respect, study results indicate that additional to the specific dimensions named above the general attitude towards energy transition has an impact on the perception of local projects (Walter, 2014). People who are critical about the process of energy transition and connected nuclear phase out, are of course more like to oppose correspondingly local renewable energy projects.

## 4 CONCLUSION

Looking at the results of the literature review, it becomes obvious that it is valid to choose a comprehensive and systemic approach in order to understand the social dynamics in the context of geothermal projects – all of the factors described above should be addressed. The complexity of factors and dimensions requires correspondingly a holistic thinking and an awareness of this multi-level interactions in order to develop adequate contextualized measures.

In this respect, the review provides a valuable starting point for the further project tasks, especially regarding the stakeholder and case study analysis in the CROWD THERMAL project's case studies (T1.3), the development of public engagement approaches (T1.4), and the work package "case studies" (WP5).

## 5 REFERENCES

- Achterberg, P., Houtman, D., van Bohemen, S., & Manevska, K. (2010). Unknowing but supportive? Predispositions, knowledge, and support for hydrogen technology in the Netherlands. *International Journal of Hydrogen Energy*, 35(12), 6075–6083. <https://doi.org/10.1016/j.ijhydene.2010.03.091>
- Barbier, E. (2002). Geothermal energy technology and current status: An overview. *Renewable and Sustainable Energy Reviews*, 6(1–2), 3–65. [https://doi.org/10.1016/S1364-0321\(02\)00002-3](https://doi.org/10.1016/S1364-0321(02)00002-3)
- Benighaus, C., & Bleicher, A. (2019). Neither risky technology nor renewable electricity: Contested frames in the development of geothermal energy in Germany. *Energy Research & Social Science*, 47, 46–55. <https://doi.org/10.1016/j.erss.2018.08.022>
- Bleicher, A., & Gross, M. (2015). User motivation, energy prosumers, and regional diversity: Sociological notes on using shallow geothermal energy. *Geothermal Energy*, 3(1), 12. <https://doi.org/10.1186/s40517-015-0032-6>
- Borg, A., Jakobs, E.-M., & Ziefle, M. (2018). Kommunikation und Akzeptanz. In M. Bauer, W. Freeden, H. Jacobi, & T. Neu (Hrsg.), *Handbuch Oberflächennahe Geothermie* (S. 691–713). Springer Berlin Heidelberg. [https://doi.org/10.1007/978-3-662-50307-2\\_23](https://doi.org/10.1007/978-3-662-50307-2_23)
- Borzoni, M., Rizzi, F., & Frey, M. (2014). Geothermal power in Italy: A social multi-criteria evaluation. *Renewable Energy*, 69, 60–73. <https://doi.org/10.1016/j.renene.2014.03.026>
- Carr-Cornish, S., & Romanach, L. (2012). Exploring community views toward geothermal energy technology in Australia. *CSIRO, Pullenvale, Australia*, 22.
- Carr-Cornish, S., & Romanach, L. (2014). Differences in Public Perceptions of Geothermal Energy Technology in Australia. *Energies*, 7(3), 1555–1575. <https://doi.org/10.3390/en7031555>
- Çetiner, Z. S., Ertekin, C., & Gültay, B. (2016). Initial Assessment of Public Perception and Acceptance of Geothermal Energy Applications in Çanakkale, NW Turkey. *Energy Procedia*, 97, 194–201. <https://doi.org/10.1016/j.egypro.2016.10.052>
- Chavot, P., Heimlich, C., Masseran, A., Serrano, Y., Zounggrana, J., & Bodin, C. (2018). Social shaping of deep geothermal projects in Alsace: Politics, stakeholder attitudes and local democracy. *Geothermal Energy*, 6(1), 26. <https://doi.org/10.1186/s40517-018-0111-6>
- Chavot, P., Masseran, A., & Serrano, Y. (2016). Information and public consultation exercises concerning geothermal projects. “The Strasbourg case”. *European Geothermal Congress 2016, Strasbourg, France*.
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319. <https://doi.org/10.2307/249008>
- Devine-Wright, P., & Howes, Y. (2010). Disruption to place attachment and the protection of restorative environments: A wind energy case study. *Journal of Environmental Psychology*, 30(3), 271–280. <https://doi.org/10.1016/j.jenvp.2010.01.008>

- Galtung, J., & Ruge, M. H. (1965). The Structure of Foreign News: The Presentation of the Congo, Cuba and Cyprus Crises in Four Norwegian Newspapers. *Journal of Peace Research*, 2(1), 64–90. <https://doi.org/10.1177/002234336500200104>
- Gustafsson, P. E. (1998). Gender Differences in Risk Perception: Theoretical and Methodological Perspectives. *Risk Analysis*, 18(6), 805–811. <https://doi.org/10.1111/j.1539-6924.1998.tb01123.x>
- Hee, C., A., Wedding, C., & Urlaub, I. (2013). Motivations and behaviors of solar PV and geothermal system owners in North Carolina, online publication. Available via NC Sustainable Energy Association (NCSEA), [http://c.ymcdn.com/sites/www.energync.org/resource/resmgr/Resources\\_Page/NCSEA\\_solarpvgeo.pdf](http://c.ymcdn.com/sites/www.energync.org/resource/resmgr/Resources_Page/NCSEA_solarpvgeo.pdf)
- Herrmann, V., & Herrmann, R. A. (2013). Geotechnische Risiken bei der Herstellung von Erdwärmesonden- Bohrungen: Lösungen durch „Geothermische Kategorien“? 19. Tagung für Ingenieurgeologie mit Forum für junge Ingenieurgeologen, München.
- Hirschberg, S., Wiemer, S., & Burgherr, P. (Hrsg.). (2015). *Energy from the earth: Deep geothermal as a resource for the future?* VDF Hochschulverlag an der ETH Zürich.
- Huijts, N. M. A., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews*, 16(1), 525–531. <https://doi.org/10.1016/j.rser.2011.08.018>
- Ibrohim, A., Prasetyo, R. M., & Rekinagara, I. H. (2019). Understanding Social Acceptance of Geothermal Energy: A Case Study from Mt. Lawu, Indonesia. *IOP Conference Series: Earth and Environmental Science*, 254, 012009. <https://doi.org/10.1088/1755-1315/254/1/012009>
- Joffe, H. (2003). Risk: From perception to social representation. *British Journal of Social Psychology*, 42(1), 55–73. <https://doi.org/10.1348/014466603763276126>
- Kardooni, R., Yusoff, S. B., & Kari, F. B. (2015). Renewable energy technology acceptance in Peninsular Malaysia. *Energy Policy*, 88, 1–10. <https://doi.org/10.1016/j.enpol.2015.10.005>
- Karytsas, S., Polyzou, O., Mendrinou, D., & Karytsas, C. (2019). *Towards social acceptance of geothermal energy power plants*. Center for Renewable Energy Sources and Saving (CRESS).
- Kepinska, B., & Kasztelewicz, A. (2015). *Public Perception of Geothermal Energy in Selected European Countries*. Mineral and Energy Economy Research Institute of the Polish Academy of Sciences.
- Kluge, J., Kowalewski, S., & Ziefle, M. (2015). Inside the User's Mind – Perception of Risks and Benefits of Unknown Technologies, Exemplified by Geothermal Energy. In V. G. Duffy (Hrsg.), *Digital Human Modeling. Applications in Health, Safety, Ergonomics and Risk Management: Human Modeling* (Bd. 9184, S. 324–334). Springer International Publishing. [https://doi.org/10.1007/978-3-319-21073-5\\_33](https://doi.org/10.1007/978-3-319-21073-5_33)
- Kluge, J., & Ziefle, M. (2016). As Simple as Possible and as Complex as Necessary. In F. F.-H. Nah & C.-H. Tan (Hrsg.), *HCI in Business, Government, and Organizations: Information Systems* (Bd. 9752, S. 171–182). Springer International Publishing. [https://doi.org/10.1007/978-3-319-39399-5\\_17](https://doi.org/10.1007/978-3-319-39399-5_17)

- Knoblauch, T. A. K., & Trutnevyte, E. (2018). Siting enhanced geothermal systems (EGS): Heat benefits versus induced seismicity risks from an investor and societal perspective. *Energy*, 164, 1311–1325. <https://doi.org/10.1016/j.energy.2018.04.129>
- Knoblauch, T. A. K., Trutnevyte, E., & Stauffacher, M. (2019). Siting deep geothermal energy: Acceptance of various risk and benefit scenarios in a Swiss-German cross-national study. *Energy Policy*, 128, 807–816. <https://doi.org/10.1016/j.enpol.2019.01.019>
- Kowalewski, S., Borg, A., Kluge, J., Himmel, S., Trevisan, B., Ziefle, M., & Jakobs, E.-M. (2014). Modeling the Influence of Human Factors on the Perception of Renewable Energies. Taking Geothermics as Example. *Proceedings of the 5th International Conference on Applied Human Factors and Ergonomics AHFE*.
- Krütli, P., Stauffacher, M., Flüeler, T., & Scholz, R. W. (2010). Functional- dynamic public participation in technological decision- making: Site selection processes of nuclear waste repositories. *Journal of Risk Research*, 13(7), 861–875. <https://doi.org/10.1080/13669871003703252>
- Krütli, P., Stauffacher, M., Pedolin, D., Moser, C., & Scholz, R. W. (2012). The Process Matters: Fairness in Repository Siting For Nuclear Waste. *Social Justice Research*, 25(1), 79–101. <https://doi.org/10.1007/s11211-012-0147-x>
- Kubota, H., Hondo, H., Hienuki, S., & Kaieda, H. (2013). Determining barriers to developing geothermal power generation in Japan: Societal acceptance by stakeholders involved in hot springs. *Energy Policy*, 61, 1079–1087. <https://doi.org/10.1016/j.enpol.2013.05.084>
- Kunze, C., & Hertel, M. (2015). Tiefe Geothermie - von hohen Erwartungen zur Risikotechnologie. *GAIA - Ecological Perspectives for Science and Society*, 24(3), 169–173. <https://doi.org/10.14512/gaia.24.3.8>
- Kunze, C., & Hertel, M. (2017). Contested deep geothermal energy in Germany—The emergence of an environmental protest movement. *Energy Research & Social Science*, 27, 174–180. <https://doi.org/10.1016/j.erss.2016.11.007>
- Lavine, H., Thomsen, C. J., Zanna, M. P., & Borgida, E. (1998). On the Primacy of Affect in the Determination of Attitudes and Behavior: The Moderating Role of Affective-Cognitive Ambivalence. *Journal of Experimental Social Psychology*, 34(4), 398–421. <https://doi.org/10.1006/jesp.1998.1357>
- Leucht, M. (2012). *Medienresonanzanalyse zu Projekten der tiefen Geothermie in Landau, Bruchsal, Brühl und Unterhaching* (S. 122). EIFER - Europäisches Institut für Energieforschung.
- Lewicka, M. (2005). Ways to make people active: The role of place attachment, cultural capital, and neighborhood ties. *Journal of Environmental Psychology*, 25(4), 381–395. <https://doi.org/10.1016/j.jenvp.2005.10.004>
- Liang, T.-P., & Yeh, Y.-H. (2009). Situational Effects on the Usage Intention of Mobile Games. In C. Weinhardt, S. Luckner, & J. Stöber (Hrsg.), *Designing E-Business Systems. Markets, Services, and Networks* (Bd. 22, S. 51–59). Springer Berlin Heidelberg. [https://doi.org/10.1007/978-3-642-01256-3\\_5](https://doi.org/10.1007/978-3-642-01256-3_5)
- Loewenstein, G., & Lerner, J. S. (2003). The role of affect in decision making. In *Handbook of Affective Sciences*. Oxford University Press.

- Manzo, L. C., & Perkins, D. D. (2006). Finding Common Ground: The Importance of Place Attachment to Community Participation and Planning. *Journal of Planning Literature*, 20(4), 335–350. <https://doi.org/10.1177/0885412205286160>
- Martin, E., Shaheen, S. A., Lipman, T. E., & Lidicker, J. R. (2008). *Behavioral response to hydrogen fuel cell vehicles and refueling: a comparative analysis of short- and long-term exposure*. In: Transportation Research Board 88<sup>th</sup> annual meeting. 2009.
- McComas, K. A., Besley, J. C., & Yang, Z. (2008). Risky Business: Perceived Behavior of Local Scientists and Community Support for Their Research. *Risk Analysis*, 28(6), 1539–1552. <https://doi.org/10.1111/j.1539-6924.2008.01129.x>
- McComas, K. A., Lu, H., Keranen, K. M., Furtney, M. A., & Song, H. (2016). Public perceptions and acceptance of induced earthquakes related to energy development. *Energy Policy*, 99, 27–32. <https://doi.org/10.1016/j.enpol.2016.09.026>
- Meller, C., Schill, E., Bremer, J., Kolditz, O., Bleicher, A., Benighaus, C., Chavot, P., Gross, M., Pellizzone, A., Renn, O., Schilling, F., & Kohl, T. (2018). Acceptability of geothermal installations: A geoethical concept for GeoLaB. *Geothermics*, 73, 133–145. <https://doi.org/10.1016/j.geothermics.2017.07.008>
- Michelsen, C. C., & Madlener, R. (2012). Homeowners' preferences for adopting innovative residential heating systems: A discrete choice analysis for Germany. *Energy Economics*, 34(5), 1271–1283. <https://doi.org/10.1016/j.eneco.2012.06.009>
- Michelsen, C. C., & Madlener, R. (2013). Motivational factors influencing the homeowners' decisions between residential heating systems: An empirical analysis for Germany. *Energy Policy*, 57, 221–233. <https://doi.org/10.1016/j.enpol.2013.01.045>
- Midden, C. J. H., & Huijts, N. M. A. (2009). The Role of Trust in the Affective Evaluation of Novel Risks: The Case of CO<sub>2</sub> Storage. *Risk Analysis*, 29(5), 743–751. <https://doi.org/10.1111/j.1539-6924.2009.01201.x>
- Montijn-Dorgelo, F. N. H., & Midden, C. J. H. (2008). The role of negative associations and trust in risk perception of new hydrogen systems. *Journal of Risk Research*, 11(5), 659–671. <https://doi.org/10.1080/13669870801967218>
- Muratore, S., Müller, S., Kulla, H., Knüsel, B., Allemann, L., de Martino, A., Meier, N., Stoudmann, N., & Tschan, D. (2016). Tiefengeothermie: Das Projekt St.Gallen. *ETH Zürich*, 40.
- Noorollahi, Y. (1999). H<sub>2</sub>S and CO<sub>2</sub> dispersion modelling for the Nesjavellir geothermal power plant, S-Iceland and preliminary geothermal environmental impact assessment for the Theistareykir area, NE-Iceland. *The United Nations University*, 38.
- Parthasarathy, S. (2010). Breaking the expertise barrier: Understanding activist strategies in science and technology policy domains. *Science and Public Policy*, 37(5), 355–367. <https://doi.org/10.3152/030234210X501180>
- Pellizzone, A. (2015). Exploring public engagement with geothermal energy in southern Italy\_ A case study. *Energy Policy*, 11.
- Pellizzone, A., Allansdottir, A., Manzella, A., Franco, R. D., & Muttoni, G. (2016). Geothermal energy, Social Acceptance and Responsibility in Italy: Two case. *European Geothermal Congress*, 8.
- Reith, S., Kölbel, T., Schlagermann, P., Pellizzone, A., & Allansdottir, A. (2013). *Deliverable 4.4 Report on public acceptance of geothermal electricity production April 2013*. Intelligent Energy Europe.

- Renn, O. (2008). *Risk Communication: Insights and Requirements for Designing Successful Communication Programs on Health and Environmental Hazards*. In: Heath, R.L., O'Hair, D. (Hrsg.) *Handbook of Risk and Crisis Communication*, S. 80-98.
- Renn, O. (2011). The social amplification/attenuation of risk framework: Application to climate change: Social amplification/attenuation of risk framework. *Wiley Interdisciplinary Reviews: Climate Change*, 2(2), 154–169. <https://doi.org/10.1002/wcc.99>
- Romanach, L., & Carr-Cornish, S. (2013). *Societal Acceptance of Geothermal Energy Technology in Australia: Media Portrayals and Public Perceptions*. CSIRO Earth Sciences and Resource Engineering, CSIRO Energy Flagship.
- Roy, R., Caird, S., & Abelman, J. (2008). YIMBY Generation—Yes in my back yard! UK householders pioneering microgeneration heat. *The Energy Saving Trust, London, UK*.
- Saxe, M., Folkesson, A., & Alvfors, P. (2007). A follow-up and conclusive report on the attitude towards hydrogen fuel cell buses in the CUTE project—From passengers in Stockholm to bus operators in Europe. *International Journal of Hydrogen Energy*, 32(17), 4295–4305. <https://doi.org/10.1016/j.ijhydene.2007.07.050>
- Schively, C. (2007). Understanding the NIMBY and LULU Phenomena: Reassessing Our Knowledge Base and Informing Future Research. *Journal of Planning Literature*, 21(3), 255–266. <https://doi.org/10.1177/0885412206295845>
- Schuitema, G., Steg, L., & van Kruining, M. (2011). When Are Transport Pricing Policies Fair and Acceptable? *Social Justice Research*, 24(1), 66–84. <https://doi.org/10.1007/s11211-011-0124-9>
- Shortall, R., Davidsdottir, B., & Axelsson, G. (2015). Geothermal energy for sustainable development: A review of sustainability impacts and assessment frameworks. *Renewable and Sustainable Energy Reviews*, 44, 391–406. <https://doi.org/10.1016/j.rser.2014.12.020>
- Siegrist, M., Cousin, M.-E., Kastenholz, H., & Wiek, A. (2007). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite*, 49(2), 459–466. <https://doi.org/10.1016/j.appet.2007.03.002>
- Stauffacher, M., Muggli, N., Scolobig, A., & Moser, C. (2015). Framing deep geothermal energy in mass media: The case of Switzerland. *Technological Forecasting and Social Change*, 98, 60–70. <https://doi.org/10.1016/j.techfore.2015.05.018>
- Tsagarakis, K. P. (2019). Shallow geothermal energy under the microscope: Social, economic, and institutional aspects. *Renewable Energy*, 147, 2801–2808. <https://doi.org/10.1016/j.renene.2019.01.004>
- van Douwe, A., & Kluge, J. (2014). Akzeptanz, Information und Kommunikation—Grundlagen für den Erfolg geothermischer Projekte. *bbr - Leitungsbau Brunnenbau Geothermie*, 48–52.
- Vargas Payera, S. (2018). Understanding social acceptance of geothermal energy: Case study for Araucanía region, Chile. *Geothermics*, 72, 138–144. <https://doi.org/10.1016/j.geothermics.2017.10.014>
- Vorkinn, M., & Riese, H. (2001). Environmental Concern in a Local Context: The Significance of Place Attachment. *Environment and Behavior*, 33(2), 249–263. <https://doi.org/10.1177/00139160121972972>

- Wallquist, L., & Holenstein, M. (2015). Engaging the Public on Geothermal Energy. *Risk Dialogue Foundation*.
- Walter, G. (2014). Determining the local acceptance of wind energy projects in Switzerland: The importance of general attitudes and project characteristics. *Energy Research & Social Science*, 4, S. 78–88
- Weaver, D. A., Lively, E., & Bimber, B. (2009). Searching for a Frame: News Media Tell the Story of Technological Progress, Risk, and Regulation. *Science Communication*, 31(2), 139–166. <https://doi.org/10.1177/1075547009340345>
- Wetang'ula, G. N. (2004). *Assessment of geothermal wastewater disposal effects: Case studies: Nesjavellir (Iceland) and Olkaria (Kenya) fields: MSc thesis, Faculty of Science - Department of Biology, University of Iceland*. UNU Geothermal Training Programme. <http://books.google.com/books?id=wwVPAQAAIAAJ>
- Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology Monographs*, 9 (2, Pt. 2).
- Zaunbrecher, B. S., Kluge, J., & Ziefle, M. (2018). Exploring Mental Models of Geothermal Energy among Laypeople in Germany as Hidden Drivers for Acceptance. *Journal of Sustainable Development of Energy, Water and Environment Systems*, 6(3), 446–463. <https://doi.org/10.13044/j.sdewes.d5.0192>
- Zaunbrecher, B. S., Stieneker, M., De Doncker, R. W., & Ziefle, M. (2016). Does Transmission Technology Influence Acceptance of Overhead Power Lines? An Empirical Study: *Proceedings of the 5th International Conference on Smart Cities and Green ICT Systems*, 189–200. <https://doi.org/10.5220/0005802801890200>
- Ziefle, M., Jakobs, E.-M., Kluge, J., Trevisan, B., Reimer, E., & Wirtz-Brückner, S. (2015). *PR bottom up: Tiefe Geothermie—Akzeptanz und Kommunikation einer innovativen Technologie (TIGER)* (S. 45).
- Zografakis, N., Sifaki, E., Pagalou, M., Nikitaki, G., Psarakis, V., & Tsagarakis, K. P. (2010). Assessment of public acceptance and willingness to pay for renewable energy sources in Crete. *Renewable and Sustainable Energy Reviews*, 14(3), 1088–1095. <https://doi.org/10.1016/j.rser.2009.11.009>

## 6 ANNEXE

In the annexe a structured overview of the most relevant studies of the review is provided.

## Study Review

reference (article, project report, etc.)	type of geothermal energy (shallow, deep, hybrid)	relevant technical aspects (Hot Dry Rock-HDR; Enhanced Geothermal Systems- EGS, etc.)	country	empirical-methodical orientation (qualitative, quantitative)	type of analysis (trend analysis, meta analysis, national study, project specific study)	spatial level (concrete project, regional or supra-regional)	time level (cross-sectional study, longitudinal study)	research subjects (investors, project manages, public, etc.)	most important content (perceptions of geothermal energy, perceived risks, benefits, etc. - see mind map: specified according to the stakeholder)
Benighaus, C., & Bleicher, A. (2019). Neither risky technology nor renewable electricity: Contested frames in the development of geothermal energy in Germany. <i>Energy Research &amp; Social Science</i> , 47, 46–55. <a href="https://doi.org/10.1016/j.erss.2018.08.022">https://doi.org/10.1016/j.erss.2018.08.022</a>	exploration drillings for deep geothermal	if successful exploration drillings then: engineered geothermal systems	Germany	focus groups (quali)	project specific study	regional (two communities where drilling of exploration wells were planned)	cross-sectional	representatives from local and regional politics (e.g. mayors), the corporate sector, municipal energy suppliers, non-governmental organizations (NGOs), interested citizens	one region was a former mining region: Emerging technology frame was referred to the most -> support the idea that an innovative technologies exploiting underground resources; environmental frame was attractive for interested citizens  Other region: Within the group of interested citizens the risk frame was dominant; group of politicians have no clear frame preference
Bleicher, A., & Gross, M. (2015). User motivation, energy prosumers, and regional diversity: sociological notes on using shallow geothermal energy. <i>Geothermal Energy</i> , 3(1), 147. <a href="https://doi.org/10.1186/s40517-015-0032-6">https://doi.org/10.1186/s40517-015-0032-6</a>	shallow	---	Germany (other EU countries)	interviews (quali)	meta analysis	supra-regional	cross-sectional	mainly results from homeowners ; expert interviews with homeowners, employees of the municipal and regional administration, representatives of drilling companies, engineers, architects,	reference to articles dealing with shallow geothermal energy and user motivation
									Perceived as environmentally friendly technology; economical aspects (consideration of electricity bill, operational costs); financial incentives are not that important for decision-making; wish to be independent from the existing energy system; technology enthusiasts; post-materiel values
									Due to the specific geology and individual facility needs each pump installation especially designed -> co-design
Borzoni, M., Rizzi, F., & Frey, M. (2014). Geothermal power in Italy: A social multi-criteria evaluation. <i>Renewable Energy</i> , 69, 60–73. <a href="https://doi.org/10.1016/j.renene.2014.03.026">https://doi.org/10.1016/j.renene.2014.03.026</a>	shallow and deep	shallow (dry steam power plant); deep (flash steam technology with partial geofluid re-injection)	Italy	social multi criteria evaluation - SMCE (quanti)	project specific study	regional (several communities in Tuscany)	cross-sectional	Regional government, investor, local authorities, residents association, environmental NGO, regional network of associations, representatives and city Council, local branch of left-wing party	This paper intends to show the potential use of a social multi criteria evaluation (SMCE) in managing problems related with conflicts arising around geothermal power. Several alternatives were tested and evaluated.
									Region government was in favour of the new power plant due to possible achievement of their targets for renewable energy
									Local authority was in favour of new geothermal power plant, because they are interested in closing a power plant that emits a lot of air pollution; another local authority was opposed to new plants due to the impact on important tourism sector; another local authority was in favour of the new geothermal power plant, because of the possibility of the development of small companies that could access low-cost sources of heat; another local authority was worried about the new power plant due to
									Residents associations were worried about ecological impacts on water (pollution); exploitation of high enthalpy resources may provoke geothermal fluid discharges; negative visual impact when further power plants are built; emissions may affect human health; geothermal power plants does not stimulate the economic development for the area
Carr-Cornish, S., & Romanach, L. (2012). Exploring community views toward geothermal energy technology in Australia. CSIRO, Pullenvale, Australia.	geothermal energy as a whole	---	Australia	questionnaire (quant), discussion (quali)	frequency analysis (summarizing the responses); comparative analysis (t-test to analyze difference before and after information)	regional (Brisbane)	cross-sectional	members of the general public	Party was worried about the environmental impact that the construction The majority of participants were receptive to geothermal technologies and projects being developed in Australia. Providing participants with science-based information and group discussion had a positive effect on participants support for the technology. Participants had many questions concerning the engineering of geothermal systems and the potential for negative impacts. Participants agreed with general community to be consulted regarding the implementation of specific technologies in the local context
Carr-Cornish, S., & Romanach, L. (2014). Differences in Public Perceptions in Geothermal Energy Technology in Australia. <i>Energies</i> , 7(3), 1555–1575. <a href="https://doi.org/10.3390/en7031555">https://doi.org/10.3390/en7031555</a>	geothermal energy as a whole	---	Australia	mix-method design: online focus groups (quali); pre-/ post- questionnaire (quanti)	national study	supra-regional	cross-sectional	citizens	general agreement to use geothermal energy by participants
									Participants that disagreed or were unsure, were more likely to report lower subjective knowledge of the technology, lower perceived benefits and higher risks, and were less likely to believe people in their community would have the opportunity to participate in consultation.
									Overall, participants that agreed with the technology both at the start and end of the online focus groups were more likely to be male, rate their knowledge as high, report stronger agreement with the technology's benefits and less agreement with the risks. They also indicated the technology could be located closer to their community.
									Similar to the risk assessment literature, the findings showed that support for geothermal energy technology is dependent on an individual's perception of the technology benefits outweighing the risks [16,17,26]. 16 - Huijts, N.M.A.; Molin, E.J.E.; Steg, L. Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. <i>Renew. Sustain. Energy Rev.</i> 2012, 16, 525–531.; 17- McComas, K.A.; Besley, J.C.; Yang, Z. Risky business: Perceived behaviour of
									perceived risks included seismicity, water usage and pollution; benefits identified by participants were mainly global in nature such as geothermal being a low emission energy technology
Çetiner, Z. S., Ertekin, C., & Gültay, B. (2016). Initial Assessment of Public Perception and Acceptance of Geothermal Energy Applications in Canakkale, NW Turkey. <i>Energy Procedia</i> , 97, 194–201. <a href="https://doi.org/10.1016/j.egypro.2016.10.052">https://doi.org/10.1016/j.egypro.2016.10.052</a>	geothermal energy as a whole	---	Turkey	interviews (quali), questionnaire (quanti)	project specific study	regional (Canakkale)	cross-sectional	students from local university	majority of focus group participants would prefer that geothermal projects be located at least 100 km away from their community
									Additionally, the "Disagree" and "Unsure" participants also reported less agreement with the notion that people in their community would have an opportunity to participate in decisions about such projects.
									60% of participants rated that geothermal energy is a kind of renewable energy
									70% of participants rated that geothermal energy is not unnecessary; students reported a lack of knowledge regarding the technology and its impact on the environment
									75% of participants thought that geothermal energy triggers earthquakes
									universities were the most reliable source of information about geothermal energy (51.6%). Other reliable sources
									upstream discussion and partnerships between operator and municipal government have reinforced the coherence of the project with local policy, which may have facilitated its acceptance by the local population; on the opposite: imposing geothermal projects without prior debate, merely invoking energy transition has generated lasting, and sometimes violent misunderstandings between operators, local elected officials and residents. => "It appears overall that

Chavot, P., Heimlich, C., Masseran, A., Serrano, Y., Zoungrana, J., & Bodin, C. (2018). Social shaping of deep geothermal projects in Alsace: politics, stakeholder attitudes and local democracy. <i>Geothermal Energy</i> , 6(1), 299. <a href="https://doi.org/10.1186/s40517-018-0111-6">https://doi.org/10.1186/s40517-018-0111-6</a>	deep geothermal energy	—	France	interviews, media analysis, public inquiries (quali)	project specific study	regional (north Alsace and around Strasbourg)	cross-sectional	34 stakeholders from 2015 to 2017: investigating commissioners, representatives of residents' and environmental groups, operators, scientists, elected officials of the municipalities affected by the projects and representatives of the EMS and prefecture.	<p>IN THE FIRST PLACE, GEOTHERMAL ENERGY HAS LONG-LASTING environmental policies and actions and sustainable economic development, consistent with local social identity"; opposite, in the western municipalities of EMS, the geothermal project "disrupts the local communities' sets of values, practices and engagements, starting with the attachment to local democracy and to the right to have a say in environment and urban development projects." =&gt; "this diversity of social meanings given to the project is a source of conflict."</p> <p>"the reasons to oppose a project are not to be seen as irrational fear regarding the risks induced by drilling or as a type of NIMBY selfishness fuelled by ignorance of the technical or/and ecological specifics of the projects. Rather, they are related to each stakeholder's social situation, their inscription in different social worlds and their social identity"</p> <p>"For the inhabitants, opposing a geothermal project is a matter of protecting their territory, preserving a lifestyle and an environment, and, for local elected officials, it is about reaffirming the sovereignty of their communities and deciding the future of their region."</p>
Chavot, P., Masseran, A., & Serrano, Y. (Sep. 2016). Information and public consultation exercises concerning geothermal projects. "The Strasbourg case" (European Geothermal Congress). Strasbourg, France.	deep geothermal energy	—	France	interviews, media analysis, public inquiries (quali)	project specific study	regional (Strasbourg)	cross-sectional	22 interviews (2015): scientists, industrial operators and industry partners, representatives of pro- or opposing associations, elected officials, IC and experts requested by the	<p>"the promoters may only be handing out information in order for their projects to be accepted, projects from which they will draw benefits. Hence, the critical questions of local residents reflect", a lack of confidence in project promoters (operators and policy-makers) develops</p> <p>"more information does not necessarily lead to a more positive attitude towards the projects"</p>
Chavot, P., Masseran, A., Bodin, C., Heimlich, C., Serrano, Y., & Zoungrana, J. (June 2019). Public perception of geothermal projects in Alsace: between energy transition and territorial rooting (European Geothermal Congress). Den Haag, The Netherlands.	deep geothermal energy	—	France	interviews, media analysis, public inquiries (quali)	project specific study	regional (Alsace)	cross-sectional	participants were inhabitants of four neighbouring municipalities (surrounding of the geothermal projects)	<p>One third of the participants were aware of the local project; "even though the project was subject to upstream consultation, that consultation does not seem to have affected a large part of the population"</p> <p>most positive rate: Geothermal technology is seen a future technology that is more environmentally friendly than other energy sources vs. most negative rate: Geothermal technology is not yet mature due to the uncertainty of risks that come with the technology - ground movement, seismicity, damaged buildings</p> <p>Residents who know about a geothermal project nearby are not always aware of the power generating potential of this technology or of the additional costs incurred by the production process</p> <p>Risk perception of geothermal technology - cracks in dwellings (most important), seismicity (second important), slow ground the formation (third important), incidents cheering drillings (fourth important), groundwater pollution, other types of pollution (least important)</p> <p>Participants who are aware of geothermal projects place more importance on certain risks</p> <p>Identification of channels through that's the population is getting informed: Traditional media (newspaper, radio, local TV) was most important, municipal information source was second important, via associations was third important and discussions with friends and colleagues is detected as least important</p> <p>Credibility of sources/ stakeholders: Scientists are seen as the most trustworthy; industrial stakeholders and municipalities are also widely trusted due to their long-term relationship of the companies or people with the residence; but when information on risks are rated respondents shift their trust towards the scientists and environmental protection associations</p> <p>a small part of results of the TIGER project are shown</p>
van Douwe, A., & Kluge, J. (2014). Akzeptanz, Information und Kommunikation - Grundlagen für den Erfolg geothermischer Projekte (Spezial Geotherm). bbr, 2, pp. 48–52.	deep geothermal energy	—	Germany	interview (quali)	project specific study	regional (Oberrhein und Bayerische Molasse)	cross-sectional	residents of the region were geothermal projects are planned	<p>Advantages of the deep geothermal technology or aspects of the German energy transition, geothermal technologies seen as a renewable energy source, regional energy supply, fostering renewable energies</p> <p>Disadvantages of geothermal technology are seen because of uncertain risks and costs, seismicity</p> <p>90% of the participants said that deep geothermal energy is seen as a sensible energy source in Germany</p> <p>46-67.65% of the 68 participants did not know what deep geothermal energy is</p>
Hee, C. A., Weeding, C., & Orland, J. (2013). Motivations and behaviors of solar PV and geothermal system owners in North Carolina, online publication. Available via <i>NC Sustainable Energy Association (NCSEA)</i> , <a href="http://c.ymcdn.com/sites/www.energy.nc.org/resource/resmgr/Resources_Research/ncseasurvey.pdf">http://c.ymcdn.com/sites/www.energy.nc.org/resource/resmgr/Resources_Research/ncseasurvey.pdf</a>	geothermal energy as a whole	—	USA	surveys (quant)	content analysis	regional (North Carolina)	cross-sectional	North Carolina residents who installed (solar PV systems or) geothermal energy systems	<p>The most important consumer motivation for installing a geothermal system was federal and state tax credits. The moment of installation of a renewable energy system and immediately thereafter emerged as the critical windows for increased utilization of energy efficient technologies.</p>
Ibrohim, A., Prasetyo, R. M., & Rekinagara, I. H. (2019). Understanding Social Acceptance of Geothermal Energy: A Case Study from Mt. Lawu, Indonesia. <i>IOP Conference Series: Earth and Environmental Science</i> , 254, 12009. <a href="https://doi.org/10.1088/1755-1315/254/1/012009">https://doi.org/10.1088/1755-1315/254/1/012009</a>	deep geothermal energy	—	Indonesia	interviews (quali)	—	regional	cross-sectional	stakeholders in affected communities (no governmental staff, companies,)	<p>But more than half of them know that there is potential of geothermal energy beneath mount lawu</p> <p>Half of the participants know the utilitisation of geothermal energy</p> <p>cultural aspect: Mt. Lawu (place of geothermal energy) is perceived as a sacred place which should not be disturbed.; it is still a local religious ritual place</p> <p>Environmental aspect: 1) "The process of making road for transportation and heavy equipment access to drilling sites is feared will disrupt the preservation of ecosystems."; 2) "people argue that the geothermal system is not completely isolated so that fluids can come out and pollute the land"; 3) "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."; 4) Java Tiger is appeared in Mt. Lawu forest</p> <p>Economic aspects: 1) people fear that jobs might be just four short time and not permanent; 2) loss of springs became the main fear of people, because most of them are farmers</p> <p>Technical aspects: "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."</p> <p>Public regulation: "The public's ignorance of the Minister Regulation of the Environment No. 17/2012" due to this ignorance the communities perceive public regulation is not sufficient;</p>

										Social aspects: "They also feel that the electricity needs are already met, so the community considers that the construction of a power plant is not needed.", "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."
										The study presents an overview of the strategies and practises implemented so far, towards the achievement of social acceptance of geothermal power projects.
Karytsas, S., Polyzou, O., Mendrinou, D., & Karytsas, C. (June 2019). Towards social acceptance of geothermal energy power plants (European Geothermal Congress). Den Haag, The Netherlands.	geothermal energy as a whole	—	worldwide	literature analysis (quali)	meta analysis	supra-regional	cross-sectional	legislative institutions, investors, citizens	project developers/ operators: can enhance social acceptance through a) the engagement of local communities, b) the prevention and mitigation of undesired effects and c) the creation of benefits for local communities public authorities on a national, regional and/ or local level: implementation of suitable legislative frameworks (e.g. distribution of specific percentage of the profits for the development of the area, realization of socioeconomic impact studies) and participation in the development of required social infrastructure.  all activities shall include honesty, objectivity, adaptation to local conditions, equality, trust, openness, taking into account interests of all involved parties, accountability and actual realization of the commitments made.  overview about geothermal energy usage in Europe	
Kepińska, B., & Kasztelniczak, A. (2015). Public Perception of Geothermal Energy in Selected European Countries (Proceedings World Geothermal Congress 2015). Melbourne.	geothermal energy as a whole	—	Hungary, Italy, Macedonia, Poland, Romania, Serbia, Slovakia	questionnaire (quantitative), open opinions (qualitative)	comparative analysis	international	cross-sectional	experts of geothermal energy	all results are based on the perception and evaluation of geothermal experts results show: level of public knowledge on RES and their uses is generally poor; Level of public knowledge on geothermal energy and possibilities of its uses was mostly poor and little sufficient evaluated  the public in all seven states is generally aware that from the economic point of view and in respect to the types of geothermal uses from a social point of view the best uses are: space heating (centralized and individual systems); agriculture, and balneotherapy and recreation.  the higher the costs of geothermal energy the less positive are people about it Suggested tools to support RES uses: grants/ subsidies; feed-in-tariffs, green certificates support tools for geothermal energy: Geological Risk Insurance Fund; support through national strategy: "No adequate governmental support now and in the documents covering the 2020 horizon makes geothermal energy a priori, a disadvantage compared to other renewable energy sources (particularly prospective in terms of electricity generation), and as a consequence, geothermal may be attracted to the inferior level of perception and social acceptance" Level of public acceptance of RES uses was mainly rated as good, only in Serbia poor Level of public acceptance of geothermal energy was lower as for RES in general ("acceptance for geothermal uses is slightly lower, around 50% for "sufficient" responses but around 20% for "good" ranks and around 30% for poor or lack of acceptance")  "Conjoint and mixed multivariate statistical analyses show that the public prefers projects sited in remote areas [which is in line with the previous literature (Carr-Cornish and Romanach, 2014; Hoşgör et al., 2013)] and using residual heat for industrial applications. The results in Switzerland and Germany were rather similar, but the	
Kluge, J., Kowalewski, S., & Ziefle, M. (2015). Inside the User's Mind – Perception of Risks and Benefits of Unknown Technologies, Exemplified by Geothermal Energy. In V. G. Duffy (Hrsg.), <i>Digital Human Modeling. Applications in Health, Safety, Ergonomics and Risk Management: Human Modeling</i> (Bd. 9184, S. 393–399).	geothermal energy as a whole	—	Germany	free answer format interview guideline (quali)	national study	no information	cross-sectional	German citizens	An interview with open answer format was used to uncover acceptance-relevant cognitions. Results show, that especially the communication about risks and possible disadvantages should be integrated in an adequate information strategy. Participants were asked for perceived risks and benefits but also about the meaning of transparency in communication of large-scale technologies and what transparent communication should be like. According to the frequency participants mentioned	
Kluge, J., & Ziefle, M. (2016). As Simple as Possible and as Complex as Necessary. In F. F.-H. Nah & C.-H. Tan (Hrsg.), <i>HCI in Business, Government, and Organizations: Information Systems</i> (Bd. 9752, S. 171–182). Springer International Publishing. <a href="https://doi.org/10.1007/978-3-319-39399-5_17">https://doi.org/10.1007/978-3-319-39399-5_17</a>	geothermal energy as a whole	—	Germany	mixed-method: Interview (quali), Questionnaire (quant), conjoint analysis	choice-based conjoint analysis	regional	cross-sectional	German citizens	The authors created a toolkit for the communication of deep geothermal energy consisting out of several hierarchical arranged tools. Transparent communication means to the people mainly the disclosure of expert opinions, involvement of the local population, and timely information. Perceived benefits of geothermal energy are mainly the ecological benefits of renewables in general and economical benefits such as local energy supply and it's cost saving capacity. Perceived disadvantages were sinking costs in rural versus urban areas involves trading off benefits of solid heat and avoided CO2 emissions and induced seismicity (IS) risk. In remote areas, IS risk is minimal, but EGS heat cannot be purposefully used for residential district heating. In urban areas, the heat can be sold, but EGS poses higher IS risk. Large EGS (150 l/s) near a large population (10.000 or 100.000 residents), enabling high heat sales, are most profitable. The CBA from the social perspective shows that	
Knoblauch, T. A. K., & Trutnvyte, E. (2018). Siting enhanced geothermal systems (EGS): Heat benefits versus induced seismicity risks from an investor and societal perspective. <i>Energy</i> , 164, 1311–1325. <a href="https://doi.org/10.1016/j.energy.2018.04.129">https://doi.org/10.1016/j.energy.2018.04.129</a>	deep geothermal energy	Enhanced geothermal systems (EGS)	Switzerland	mocking 22 hypothetical EGS scenarios with different size and siting, bound uncertainties using Monte Carlo and cost-benefit analysis (CBA)	cost-benefit analysis (CBA)	concrete project	cross-sectional	Private Investors' Perspective, Social Perspective		
Knoblauch, T. A. K., Trutnvyte, E., & Stauffacher, M. (2019). Siting deep geothermal energy: Acceptance of various risk and benefit scenarios in a Swiss-German cross-national study. <i>Energy Policy</i> , 128, 807–816. <a href="https://doi.org/10.1016/j.enpol.2019.01.019">https://doi.org/10.1016/j.enpol.2019.01.019</a>	deep geothermal energy	—	Germany an Switzerland	online questionnaire (quant)	Conjoint and mixed multivariate statistical analyses	regional (German-speaking part of Switzerland, German federal state of Rhineland Palatinate)	cross-sectional	citizens	"revealed that in terms of effects on acceptance, induced seismic risks have most importance among the tested attributes. This stands in contrast to previous models in which the benefits of renewable energy technologies were the best predictor of acceptance (Bronfman et al., 2012; Visschers and Siegrist, 2014)."  "the public accepted deep geothermal energy scenarios with high levels of benefits more fully than those with lows of benefits when the projects were sited in remote areas"  "The results thus indicate that when risk perceptions are especially high, such as among German women, the compensatory weighing of risks and benefits does not fully apply. Women have also previously shown higher risk perceptions than men (Gustafson, 1998)."  "acceptance and the perception of induced seismic risks and benefits are stable across the two considered countries"  "the willingness to take risks was higher among the Swiss public, which is in line with the previous literature (Volken et al., 2017)."  The article describes the history of protests and accidents in regards of geothermal energy in Germany; timeline was provided when civil initiatives were founde	

Kowalewski, S., Borg, A., Kluge, J., Himmel, S., Trevisan, B., Ziefle, M., & Jakobs, E.-M. (2014). Modeling the Influence of Human Factors on the Perception of Renewable Energies. Taking Geothermics as Example. <i>Proceedings of the 5th International Conference on Applied Human Factors and Ergonomics AHFE</i> .	deep geothermal energy	—	Germany	questionnaire with Likert Scale (quant)	national study	regional (western Germany)	cross-sectional	German citizens	Aims of the study: Quantification of acceptance and investigation of influencing factors regarding deep geothermal energy; Explanation of acceptance by underlying usage benefits and barriers; Contrast of acceptance for knowledge and not knowledge groups; Derivation of guidelines for development of communication strategies in the context of renewable energies and geothermics in particular. The comparison of a group that is well informed with a
Kubota, H., Hondo, H., Hienuki, S., & Kaieda, H. (2013). Determining barriers to developing geothermal power generation in Japan: Societal acceptance by stakeholders involved in hot springs. <i>Energy Policy</i> , 61 1079–1087. <a href="https://doi.org/10.1016/j.enpol.2013.05.084">https://doi.org/10.1016/j.enpol.2013.05.084</a>	geothermal energy as a whole	hot springs	Japan	semi-structured interviews (qual)	national study	supra-regional	cross-sectional	developers, hot spring inn managers, local government officials	Hot spring managers and local government officials - they were concerned about the uncertain effects of geothermal energy on underground water resources. A further key reason for opposition was the uncertainty about the reversability and predictability of the adverse effects on hot springs and the underground structures by geothermal power production and reinjection of hot water from reservoirs -> fear of irreversible damage
Kunze, C., & Hertel, M. (2017). Contested deep geothermal energy in Germany—The emergence of an environmental protest movement. <i>Energy Research &amp; Social Science</i> , 27, 174–180. <a href="https://doi.org/10.1016/j.erss.2016.11.007">https://doi.org/10.1016/j.erss.2016.11.007</a>	deep geothermal energy	—	Germany	desktop research, interviews (qual)	content analysis	supra-regional	longitudinal (2006-2015)	Stakeholders involved in the participation process	The number of active citizen initiatives is higher than for wind power (the rate of protest is 32%) "2009 to 2015 16 DG systems successfully went into operation and 19 were canceled or suspended without being further developed." only one geothermal plant was cancelled due to local protest, in many cases no official reasons were given - financial or geological conditions were blamed The author "argued that a new risk discourse following a series of accidents caused the emerging protest movement against DG."; "After two decades with a complete absence of protests, deep geothermal energy in Germany is now as conflictive as wind parks." One difference in contrast to other technologies might be the legal embedding of these risks is underdeveloped.
Leucht, M. (2012). <i>Medienresonanzanalyse zu Projekten der tiefen Geothermie in Landau, Bruchsal, Brühl und Unterhaching</i> (S. 122). EIFER - Europäisches Institut für Energieforschung.	deep geothermal energy	—	Germany	media analysis (qual)	content analysis	regional (Landau, Bruchsal, Brühl, Unterhaching)	longitudinal	leading media, selected regional and local newspapers	First, a positive view with focus on the potentials of the innovation dominated reporting. After the seismic event in Landau 2009 the preponderant technological angle was expanded. The perspective of a possibly dangerous innovation with technological and social risks was taken in. The media of the most recent year the analysis took account of revealed a mitigation of the negative view point. A more ambivalent atmosphere with focus on social agreeableness dominated.
Meller, C., Schill, E., Bremer, J., Kolditz, O., Bleicher, A., Benighaus, C., . . . Kohl, T. (2018). Acceptability of geothermal installations: A geoethical concept for GeolAB. <i>Geothermics</i> , 73, 133–145. <a href="https://doi.org/10.1016/j.geothermics.2017.07.008">https://doi.org/10.1016/j.geothermics.2017.07.008</a>	deep geothermal energy	EGS	—	literature analysis (qual)	unsystematic literature review	international	—	all affected stakeholders	The article is a literature review and an introduction to the geothermal Laboratory in the crystalline Basement (GeoLAB); the article introduces case studies of other researchers and their main results; the GeoLAB is an underground laboratory that addresses fundamental challenges of reservoirs technology and borehole safety Based on an geoethical approach the article considers aspects of deep geothermal energy regarding all affected stakeholders Public perception of Enhanced geothermal systems (EGS) is most completely document the case Soultz in France. Most concerns: Noise, introduce seismicity (Lagache et al, 2013) "Existing research reveals that discourses on geothermal energy are closely related to the local site of the project, thus they are similar to discourses on other emerging technologies (c.f. Hirschberg, 2015)." Differentiation between short-term nuisance doing this relation and permanent nuisance: Lifestyle habits, long-term effects of noise, pollution or micro-seismicity "Case studies on geothermal energy reveal that the acceptance of a deep geothermal plant is higher, if the community and the individual people enjoy benefits related to economic opportunities, sharing of property rights or lifestyle improvements associated with the realisation of the project." "The assessments and perceptions of risks related to geothermal energy projects differ widely among the public and experts and can cause huge conflicts." "An identification with a specific project by individuals enhances the probability for the approval of this project." "An identification with a specific project by individuals enhances the probability for the approval of this project."; NGOs do not participate in problem definition in media discourse. Positive and negative aspects brought forward in public debate on deep geothermal energy (Canan 1986; Kousis 1993; Popovski, 2003; Krater and Rose, 2012; Moser and Stauffacher, 2015; Pellizzone et al., 2017): 1) negative perception: Environment - induces seismicity, water pollution, air pollution, noise, damage of flora and fauna; economy - damage of infrastructure, financial risks; governance - public participation in planning, responsibility in case of damages, commitment of public Six important aspects on which public perception and responses depend (Canan, 1986; Krater and Rose, 2012; Kousis, 1993): "experience with geothermal projects, the relevance of local ecological issues, and the potential to establish links to related topics in public debate, the historic-cultural context, local socio-economic conditions, and trust in experts, institutions, and procedures."
Pellizzone, A., Allansdottir, A., Franco, R. de, Muttoni, G., & Manzella, A. (2015). Social Acceptance of	geothermal energy as a		Italy	focus groups (qual) and	content analysis; frequency	regional (southern Italy)	cross-	focus groups: students, citizens, energy experts,	42% of respondents can't say if this energy would have a positive or negative effect on its daily life; only 17% said they knew what geothermal energy is "In the general focus group [citizens], participants were optimistic about geothermal energy and considered its exploitation with keen interest, because of potentially positive consequences on employment, environment, advancement of innovation in Sicily, independence in energy supply from other countries and reduction of energy costs." interviewees would like to have more information on economic impacts on local communities than for environmental consequences. "reason for low level of concerns could be the general perception of geothermal as a low emission and green technology and the presence in the area of Termini Imerese of a great automobile industrial area that was abandoned."

	Geothermal Energy in Southern Italy (Proceedings World Geothermal Congress 2015). Melbourne.	energy as a whole	—	Italy	questionnaire (quant)	frequency analysis	local (Viterbo and Palermo, Sicily)	sectional	fiat workers; quant: citizens	<p>"Focus group discussion clearly showed that energy management is strongly perceived as very politicized and major concerns to a fair development of power plants rise from a lack of confidence towards public institution."; "intricately interrelated with Mafia and crime in general and far removed from beneficial effects for citizens."</p> <p>distributive justice issues: "many participants mentioned local interest in contrast to national ones and ask for directs benefits for Sicilian people as an essential condition for the exploitation of geothermal energy on their land"</p> <p>"respondents indicate scientists and researchers as more competent actors (54.3% of respondents think they are competent or very competent). Lower levels of competence are attributed to energy companies and national governments"</p>
	Pellizzone, A., Allansdottir, A., Manzella, A., Franco, R. D., & Muttoni, G. (2016). Geothermal energy, Social Acceptance and Responsibility in Italy: Two case. <i>European Geothermal Congress</i> , 8.	geothermal energy as a whole	—	Italy	focus groups (quali) and surveys (quant)	comparative analysis	regional (Viterbo and Palermo)	cross-sectional	Italian citizens and stakeholders. Relevant groups: General public, university students, stakeholders of the energy sector, ex-workers of the Fiat plant in Termini Imerese, environmental activists, etc.	<p>Energy questions are perceived as very politicized. There is a considerable openness towards geothermal technologies, but the lack of trust in the decision makers can prepare the ground for important social conflicts. Concerns and the support for geothermal technologies are strongly related to the local context and past experiences. In both case studies, the views of the participants were clearly shaped by local contextual factors that need to be taken into account when designing eventual</p>
	Romanach, L., & Carr-Cornish, S. (2013). <i>Societal Acceptance of Geothermal Energy Technology in Australia: Media Portrayals and Public Perceptions</i> . CSIRO Earth Sciences and Resource Engineering, CSIRO Energy Flagship.	geothermal energy as a whole	—	Australia	coding and analyzing news articles and focus group discussions (quali), questionnaire surveys (quant)	media analysis, frequency analysis (distribution of answers concerning benefits and risks)	national	longitudinal (media analysis) and cross-sectional (focus group discussions and questionnaire surveys)	News articles, Australian citizens	<p>Geothermal energy technology is currently relatively well received by Australia media and public. A geothermal technology can progress through large-scale demonstrations → public perceptions and media reporting: potential to change → acknowledging this will be critical to the industry maintaining effective communication strategies</p>
	Stauffacher, M., Muggli, N., Scolobig, A., & Moser, C. (2015). Framing deep geothermal energy in mass media: the case of Switzerland. <i>Technological Forecasting and Social Change</i> , 98, 60–70. <a href="https://doi.org/10.1016/j.techfore.2015.05.018">https://doi.org/10.1016/j.techfore.2015.05.018</a>	deep geothermal energy	—	Switzerland	media analysis (quali)	content analysis	supra-regional	longitudinal (1997-2003)	media articles of Neue Zürcher Zeitung (NZZ) and the Tages-Anzeiger (TA)	<p>debate in newspapers are largely driven by events with news value; the focus is on negative rather than positive aspects</p> <p>4 broad frames of deep geothermal: "energy transition and risks being the two dominant ones. The technology and cost frames are less prevalent, but still quite common in the articles on deep geothermal energy"</p> <p>different actor groups emphasize different frames: "Whereas deep geothermal energy is perceived as an opportunity for energy transition from the perspective of industry, scientists highlight the issue of the associated risks."</p> <p>The article reviews unstructured literature on</p> <p>It refers to an economic evaluation, social aspects, institutional approach</p> <p>The GDP growth seems to be positively related to the consumption of renewable energies (Matei, 2018; Apergis, 2010)</p> <p>"SGE systems bear economic, environmental, and social benefits, as owners feel that they are protecting the environment and contribute to CO2 emissions' reduction [89]. Bleicher and Gross [90] reviewed the motives of using SGE, with the most important ones being the increasing fuel prices [91], the environmental friendliness technology [89,92,93], and the onsite energy production, increasing self dependence on energy production [93]."</p> <p>The article refers to the importance of sufficient information for users ( individuals, districts, agglomerations or most people use establishments): how high are in the insulation and maintaining costs, when do you owners benefit financially from an installed system, what are positive environmental aspects. "Such a targeted approach with key economic and environmental benefits could result in an increased willingness to pay for said systems [99]."</p> <p>"Organizational and institutional barriers complemented with the lack of legislation [28], are reported to be among the most important issues in SGE for several European countries that participated in the REGEOCITIES EU project [27]"</p> <p>"One of the most important drivers for SGE penetration is to establish guidelines, simplify and homogenize the legal framework for the permitting procedure."</p> <p>"Financial Incentives should be in benefit of the owners and users of the SGE systems with subsidies that overcome the high installation cost bottleneck. Direct grants, tax reductions, loans at privileged rates, and housing subsidies are the most common ones 114,115]."</p> <p>Hot spring managers - their perception was affected by the uncertain effects of geothermal energy on underground water resources</p>
	Tsagarakis, K. P. (2019). Shallow geothermal energy under the microscope: Social, economic, and institutional aspects. <i>Renewable Energy</i> . Advance online publication. <a href="https://doi.org/10.1016/j.renene.2019.01.004">https://doi.org/10.1016/j.renene.2019.01.004</a>	shallow geothermal energy	—	—	—	desktop research	international	—	—	<p>The article reviews unstructured literature on</p> <p>It refers to an economic evaluation, social aspects, institutional approach</p> <p>The GDP growth seems to be positively related to the consumption of renewable energies (Matei, 2018; Apergis, 2010)</p> <p>"SGE systems bear economic, environmental, and social benefits, as owners feel that they are protecting the environment and contribute to CO2 emissions' reduction [89]. Bleicher and Gross [90] reviewed the motives of using SGE, with the most important ones being the increasing fuel prices [91], the environmental friendliness technology [89,92,93], and the onsite energy production, increasing self dependence on energy production [93]."</p> <p>The article refers to the importance of sufficient information for users ( individuals, districts, agglomerations or most people use establishments): how high are in the insulation and maintaining costs, when do you owners benefit financially from an installed system, what are positive environmental aspects. "Such a targeted approach with key economic and environmental benefits could result in an increased willingness to pay for said systems [99]."</p> <p>"Organizational and institutional barriers complemented with the lack of legislation [28], are reported to be among the most important issues in SGE for several European countries that participated in the REGEOCITIES EU project [27]"</p> <p>"One of the most important drivers for SGE penetration is to establish guidelines, simplify and homogenize the legal framework for the permitting procedure."</p> <p>"Financial Incentives should be in benefit of the owners and users of the SGE systems with subsidies that overcome the high installation cost bottleneck. Direct grants, tax reductions, loans at privileged rates, and housing subsidies are the most common ones 114,115]."</p> <p>Hot spring managers - their perception was affected by the uncertain effects of geothermal energy on underground water resources</p>
	Vargas Payera, S. (2018). Understanding social acceptance of geothermal energy: Case study for Araucania region, Chile. <i>Geothermics</i> , 72, 138–144. <a href="https://doi.org/10.1016/j.geothermics.2017.10.014">https://doi.org/10.1016/j.geothermics.2017.10.014</a>	geothermal energy as a whole	—	Chile	in-depth semi-structured interviews (quali)	content analysis	regional (community that surrounds the Villarrica Volcano in the Araucania region of Chile)	cross-sectional	hot spring managers, community members, non-indigenous community members, local officials; consultants/government officials	<p>Government officials - see the potential negative effect of geothermal projects on tourism (due to the uncertain environmental consequences and other impacts on sustainability); they acknowledge the potential environmental benefits for reducing CO2 emissions ( Geothermal energy instead of wood-burning for heating)</p> <p>Local community - a) see geothermal energy as negative for environment (steam discharge white exploration shaped the perception of the public); b) the cost-benefit relationship is evaluated negatively (unequal distribution of costs and benefits); c) predominant lack of trust among stakeholders (both indigenous and non-indigenous community members see a relationship between geothermal energy and mining); d) has a spiritual relationship to volcanoes - humans should not disturb</p> <p>Consultants, and national government officials - lack of national government support</p> <p>This research illustrates how perception changes among stakeholders.</p> <p>article deals with a CASE STUDY and an ENGAGEMENT PROCESS in Groß-Gerau that was an success</p>
										<p>Social site characterization (Phase 1): "continuous media analysis and more than 30 semi-structured interviews with representatives of various stakeholder groups from agriculture, environmental organizations, community groups, and individuals, it was possible to understand the issues that were on people's minds in relation to geothermal power in their vicinity"</p>

Wallquist, L., & Holenstein, M. (2015). Engaging the Public on Geothermal Energy (Proceedings World Geothermal Congress 2015). Melbourne.	deep geothermal energy	—	Germany	semi-structured interviews (quali); questionnaire (quanti)	content analysis; frequency analysis	regional (Groß-Gerau)	cross-sectional	various stakeholder groups from (agriculture, environmental organizations, community groups, and individuals)	<p>positive aspects from the interviews: contribution to entity transition, baseload capacity, closed loop, independence of the region, decentralization of production, benefit for science, local value creation, avoidance of over power lines were main aspects found in the interviews</p> <p>negative aspects from the interviews: induced seismicity, noise pollution, planr esthetics, groundwater pollution, changes in groundwater levels, cooling down to earth, settlement of claim, chronic movements, cost efficiency, collapse, public acceptance, etc.</p> <p>Stakeholder dialogue (Phase 2): establishment of an advisory boards of 20 members representing a broad range of stakeholder groups in order to take up all questions, wishes and returns from other stakeholders and the general public; thematic sub-groups were administered (Environmental issues, cost effectiveness and local benefits, risk governance and communication); regular meetings -&gt; advisory board had reached a consensus and came up with 31 points that it requested to</p> <p>Civil dialogue (Phase 3): public meetings, in-depth discussions, ; results were published in accessible on my intimate; large-scale telephone survey was conducted (1000 people randomly) -&gt; "Results showed that the engagement process was well received and that a majority of the people living in the surrounding communities supports the geothermal project."</p> <p>Project operator had a high baseline level of trust, because it is a public utility company and has worked in various projects before in the region</p> <p>"The credibility of the process, which was assured by the neutral process design and moderation as well as through the transparent documentation on <a href="http://www.dialoggeo.de">www.dialoggeo.de</a>, was of crucial importance"</p> <p>the authors have proposed a socio-technical approach, Overall System Design (OSD), which is a concept aimed at maximizing business profitability and social acceptance</p>
	geothermal energy as a whole	—	Japan	questionnaire (quanti)	frequency analysis	supra-regional	cross-sectional	municipal governments	<p>OSD is dicribed in the article; "Visualization of the benefits of geothermal development is an important part of this approach because it promotes mutual understanding among stakeholders."</p> <p>main result: "Results of attitude surveys of local municipal governments as key stakeholders suggest that governments and developers should continue to provide information to improve social acceptance."</p> <p>"Municipal governments thought that hot springs were important tourism resources and contributed economic ripple effects to the community"; "Municipal governments thought that hot springs were important tourism resources and contributed economic ripple effects to the community"; "regarding development of large-scale geothermal power plants outside of national parks were divided and the acceptance of development in national parks was low."; "regarding development of large-scale</p> <p>"A possible reason for opposition to geothermal development is perceived imbalance of risks and benefits among individual stakeholders."; OSD helps to visualize benefits</p> <p>significant correlation was found between the emotional evaluation of the pictures and the acceptance of geothermal energy</p>
	geothermal energy as a whole	—	Germany	questionnaire with drawings (quali and quanti)	analysis of pictures, colours, word associations (as well frequency)	regional	cross-sectional	general public and visitors of information events (convenience sample)	<p>"From the picture associations, it can be deduced that near-surface geothermal energy was the most known application of geothermal energy in the sample."</p> <p>despite a general positive image of geothermal energy, power stations were negatively denoted (evident from the evaluation of the pictures as well as by the words associations)</p> <p>"In this line of argumentation, the prevailing negative image of power plants then "overshadows" even the otherwise positive association of a renewable energy. Bearing in mind that these are used for large-scale application of geothermal energy, with a greater number of residents affected, they present a possible barrier"</p> <p>"Further essential components of geothermal energy plants are the bore holes, which require deep drilling. "Drilling" was also one of the most dominant elements in the pictures representing a central aspect of the mental model of geothermal energy" BUT: "The drilling process was rated neutral to negative in the picture and word associations"</p> <p>"two conflicting poles exist: on the one hand, the positively rated environmental impact of geothermal energy and on the other hand the negatively evaluated high invest and the necessary infrastructure."</p> <p>"It was further shown that the more negative participants' (self-rated) imagery associations with geothermal energy, the more negative their attitude towards geothermal energy was. This referred mostly to deep geothermal energy, for which "drilling" and "power stations" represented especially negative associations."</p> <p>summary of the whole TIGER project: communication recommendations are given and a communication tool kit is developed: "The basis for a broad acceptance is trust in the stakeholders and transparency on the part of the project actors. Building on this, the studies showed that an early, regular communication as well as a "local face" (in the sense of unambiguous, officially communicated responsibilities) are essential for such geothermal projects. In order to design this basis, the transfer of</p>
	deep geothermal energy	—	Germany	qualitative and quantitative	different analyses (specified below)	all spatial levels (see below)	cross-sectional and longitudinal	see below	<p>central acceptance factor are: transparency, trust, knowledge, informational dissemination in the right extent and at the right time and the possibility to participate ==&gt; for detailed results see below (all analyses are conducted in the context of the TIGER project)</p> <p>Predominantly technology-savvy middle-aged men, who live in a partnership, discuss renewable energies.</p>
	deep geothermal energy	—	Germany	actor analysis (quali)	actor analysis using Facebook (quali)	supra-regional	cross-sectional	Facebook user connected with the topic of geothermal energy	Ecological, financial and technical consequences influence the attitudes, perceptions and assessments of citizens towards geothermal energy, e.g. road conditions after construction of a geothermal plant, noise.
	deep geothermal energy	—	Germany	media analysis (quali)	media analysis of two websites (quali)	supra-regional	longitudinal	journalists, users	The results show that the evaluation aspects - depending on the location and time - are different

Ziefle, M., Jakobs, E.-M., Kluge, J., Trevisan, B., Reimer, E., & Wirtz-Brückner, S. (2015). PR bottom up: Tiefe Geothermie-Akzeptanz und Kommunikation einer innovativen Technologie (TIGER): Akzeptanzmodellierung. Abschlussbericht.

deep geothermal energy	—	Germany	trend analysis (quali, quanti)	trend analysis of two websites (quali)	supra-regional	longitudinal	journalists, users	Media often paints a distorted picture of public opinion about deep geothermal energy. There is no differentiated consideration of the public's complex assessment criteria (e.g. location, time, subject) for deep geothermal energy; rather, opinions of individuals are described as general attitudes in the media. However, it turns out that public opinion - whether positive, negative or neutral - varies with time and place.
								Technical and ecological events (e.g. earthquakes) have a major impact on the perception and evaluation of deep geothermal energy.
deep geothermal energy	—	Germany	media analysis (quali)	media analysis of articles etc. from civil initiatives (quali)	regional (Landau, Steinweiler)	longitudinal	members of civil initiatives	within a Facebook study it was shown that geothermal energy is associated with costs (neg. rated), ambivalently rated in its benefits; Facebook is primarily used to maintain contacts. The platform is suitable as an element of a cross- and multimedia communication concept, but should not be the central element.
deep geothermal energy	—	Germany	media analysis (quali)	comparative analysis using Facebook (quali)	supra-regional	cross-sectional	Facebook user connected with the topic of geothermal energy	The most important factors for the acceptance of deep geothermal energy are transparency and trust. All surveys have shown that citizens would like to have an opportunity to participate (e.g. by having a say in power plant design).
deep geothermal energy	—	Germany	online questionnaire (quanti), online questionnaire with open questions (quali)	national study	supra-regional	cross-sectional	German citizens	The citizens see the benefit of deep geothermal energy mainly in the environmental and climate friendliness of this technology and in the independent power supply
								The biggest concerns that hinder acceptance are the fear of earthquakes, the unknown risks and the incalculable costs that can accompany a major project.
								It can be concluded that geothermal energy is not perceived as a prototype form of renewable energy.
								The group of the informed participants (about geothermal energy) shows the tendency to evaluate geothermal energy more positively. An exception is the evaluation of the economic advantage of geothermal energy.
								The argument against geothermal energy with the highest approval is in the uninformed group the fear of a loss of value of the surrounding houses of a geothermal plant. In the group of the informed ones the concern is about too high costs is most important.
deep geothermal energy	—	Germany	Conjoint-Analyse analysis (quanti)	project specific study	regional (Landau, Insheim, Eich, Traunreut, Edenkoben)	cross-sectional	citizens in the region/ cities/ municipalities	Respondents clearly indicated that they wanted to be informed from the pre-planning stage onwards.
								Far ahead of the other possible informants, the respondents would like to be informed about the project by an external expert.
								There is a certain mistrust of the objectivity of the project participants, which is reflected in the desire for transparency and disclosure of all expert opinions.
								Much less important than the external expert, but still well ahead of the other informants, is the position of the independent journalist. The managing director of the operating company, a political person or the press spokesman of the operating company are less desired by the given options.