Renewable energy or risky technology? – Framings of deep geothermal energy in Germany

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ABSTRACT

Deep geothermal energy in Germany is seen as a promising source of renewable energy which can contribute environmentally sustainable to the German Energy Transition. Therefore, the public perception of this innovative energy technology is usually positive. However, geothermal technology is not undisputed in Germany and it has been increasingly debated in the last few years. Potential environmental impacts such as earthquakes or damage of buildings are issues of concern, but also aspects such as the efficiency of the technology or other risks of drilling. The intensity of dicussion and the perception of geothermal energy technology differs across regions. Regions can be identified where geothermal projects are opposed, others where the technology is supported and others where such projects are only marginally noticed.

We argue that local responses are grounded in different framings of the technology. Frames are understood as collective beliefs and shared meanings that allow individuals to organize their experiences and to make sense of events and issues.

By analyzing two case studies, we carve out six frames applied by local actors to geothermal energy that highlight different aspects of the technology – environment and risk-related aspects, economical aspects, aspects related to the transition of the energy system, technological aspects, and aspects of regional development. Some of the arguments given emphasize negative aspects of geothermal energy.

The overall recommendation of the participants in both case studies is to further research and develop geothermal energy. This shows general openness on a local level for research to further develop the technology and to answer so-far unanswered questions in Germany.

1. DEEP GEOTHERMAL ENERGY IN EUROPE

1.1 Energy transition: geothermal energy is part of the energy mix

The transformation from nuclear and fossil energy to more sustainable, renewable energy is a political target in the context of energy transition in many countries in Europe – for example, in Denmark or Germany. The German Government defined that at least 60% of German energy demands should be fulfilled by renewable resources by 2050 (Deutscher Bundestag, 2010: 2). The Danish Government set a long-term goal in its Energy Plan of 2006 that was more ambitious, aiming for 100% renewable energy (Lund and Methiesen, 2009). Today, deep geothermal energy is seen as one of the key alternative sources of renewable energy, as well as wind, biomass, hydro or solar power, which can substitute fossil and nuclear resources.

Although today in some countries, such as New Zealand, geothermal energy contributes shares up to 16% to the electric energy supply, in Europe it is still less important than other renewables such as photovoltaic or wind power (Bertani, 2015). Recent evaluations conclude that technologies to exploit deep geothermal energy in Europe are still under development (Breede et al., 2013).

1.2 Renewable or risky technology?

The proponents of geothermal energy argue that deep geothermal energy could deliver an important share of the future (renewable) energy mix (heat and electric energy). It is a local (decentral) resource with low CO2 emissions, and it is considered as an option to deliver base load (electric) energy in addition to rather fluctuating renewable sources such as wind or solar energy (Kayser and Kaltschmitt, 1998; Bruns, 2011; Agemar et al., 2014; Stauffacher et al., 2015). Nevertheless, this optimistic view of geothermal energy technology has been criticized in Germany and European other countries. Geothermal installations are increasingly requested, notably by local groups (Kousis, 1993), but also the wider public, in several countries (Dowd et al., 2011). Furthermore, the picture drawn in media shifted from an initially optimistic view to more diverse (re-)presentations (Leucht, 2012; Stauffacher et al., 2015).

Although less visible than, for example, wind turbines or solar power fields, geothermal energy installations are primarily debated when it comes to site projects in local communities. While different framings of geothermal energy in media have already been analyzed, so far only a few studies exist on how geothermal energy is framed when it comes to siting geothermal drillings and power plants at specific places (Kousis, 1993; Kunze and Hertel, 2015).

2. METHOD

2.1 Framing Approach

Taking a framing theoretical approach, we shed light on collective beliefs in which local debates and actions concerning geothermal technology are grounded (Gamson and Modigliani, 1989). Different positions on geothermal energy originate from different perspectives of benefit and risk. However, what is perceived specifically as a benefit and a risk can only be derived from the knowledge of the frame.

Several authors recently pointed to the fact that no common understanding of frames or framing exists, although the work of Entman (1993) tried to provide exactly this: a common understanding of what frames are and how the process of framing should be understood (Entman, 1993). His definition suggests two main functions of frames: first, to select aspects from the perceived reality and second, to structure communication processes about this reality (Entman, 1993;

Dahinden, 2006): "To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described" (Entman, 1993: 52).

One of the origins of the framing theoretical approach is traced back to Erving Goffman (1974) who described frames as "schemata(s) of interpretation" that allow individuals to locate, perceive, identify, and label issues, events, and topics and to classify unknown phenomena into known categories (Goffman, 1974). By using frames, individuals are able to distinguish what is relevant and irrelevant and how to behave appropriately in a specific situation (Goffman, 1974; Vliegenhart and van Zoonen, 2011). All frames of a social group build a shared understanding of interpretative schemas (Goffman, 1974).

In the case of geothermal energy technology, two media analyses in Germany and Switzerland revealed that the technology is framed differently by societal actors. Furthermore, it has been shown that framings changed during the last few years (Leucht, 2010, 2012; Stauffacher et al., 2015). Frames of risk technology (Kunze and Hertel, 2015) and environmental justice (Kousis, 1993) emerged in addition to framings that see geothermal energy as innovative, progressive and renewable energy technology.

Within this article we are interested in how frames as schemas of interpretation shape the debate on a new energy technology. Based on two case studies, we will reveal how geothermal energy technology is framed in local discussions and what conclusions for public perception action are drawn from these frames.

3. CASE STUDIES

Two communities in rural areas in two different average (300–1000m altitude) mountainous regions in the eastern part of Germany were selected; the community of Meiningen in the federal state of Thuringia and the community of Schneeberg/Bad Schlema in the federal state of Saxony. In both communities a research project was intended, an explorative drilling, to investigate the potential of petrothermal geothermal energy by using the innovative Hot Dry Rock (HDR) technology which is still under development. Based on potentially positive results of the intended research, a future geothermal power plant could have been realized. The initiators and facilitators of the project idea – researchers, federal state ministries, some local actors – emphazised in newspaper articles and interviews the research nature of both projects, including the open-endedness of research results. Up until the writing of this article, none of the explorative drillings had been realized. Both projects were accompanied by debates in the media and during citizens' assemblages. However, the debate in Meiningen was much more intensive than that in Schneeberg/Bad Schlema.

3.1 Focus groups

In each community we carried out two focus group discussions in 2014, in order to learn how geothermal energy technology is framed by local actors. Focus groups are used to explore how people feel and think about a specific topic or theme, to work out specific arguments and reflect them within a group interaction setting (Morgan, 1997; Krueger and Chasey, 2015). They were invented by the sociologist Robert Merton at Columbia University in order to assess radio and film programmes in the 1940s (Morgan, 1997; Bloor et al., 2001). Subsequently the method was taken up in market research and product development due to its pragmatic approach and is nowadays widely applied in social science research (Lamnek, 1998; Bloor et al., 2001; Buber, 2009).

As we wanted to achieve a broad scope of the participants' views, we selected representatives from local or regional politics (e.g., mayors), industry, municipal energy suppliers and non-governmental organizations, as well as interested citizens. The participants varied in age, gender, profession and interests; they had in common an engagement with the intended project or were at least interested in deep geothermal energy and they lived or worked in the region. Participants for each focus group were identified in individual pre-interviews by the snowball principle. In total 26 persons participated in the four focus groups. Each group interview lasted three hours and the interviews were audio-taped and literally transcribed for a detailed and substantive analysis (Bloor et al., 2001). The focus groups followed the same interview guideline in order to make them comparable and to maintain the focus of the topic (Morgan, 1997). Our guideline covered the following topics:

- Heat and electricity production in Germany
- Renewable energies and the role of deep geothermal energy
- Challenges, benefits and risks: pro and cons of deep geothermal energy
- Perception of the locally planned project
- Recommendations for local, regional and national policy

3.2 Coding scheme

According to the well-established approach of social scientific content analysis described by Hopf et al. (1995), we followed a procedure: first, all text passages delivering arguments on geothermal energy have been coded based on the qualitative content analytical approach (Mayring, 2003). Second, the arguments were thematically clustered into categories that built the frames (see Table 1). Each frame is described according the schemata from Entmann et al. 2009: problem definition, causal attribution of responsibility to actors, moral judgement, recommended action.

The coding was based on paragraphs (contributions) which means that each single argument was coded only once per contribution and different arguments within one contribution were coded seperately.

4. RESULTS

4.1 Deep geothermal energy as part of the renewable energy mix

In both communities, focus group participants wished to see a growing percentage of renewable energy in Germany and in their region by the year 2030. The percentage that deep geothermal energy could contribute to such a development was controversial in discussions. Participants argued that the increase could be anywhere between zero and 15% in Germany. Generally, deep geothermal energy has been

understood to be a renewable source of energy that has the potential to contribute to a renewable energy system.

4.1 Arguments identified in the focus groups

In total 22 arguments related to geothermal energy have been identified 310 statements that have been made on geothermal energy within in all four focus group discussions.

Arguments identified in the focus groups discussions (N=18)
Technology is uncertain/in development
Risks are low/controllable
High geologic potential for development
Seismic risks/triggering earthquakes
High cost/less efficient
Autarchy/low energy price
Environmental damage/ground water contamination
Environmental friendly (low C02 emission)
Base-loadable energy
Insurance of damage
Damage of buildings
Geology unknown/unsure
Noise of drilling/production
Low local benefit
Technology is benefit for the region
Sustainable/renewable energy/energy transition
Tradition/experience in mining
Electricity and heat generation

Table 1: Arguments in the different communities retrieved from the transcribed text material of the focus groups.

These arguments cover aspects such as the contribution to renewable energy provision and the potential to provide base load energy, but also the fact that a new technology has to be developed, benefits for regional development and the environment. Further arguments concern potential damages to buildings due to uplift, subsidence or seismic events, and groundwater pollution by radioactive elements. The following table will list all arguments which were identified in the focus groups (Table 1).

4.3 Major frames of geothermal energy

Arguments that share a specific perspective on geothermal energy have been grouped into frames (Stauffacher et al., 2015), regardless if they make a positive or negative judgment on geothermal energy. Table 2 shows how arguments were assembled into frames and their description. Six frames were identified: cost frame, regional development frame, environmental frame, emerging and innovative technology frame, risk frame and renewable energy frame. Each frame emphasizes specific aspects of geothermal energy technology with a benefit (Pro) and a risk-related (Con) aspects.

Description of frames found in the focus groups
Renewable energy frame
Pro: Deep geothermal energy contributes to the renewable energy mix and provides a share of the power baseload.
Con: Deep geothermal energy will not contribute to the renewable energy mix and is a niche product.
Regional development frame
Pro: Deep geothermal energy is an emerging technology that promises regional benefits.
Con: Deep geothermal energy technology increases risk exposure in the region without any regional benefit.
Cost frame
Pro: Deep geothermal energy is economical efficient and contributes to independence from fossil fuels.
Con: Exploitation of deep geothermal energy is expensive and damages are not covered by insurance.
Environmental frame
Pro: Deep geothermal energy is environmentally and climate friendly.
Con: Deep geothermal energy produces environmental damages and emissions.
Risk frame
Pro: Risks associated with geothermal energy are under control.
Con: Risks are high and will impact human lives, environment, infrastructure or buildings.
Emerging and innovative technology frame
Pro: Deep geothermal energy technology is promising and should be further developed.
Con: Success of deep geothermal energy is too uncertain and the development will be stopped.

Table 2: Grouping of arguments to frames based on N=265 arguments in four focus groups.

4.3.1 Renewable energy frame

The renewable energy frame is associated with the understanding that geothermal energy is renewable, contributes to CO2 reduction and might provide base-load energy: "Deep geothermal energy, or geothermal in general, is the most effective and simplest and enduring form of energy besides solar energy," (participant of the focus group). The link to the nation wide debate on transforming the energy system is obvious. Within the collective understanding the question is not "if" but "how" and based on which technologies energy transformation can be achieved. In the understanding of all focus group participants geothermal energy can contribute to this transformation process. Thus, concerning this point a positive evaluation dominated the discussions. However, the opposite evaluation also was brought forward: this energy source is and will remain a niche product. Consequently at least two contrary activities are supported within this frame: further exploration of the energy potential and stopping investments in exploration and technology development. As regards the role

and responsibility of actors the energy transision frame requires efforts of the whole society, but first and foremost of political actors on national, regional and local level who bring the issue on the political agenda (e.g. within local strategies on climate protection) and of energy suppliers who are still the dominant player in energy supply.

4.3.2 Regional development frame

Within the regional development frame, positive expectations raised concerning the technology seem to be grounded in the expectation that the technology might initiate development in a region that suffer from economical weakness and demographic change. As a participant of the focus groups stated: "A pilot project of geothermal energy could be a unique feature of the region and attract scientists and experts from everywhere". A rather negative moral evaluation is suggested when participants refer to the fact that local communities will suffer from future geothermal energy installations without having benefits. "What do the people here in the region have got in the end, does it affect the electricity prices somewhere? Where is it used?", (participant of the focus groups). As regards responsibility of actors it can be said: in either evaluation, local and regional politicians have the central role in promoting or preventing the further development of geothermal energy.

4.3.3 Cost frame

The cost frame is associated with cost of initial drilling and construction of a geothermal facility and the efficiency of long-term running the facility. Participants framed deep geothermal energy as an expensive technology that might reduce independence from external energy sources and regarded it as less efficient "So what is there now energy has to be used up to what energy can be retrieved - this is my knowledge [emphasized] - something at 15 - 20% and that is completely ineffective, " (participant of the focus groups).

Although the initial investment of drilling is high for deep geothermal energy, deep geothermal energy could compete with other technology economically over a long term"…if quite significant cost reductions can be achieved by research and development, standardisation and simplification", (Hirschberg et al. 2014:180). Most frequently mentioned within the cost frame is the idea to gain a certain independency from energy markets. One might interpret that the potential of geothermal energy to make communities independent from fossil fuels can be seen as a strong motivator in local decision making.

4.3.4 The environmental frame

The environmental frame refers to potential environmental impacts such as groundwater pollution, drilling noise (negative), but also to low CO2 emissions and low landscape impacts (compared to other RE-technologies) (positive). The overall picture within the discussions is a preference for negative aspects within this frame. Local and regional administrative bodies are responsible to avoid damages. The environmental frame is often part of technology research discussions (e.g., Lakoff, 2010).

4.3.5 The risk frame

The risk frame refers to the understanding that technology might cause unfavourable developments. In the case of geothermal energy these are notably earthquakes and the damage of buildings. The risk frame is characterized by the two dimensions of controllability and responsibility which come into play in moral judgment. The case studies show that in the risk frame negative assessments dominate quite clearly. Only in few statements risks are assumed as being low and controllable. Actions that are supported within this frame are manifold and contradictory. They reach from: no further development of geothermal energy to: further investigation in order to know potential risks, communication of risks, and the development of appropriate strategies to deal with risks, e.g. appropriate insurance models. Scientists are seen as responsible to advance knowledge on risks and local politicians as well as project developers to develop strategies for dealing with risks.

4.3.6 The emerging and innovative technology frame

The emerging and innovative technology frame emphasises the fact that deep geothermal energy technology is an innovative technology that is still under development. If the development of the technology will succeed is unsure as the following citation indicates: „So far it is not clear if deep geothermal energy will be applied nationwide or if this pilot project will be the only project" (participant of the focus groups). Within the discussions the dominant moral evaluation highlights the innovative character and the potential of the technology to serve human beings. The frame supports an openess towards technology development and experimental strategies. Actions that are possible within this frame reach from a commitment to continue research and development in order to generate knowledge and take evidence based decisions to abandon short term expectations on low cost energy. Most important actors within this frame are scientists who generate knowledge and advance technology development, but also regional and national political bodies that support this research and development.

2. CONCLUSION

Deep geothermal energy is seen in both communities as a potential contributor to a successful energy transition in Germany. It is understood to be a renewable energy type that delivers continuous energy (heat and electric power) and allows local communities to have a greater independence from energy imports (mainly oil and gas). The national goal of transforming the energy system towards a higher usage of renewables was strongly supported in both communities.

Contrary to this positive view, the citizens and stakeholders in all focus groups brought forward numerous arguments criticizing deep geothermal energy. The main argument thereby has been that the technology is not matured enough in Europe and invites several risks, reaching from environmental damages to impacts on infrastructures such as buildings. Critical arguments are obviously inspired by negative events reported by mass media in the context of geothermal energy, such as the rise of some central buildings in the German city of Staufen and earthquakes reported in the context of deep geothermal drillings in Basel, St. Gallen and Landau.

Based on the analysis of focus group discussions in two German communities, we revealed frames that are used by local people to make sense of geothermal energy and develop a shared understanding of this topic. The majority of participants referred to more than one frame concerning geothermal energy. This shows the variance of interpretations used by local actors make sense of this technology. These interpretations furthermore allow for manifold actions. Thus, a dichotomous view on local responses on geothermal energy – support or rejection, positive or negative – falls short.

Social scientists suggested the renewable frame within the focus group format, but not all participants followed the initial frame. Besides the renewable energy frame, five other frames have been identified that are used by local actors to make sense of geothermal energy: risk frame, cost frame, regional development frame, environmental frame, emerging and innovative technology frame. Interestingly, the risk frame that has a high salience in national media is not clearly supported by local actors. In addition to the frames that mirror the debate in mass media - risk frame and cost frame, (Leucht, 2012, Stauffacher et al., 2015) - we identified a regional development frame. This frame is applied when local actors link the development of the innovative technology to specific regional contexts. As our analyses show, in all focus group discussions references to all 6 frames can be found. However, not all participants share all frames and also the intensity in which arguments belonging to a specific frame are used, differs between the groups. Especially the renewable energy frame isn't shared. This hints at a rather critical view on local level on the understanding of geothermal energy as renewable energy.

In all focus groups geothermal energy was mainly discussed under a technological frame. It was emphasized in both communities that projects introducing the technology in its current, not mature state of development are seen as potentially dangerous for infrastructure and buildings, as well as for the environment. The participants argued that deep geothermal energy could pose economical risks for local communities and the whole society. However, the potential of the renewable energy in national (energy transition) and regional contexts has been seen and therefore the need to foster research and technological development was expressed. Even though when the negative arguments dominated in some parts of the discussion, a general support for the development of geothermal energy was stated in the final statements of the focus groups.

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