Published on Energy Policy 101 (2017) 561–570
http://dx.doi.org/10.1016/j.enpol.2016.11.013

Geothermal energy and the public: A case study on deliberative citizens' engagement in central Italy

Anna Pellizzone a,c,∗ , Agnes Allansdottir b, Roberto De Franco c, Giovanni Muttoni a, Adele Manzella d

a) Università degli Studi di Milano, Dipartimento di Scienze della Terra 'Ardito Desio', via Luigi Mangiagalli 34, I-20133 Milano, Italy

b) Fondazione Toscana Life Sciences, Via Fiorentina, 1, 53100 Siena, Italy

c) CNR, Istituto per la Dinamica dei Processi Ambientali, Via Mario Bianco 9, 20133 Milano, Italy

d) CNR - Istituto di Geoscienze e Georisorse, Via Moruzzi 1, I-56124 Pisa, Italy

*Corresponding author: Anna Pellizzone, E-mail address: pellizzone.anna@gmail.com.

Keywords: Geothermal energy, Public engagement, Social acceptance, Common goods, Trust, Italy.

ABSTRACT

This paper reports on a case study on the citizens' engagement with developments towards the harnessing of geothermal energy in central Italy. The research has been conducted within the framework of a larger project on the feasibility of further geothermal developments in Italy, funded by the Italian government. The aims of the case study research were first to explore the role of public and stakeholder engagement in the processes of innovation in the geothermal energy sector. Second, to design, implement and consolidate a methodological framework for comparative analysis of case studies on citizens' engagement, thus bringing a social scientific perspective into geothermal energy research. The results show general support for renewable energy but knowledge and understanding of the potential of geothermal is remarkably low. Lack of trust in politics and unsure public communication emerged as prominent themes where the common good and community developments are sharply contrasted with corporate and private interests. As geothermal energy is included and encouraged under the European Strategic Energy Plan and in the Paris agreement on halting climate change, the results can make significant input into future policy making, by providing concrete guidelines on citizens' engagement in processes of culturally sustainable innovation.

1. Introduction

1.1. Geothermal energy in Italy

Accessible geothermal resources have been used for more than a century for direct use (heating and cooling) and for indirect use (electricity generation by power plants). Geothermal technologies are currently producing base load electric generation in 24 countries (12.6 GW of installed capacity, see Bertani, 2015) and are used directly for heating and cooling in 78 countries, generating 163.7 TWh/yr of thermal energy in 2015 (Lund, 2015), with geothermal heat pump (GHP) applications having the widest market penetration. Thanks to recent technological development it is estimated that future geothermal deployment could meet more than 3% of global electricity demand and about 5% of the global demand for heat by 2050 (Goldstein et al., 2012).

Currently, geothermal energy is considered a strategic and sustainable resource that can help with putting societies with access to such resources on the path towards a decarbonised future, as articulated in the European Strategic Energy Technologies Plan.[1] Worldwide, a new Global Alliance on responsible

[1] The European Strategic Energy Technology Plan (SET-Plan) was defined in 2015 with the aim to accelerate the development and the deployment of low-carbon technologies. It seeks to improve new technologies, promote research and innovation, bring down costs by coordinating research and helping to finance projects. It also promotes

development of geothermal energy was approved at the Paris summit on climate change.[2] In the light of these recent developments community engagement with geothermal energy is clearly of prime interest.

Geothermal technologies are considered to be environmentally advantageous because they don't need combustion process emitting carbon dioxide (CO2), with the only direct emissions coming from the underground fluids in the reservoir. Local hazards arising from natural phenomena, such as micro-earthquakes, may be influenced by the operation of geothermal fields, but they seldom reached levels high enough to lead to human injury or relevant property damage, and the expertise developed in such cases should be sufficient to prevent similar events in the future. Climate change is not expected to have any major impacts on the effectiveness of geothermal energy use, and the widespread deployment of geothermal energy could actually play a meaningful role in mitigating climate change.

Current levelized costs of heat (LCOH) from direct uses of geothermal heat are generally competitive with market energy prices, and levelized costs of electricity (LCOE) are relatively low. However, geothermal projects have relatively high upfront investment costs. High-temperature geothermal resources are already economically competitive with market energy prices in many locations but have restricted geographic distribution. To support the development of lower-grade hydrothermal resources, which are widely distributed, public and private support for research along with favourable deployment policies may be needed.

Although geothermal energy has the potential to provide long-term, secure base-load energy and greenhouse gas (GHG) emissions reductions with minimum and manageable environmental risks, it currently enjoys only modest growth per year with respect to solar or wind technologies. From ancient roman thermal baths to the construction of the first geothermal power plant in Larderello (Borzoni et al., 2012), Italy has historically played a leading role in the cultivation of geothermal resources, and 25% of the energy demand of the Tuscany Region comes from geothermal resources. Italy has recently experienced controversies over the further development of geothermal resources for energy production, an on-going dispute over the development of the Monte Amiata (southern Tuscany) geothermal field. The issues raised regard potential risk to human health and the environment but questions are also raised about the adequacy of the technologies and infrastructures in place for the harnessing of geothermal resources (Bravi and Basosi, 2014).

In order to characterize, classify and map the conventional and non-conventional geothermal resources of Central and Southern Italy and to understand the eventual reasons for opposition or support to geothermal technologies, the Italian National Research Council conducted a research project "AtlanteGeotermico del Mezzogiorno". As energy issues and policies strongly impact society the project also includes studies on the assessment of social acceptance.[3] This project is an important opportunity for two main reasons: (1) recent interest in the use of geothermal technologies using different enthalpy levels of geothermal resources has increased, however knowledge and understanding of the potentials of this renewable energy source and its implications for the general society seems to be rather low; (2) geothermal technologies and their impact on society are particularly interesting since they cross a variety of questions: environmental (i.e. water usage, drilling and exploitation risk, gas emissions), socioeconomic-political (i.e. procedural and

(footnote 1 continued) the cooperation amongst EU countries.http://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan

[2] At a global level, in the context of the 21st Meeting of the Conference of the Parties of the United Nations Framework Convention on Climate Change in Paris, a coalition of 38 countries and over 20 development and industry partners joined forces in the Global Geothermal Alliance. The GGA is a platform for enhanced dialogue and knowledge sharing within the constituency as well as for coordinated action to increase the share of installed geothermal electricity and heat generation worldwide.

[3] This is also in line with the recent innovation policy approach by the European Commission termed Responsible Research and Innovation (Owen et al., 2012; Van der Hoven, 2013; Von Schomberg, 2013),

distributional justice, public engagement in science, carbon lock-in debate, costs) and innovationrelated (smart grids, the role of prosumers, new geothermal technologies).

1.2. The New Energy Societies framework

Recently, many authors have pointed out that the social sciences still play a relatively minor role in energy research (Pidgeon et al., 2014; Stirling, 2014; Sovacool, 2014). “Energy advocates, the climate change community, and related policy makers need to recognize that energy production, consumption, and policy are both social and technical domains” (Sovacool et al., 2015, p. 95) and society plays an active role in either accelerating or preventing the development of new energy technologies. Carefully designed and conducted public engagement activities are examples of the contribution of the social sciences and are based on the assumption that research and innovation (R & I) can gain important input and insights from societies and communities in terms of their hopes, concerns, needs, resistances, knowledge and experiences. As Sheila Jasanoff has eloquently written (2004, p. 5): “the need for a generative discourse for discussing the role of science and technology in society is abundantly clear. What happens in science and technology today is interwoven with issues of meaning, values, and power in ways that demand sustained critical inquiry”. Science impacts on society as well as society impacts on science: “in a word, [science and society] are co-produced, each underwriting the other's existence” (Jasanoff, 2004, p. 9). This is particularly pertinent for renewable energy technologiesthat (1) require sustained and diffuse efforts from all stakeholders (public, investors, governments) and (2) need to overcome a series of technical, economical, cultural and political barriers posed by the energy system in which we live in, which is mainly locked in on fossil resources (carbon-oil-gas; Lehmann et al., 2012).

Implementing research and innovation programs with social scientific research is vital for a culturally sustainable development of energy technologies, and in this respect, opposition to new developments should neither be approached by a deficit model of public understanding of science, nor regarded as phenomena driven by selfishness, ignorance or irrationality (Batel and Devine-Wright, 2015). The motivations and the mechanisms underpinning social behaviors and attitudes should instead gain centrality in the innovation process itself, and conceptual frameworks that assume a top-down approach in innovation -such as the Nimby hypothesis - should definitively be overcome (Breukers and Wolsink, 2007) More nuanced concepts such as place attachment have been proposed (Devine-Wright, 2011) but still rest on the tacit assumption that only opposition to developments is a worthy object for social scientific research. Rather, researchers need to take a broader view on community engagement with technology innovation, taking into account issues such social trust that plays a pivotal role in social and community acceptance of technology development (Bell et al., 2005; Gross, 2007, Greenberg, 2014).

Similarly, innovation policy becomes a matter regarding all social actors in which careful and sensitive forms of public engagement are required. Public engagement is not only a matter of R & I improvement, it is an essential feature of democratic decision making processes. See Fishkin, (2009) and Thompson (2008) for detailed discussions of the processes of deliberative democracy; Hagendijk and Irwin (2006) and Wilsdon and Willis (2004) for a discussion of deliberative public engagement. Although the literature on public engagement with geothermal energy and new deliberative exercises on the energy issue are rapidly growing, contemporary literature on social issues relating to the development of energy technologies risks to become an unfertile list of disconnected studies (Stilgoe et al., 2014). A first case study on the views of stakeholders and local communities on harnessing geothermal resources in southern Italy was reported by Pellizzone et al. (2015); in this paper, we report on a second case study from central Italy using the same methodological approach.

1.3. Geothermal energy and social acceptance: a short literature review

The literature on the social acceptance of geothermal energy is still scant but growing on a global scale. First of all, public views on uses and developments of the geothermal energy are highly differentiated, in

fact attitudes evolve over time and vary across places. For instance, concerns about eventual risks related to the activities of geothermal harnessing are strongly place-related: in Australia (Carr-Cornish and Romanach, 2012; Dowd et al., 2011) participants seem to be much more concerned about adverse effects on water usage than in southern Italy (Pellizzone et al., 2015), where concerns about eventual induced seismicity is more salient, or in Greece (Polyzou and Stamataki, 2010) where people are typically worried about air pollution. In southern Italy (Termini Imerese, Sicily), deindustrialization and unemployment are sources of concern, and thus the eventual development of job opportunities related to the geothermal harnessing has a very strong effect on the views of the public, stakeholders and decision-makers. Beyond the issue of potential risks, a fair distribution of benefits (i.e. reduction of utility bills and taxes; increased employment; innovation development) is also a key determinant of the acceptability of geothermal developments in Termini Imerese (Pellizzone et al., 2015). Levels of knowledge and awareness also seem to differ between and within different countries: the Greek islands of Milos and Nisiros registered higher levels of knowledge of geothermal energy than Sicily, but there are also some differences between the two islands (in Milos the knowledge about geothermal energy is highest in the age group between 40 and 50 years old, while in Nisiros the same applies for the young and middle-aged adults).

Stakeholders' attention towards the opportunity of geothermics in energy transition, risk uncertainty, technology benefits and handicaps, and economic issues also change over time. For instance, Stauffacher et al. (2015) show that in Switzerland media attention towards geothermal technologies peaked after threedistinctevents: the Basel 2006 and St. Gallen 2013 earthquakes, allegedly triggered by geothermal exploitation activities, and the halting in 2010 for technical and economic reasons of the Triemli deep drilling geothermal project in the city of Zurich, which started only one year earlier.

The debate on deep drilling for energy production in Italy was reignited by the tragic 20th May 2012 Emilia-Romagna earthquake in northern Italy, a region hosting hydrocarbon as well as geothermal resources, these latter the source for the Ferrara geothermal project.[4] Have energy-related human activities in the area triggered the seismic events? This debate was also amplified by the interlocutory conclusions reached by the Report issued by the ICHESE (International Commission on Hydrocarbon Exploration and Seismicity in the Emilia Region) Panel, which claimed that "it cannot be excluded" that hydrocarbon activities in the Cavone oil field initiated the 20th May quake (Cartlidge, 2014). This debate is strongly perceived as linked to – but sometimes confused with – the alleged application of the 'fracking' technology that has mostly been developed in the US and has recently become a highly contentious issue in Europe, particularly in the UK.

Fracking for the extraction of unconventional fossil fuel has given rise to protests centred on the possible contamination of water resources, extreme water consumption and induced seismicity. Public support or opposition have therefore become a key issue in the policy story-line of fracking. Social science research on the use of deliberative focus groups with lay publics strongly indicates that institutional framings of fracking are poorly aligned with actual publicconcerns. The institutional narrative of fracking relegate the "participation" or the "engagement" of the public to the passive role of assimilating knowledge, arguing that the motivation for opposition lies in a "failure on the part of the public to recognize the benefits of fracking", which means that people need to be "reassured by institutional commitments to effective risk assessment and management" (Williams et al., 2015).

2. Methods

2.1. Overview on methods used in the literature

[4] The Ferrara district heating and cooling uses the geothermal sources in an integrated system together with a biomass plant. The project was launched after the energy crisis of the 70' by the Municipality of Ferrara in order to exploit the geothermal resource as a primary source.

Although the literature on the societal aspects of geothermal technologies implementation is scarse, some interesting case studies have recently been published (Polyzou and Stamataki, 2010; Dowd et al., 2011; Carr-Cornish and Romanach, 2012; Pellizzone et al., 2015; Kubota, 2015). In general, these studies rely upon qualitative methods (focus groups, workshops, interactive conferences), or quantitative methods (surveys) and in some cases also media analyses (Stauffacher et al., 2015; Romanach et al., 2015).

Given that a comprehensive theoretical framework able to describe public responses to energy innovation is still work in progress (Stilgoe et al., 2014), we built our approach on the following key elements: (1) the use of a mix of quantitative and qualitative methods as the best solution for a comprehensive, replicable and comparable description of single case studies; (2) the comparison with the results from similar investigations on the social acceptance of other energy technologies (i.e., wind and solar plants, fracking, etc.) or facilities siting (wind farms, nuclear plants, railway lines, etc).

2.2. Sources of data

This case study was conducted in the province of Viterbo (Latium Region) incentral Italy. The area includes two of the main geothermal districts of the Tuscany-Latium region: Mt. Cimino-Vicano and Vulsini. In particular, the area around the city of Viterbo is of great geothermal interest (Barbier et al., 2000; Buonasorte et al., 1995; Cataldi et al., 1995; Della Vedova et al., 2001; Geothopica, 2009). Several thermal springs and wells are located in this area and some of these have been known for their therapeutic properties since Roman times. Currently, these thermal waters are used to supply thermal spas, public pools and other direct uses (Baiocchi et al., 2013). The geothermal assessment indicates temperature over 75 °C at about 1000 m depth, and suggests that the area is suitable for geothermal power production using geothermal binary technology (Chiocchini et al., 2010 and references therein).

The CNR selected Viterbo as a significant case study for three main reasons: (i) it was the site of an unsuccessful development of a binary cycle geothermal power plant prototype in 1999 (Latera) and it was also the site of a nuclear power plant than converted (Montalto di Castro) into a multi fuel power plant; (ii) the current debate about the source of arsenic contamination of ground water, which is over the threshold value prescribed by the law; and (iii) the proximity to the southern Tuscany geothermal province, where consistent local opposition has been brewing lately, especially in the Monte Amiata area.

2.3. Data description

Data were collected with the same combination of (a) qualitative (focus groups) and (b) quantitative (survey) methods used by Pellizzone et al. (2015) in the Termini Imerese (Sicily) case study. The research ensured the comparability of the two case studies while allowing local issues, hopes, and concerns to emerge. Focus groups refer to collective interviews of semi-structured type with the aim of eliciting the views and opinions of participants with different backgrounds from those of the persons initiating the interview (Krueger and Casey, 2009; Morgan, 1997). Focus groups discussions allow participants to express their priorities on the subject proposed and to "further elaborate upon their points of view on the subject under discussion, resulting in a more fine-grained or nuanced picture of the societal fabric that future policy-making will impact" (Pellizzone et al., 2015, p. 4). We designed 4 focus groups with 8 participants each; the discussions were conducted according to a common guide in order to guide the discussion without preventing the emergence of relevant issues. Each focus group lasted around an hour and a half and was moderated by a facilitator and an observer who helped, when necessary, to keep the debate into the guide lines and invite participants to express further their knowledge and opinions.[5] All focus groups

[5] The participant in four focus group were recruited by a survey agency and involved four different groups of citizens and stakeholders from the selected area: (i) a homogeneous sample of University students (Students Focus Group), (ii) members of the general public of Viterbo (Citizens Focus Group), (iii) local politicians (Politicians Focus Group), and (iv) local activist in environmental associations (Environmentalists Focus Group). All the discussions were recorded and

began with a short presentation what is meant by “geothermal resources”, both direct and indirect actual and potential uses. The duration of the presentation was around 10 min, using explanatory slides for technical issues, images of geothermal related activities and suggested sources of further information for interested participants. This presentation was the same one used in our previous case study in Sicily. All discussion were conducted to the same funnel format, with the issue of energy in general raised as the opening issues and discussions then turned increasingly specific. Discussions were very lively and the moderator had little or no use for the extra probes that had been prepared.

Survey results should be interpreted as useful indications of the distribution of given sets of beliefs across social groups. A telephone survey of a sample of 400 citizens living in the Viterbo Province was conducted by a survey agency.[6] Twelve closed questions on energy, environment, and renewable energy issues compose the survey. All questions, except one, were ranked on a six-point scale ranging from 1 (very low level of agreement/acceptance) to 5 (very high level of agreement/acceptance), and including 0 to for uncertain agreement/ acceptance. The questionnaire was inspired by the same basic format of the Eurobarometer series of surveys on European societies and technological developments (e.g. Gaskell et al., 2000, 2010, 2011).

3. Results

3.1. Salience of energy issues and renewable technologies

As a general introduction to the topic of geothermal energy development, questions about how pressing energy issues are perceived opened both the survey and the focus group discussions. In general, energy issues are clearly perceived as pressing (very pressing, salient or at least partially pressing) by a large majority of respondents: about 15% of the interviewed perceived it as very pressing, 30% as extremely pressing urgent, 31% as somewhat pressing (Fig. 1). Focus groups discussions resonated with the results from the survey: energy issues are perceived as very pressing at the moment for several reasons. “[Energy issues] are very important at the moment and we also need to find solutions that respect the environment” (Student focus group). The main reasons for this sense of urgency are firstly related to environmental issues (pollution caused by traditional energy sources, gas emissions and climate change), secondly to political issues (the energetic independence from other countries, the interest for a distributed production of energy), and thirdly to energetic issues (the need to find alternative energy resources and thus avoid the consequences of oil and gas exhaustion). Finally, economic reasons (i.e. lower utility bills, innovation in order to launch the local economy into new energy markets) emerged “Energy issues are very urgent… We should invest in renewable energies, in solar, wind and every source that is not oil” (Citizens focus group) and “We need to direct our efforts towards renewable technologies, because non renewables have two big limits: the first is that they are expected to run out, the second is that they are polluting the environment” (Environmentalist focus group).

FIGURE 1

(footnote 5 continued) later fully transcribed and prepared for textual analysis; key themes of the debate were then characterized. It is important to note that no particular proposals for developments were presented to the participants

[6] The sample was calibrated by: gender (52% female, 48% male); age (44% between 18 and 34 years, 37% between 35 and 54 years, 19% more 55 years and more); education (1% no education, 10% low school, 28% middle school, 44% high school, 18% university); job condition (6% entrepreneur, 4% retailer, 3% artisan, 19% employee/ teacher, 8% student, 21% housewife, 28% pensioner, 7% worker, 4% unemployed, 1% other job condition).

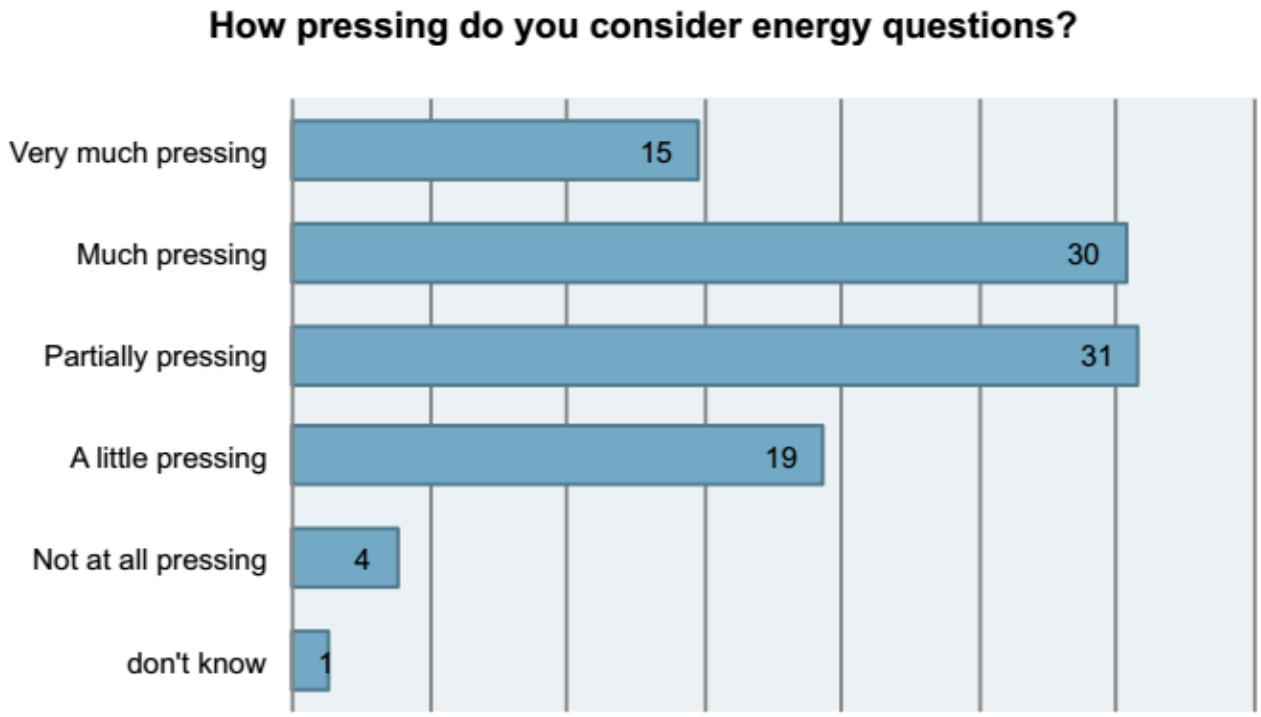

Fig. 1. Pressure of energy questions (data in %).

The survey attempted to prioritize these reasons by exploring the importance given to a set ofactions related to environment conservation, energy issues, and renewables development (Fig. 2). Environmental reasons seem to be considered more important than economic ones: 91,6% of respondents considered reducing pollution very important or important, 92,8% respondedthe same for energy conservation, and 85,3% for climate change mitigation. Respondents also considered the stability of energy prices and energy access of importance, but with a somewhat lower interest (price stability is considered very much important or very important by 86,3% of the interviewed, and energy access by 77,8% of them). The development of Renewables lies in the middle as far as relevance is concerned, with 49,3% of the respondents considering it very much important, and 37,8% very important.

During the focus group discussions, it emerged that renewables are immediately associated – and often proposed as a solution (or at least as a part of the solution) – to mitigating the energy dependence of Italy from oil and gas import: “We have to consider that we are the only country in Europe where a clear discussion on energy is missing. We have one of the highest cost of energy in the world” (Politicians focus group). According to the participants, Italy needs a clearer energy strategy, uniformly distributed across the country: “Maybe they [other countries] are wrong on nuclear, but they have taken also other choices, wind farms, solar farms, biogas plants also in the cities… Unfortunately these plants are all in the North. Here nobody has trust and the firms are afraid to invest” (Politicians focus group). Solar and wind energy are the bestknown green technologies, but also biomass, hydroelectric and geothermal are cited as possible alternatives to fossil fuel. Nuclear energy is often mentioned, but is perceived as very controversial and the potential risks mostly considered unacceptable. The excessive land use of solar and wind farming is also considered a threat: “Imagine the environmental impact of wind and solar farms all around the world. There would be no more agricultural farmers” (Citizen focus groups). Photovoltaic panels are mostly perceived as positive - when they are placed on buildings but not on arable land “Here in Viterbo there is a farm that has placed photovoltaic panels on the rooftop of the buildings without using a meter square of land” (Environmentalist focus group).

The survey included measure that allowed for the comparison with four other energy technologies (solar, wind, biomass, nuclear) and two controversial technologies (biotechnology, nanotechnology) (Fig. 3). When asked how this series of technologies would impact their life in the next 20 years (positively, negatively or with no effect), about 86% of the respondents answered that solar power would have a positive impact, while about 84,3% answered the same for wind power. For biomass, the rate of positive answers was important (43%), but the high rate of "I don't know" answers (43%) highlighted significant levels of uncertainty. Significant levels of uncertainty were also registered for nanotechnologies (59%), biotechnologies (34%), and geothermal energy (44%). Despite the impressive level of uncertainty, geothermal energy is perceived as anappropriate technology by 46% of respondents. Very negative views emerged towards nuclear energy: 73% of respondents thinkit would have a negative effect and only 16% thinks it would be positive.

FIGURE 2

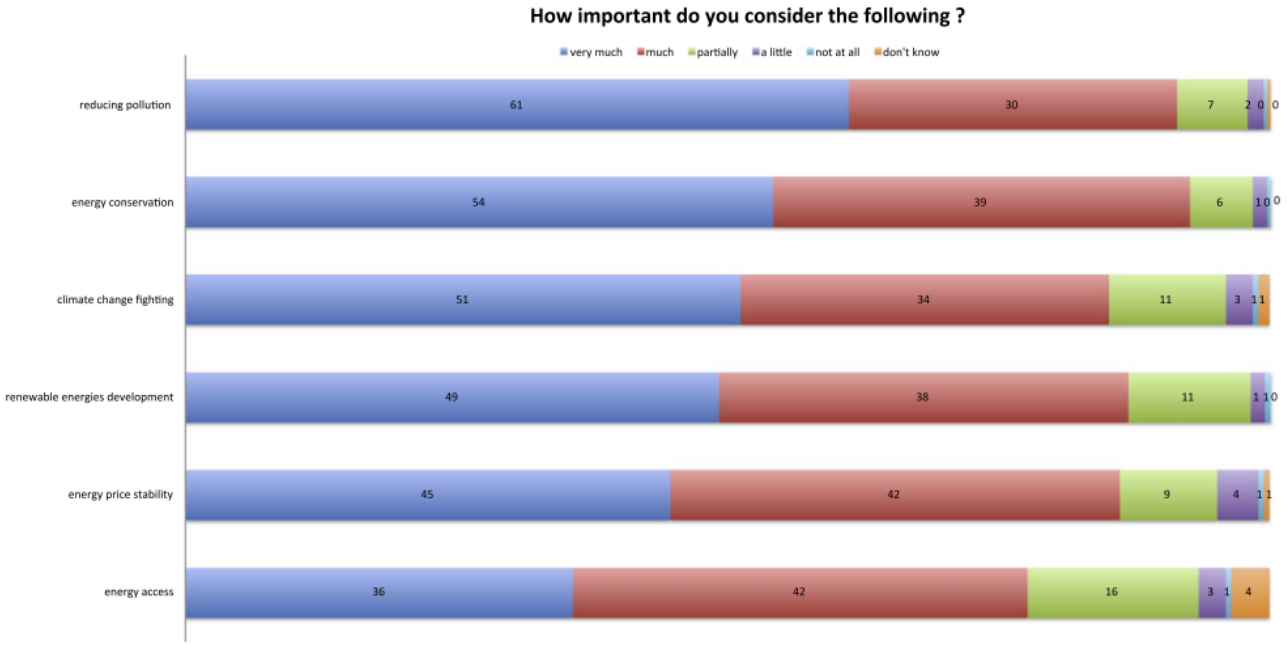

Fig. 2. Importance of a series of action (data in %).

FIGURE 3

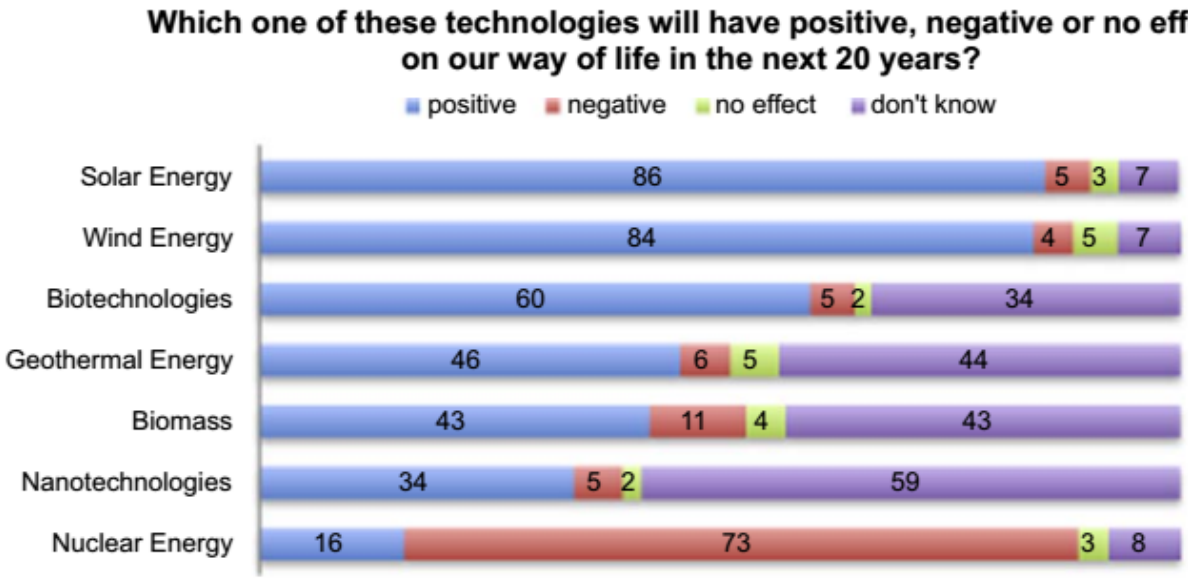

Fig. 3. Optimism about technologies (data in %).

High levels of uncertainty for geothermal energy are consistent with answers to the question "Have you ever heard about geothermal energy? ": less than half of the respondents (42%) answered positively. This resonated with low levels of knowledge about the geothermal option for energy supply recorded in the focus group discussion. A few participants showed a higher level of knowledge on geothermal resources: "I think low enthalpy could be interesting… but I disagree with the development of geothermal power plants" (Politicians focus group). Surprisingly, the geothermal power plant of Latera (built in the '80 s in the area and stopped after a short test time), was unknown to the general public: "If there was any attempt to exploit geothermal energy in this area, it was not publicized by the media" (Citizens focus group). The Environmental activists group was more sensitive and informed about geothermal technology and about the history of the Latera: "We still see what remains of the old geothermal power station, but I do not know much about this".

There are considerable geothermal resources in the area that have been used throughout the centuries in thermal baths but there does not seem to be any awareness for potential alternative uses. "They have [geothermal] in Tuscany, is it possible also here? " (Citizens focus group). Altogether, these findings suggest that at a very general level the opinion on geothermal energy are not yet consolidated and the issue needs to be discussed in public. However, some participants – involved in different focus groups - already have formed impressions both encouraging, or discouraging the development of geothermal technologies, indicating a coexistence of different points of view. What is clear, is that the public asks for more information in order to form solid opinions, acquire awareness on the issue, and participate in eventual exploitation programs.

3.2. Geothermal technologies and risk perception

Some concerns about potential risks associated to geothermal exploitation emerged in the focus groups: "I have heard that drilling can cause earthquake" (Citizens focus group),"[Geothermal exploitation] could cause water contamination" (Environmentalists focus group). Similar concerns were also evident in the survey results (See Fig. 4). Water contamination is a very sensitive issue at the moment, since the area has to deal with the problem of high arsenic concentrations in aquifers, a central issue in the local debate on water conditionsbecause of the geological features of the area: "You don't know how deep they drill and there is the possibility that they contaminate "good aquifer" with waters that contain arsenic; this is a big question and the Bolsena lake is the only one with waters that don't have high arsenic content"

(Environmentalists focus group). However, several participants do not seem to be worried about arsenic: “There has always been arsenic. But today it has become a political issue“(Citizens focus group). Some participants also noticed the business around the de-arsenification technologies: “Arsenic has also become like manna from heaven for my business sectors… However, I don’t think it is only a matter of concentration thresholds: we have some customers that have seen the concentration increasing in the last ten years from 10 to 15 µg/l to 49 µg/l” (Environmentalist focus group).

The question of potential micro-seismic phenomena related to drilling was also a very delicate issue fuelled by the recent controversial debate about the causes of the highly destructive earthquake that occurredin Emilia Romagna in 2012: “Some studies tell us that drilling activities have caused earthquakes in Emilia” (Environmentalists focus group). The debate about risks in all focus groups always led to the issue of lack of information (see next paragraph): “I think we need information from experts that can evaluate pros and cons” (Students focus group).

FIGURE 4

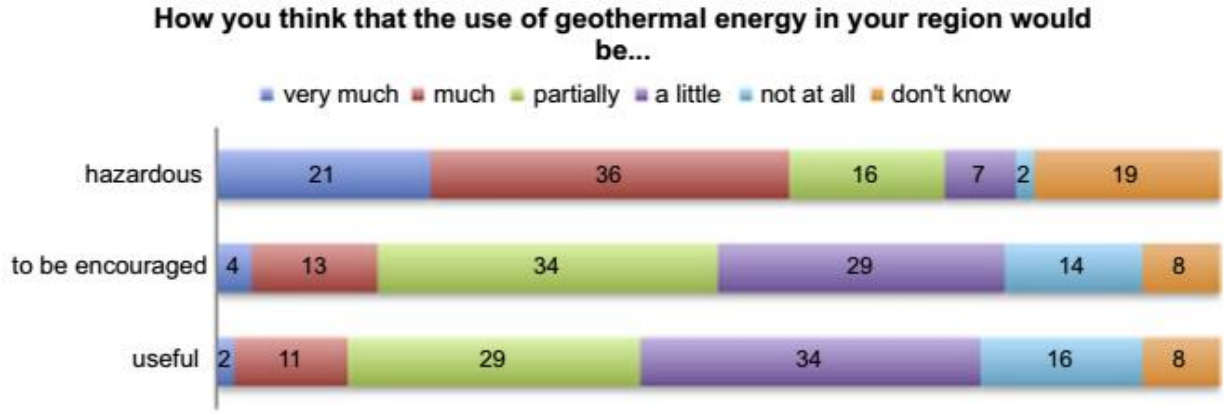

Fig. 4. Perception of eventual geothermal energy development in the area of Viterbo (data in %).

FIGURE 5

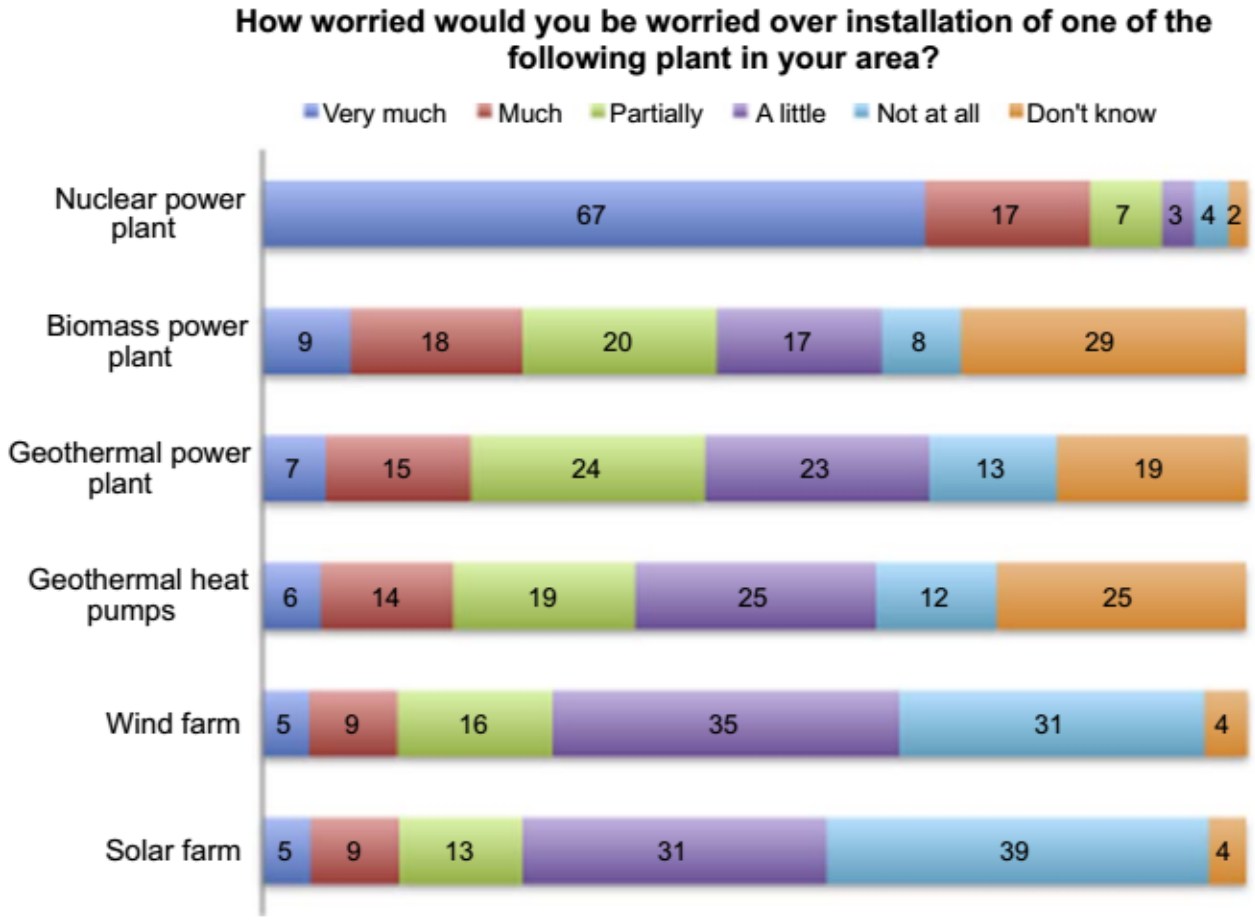

Fig. 5. Concerns about plants installation in the area (data in %).

We also explored risk perception related to geothermal development in the survey (Fig. 4): 57% of respondents think that geothermal energy would be very much or much hazardous; 17% think that it should be encouraged and 13% think it would be useful. The higher rate of "I do not know" answers (19%) in this case is related to hypothetical and unspecified dangers.

To further understand risk perception about geothermal exploitation, we asked respondents how worried they would be over installation of different energy plants in the area (Fig. 5). Highest levels of concern emerged for nuclear power (84% answered they would be very much or much worried). Lower levels of concern are related to solar energy (only 14% answered they would be very much or much worried) and wind farm (14% answered they would be very much or much worried). Concerning geothermal power plants, 22% of respondents declare they would be much worried or very much worried, 24% partially worried, and 36% not at all or a little worried. The level of uncertainty ("I do not know" answers) is 19%. Concerns about the use of geothermal heat pumps are a little lower than concerns about geothermal power plants (20% would be very much worried or much worried), but uncertainty ("I do not know" answers) is higher (25%).

The reasons for concern about geothermal power installation (Fig. 6) are either related to techno-scientific issues (emissions, environmental impact, micro-seismic risk, hazard for aquifers) or lack of trust (transparency of public institutions and private-sector speculations). The main reason of concern found in the survey is the lack of transparency of public institutions (32% very worried and 36% worried), followed by risks for aquifers (31% very worried and 31% worried). This was consistent with the outcomes of the

focus groups, where discussion on favorableness of geothermal exploitation was strongly related to trust in developers, politicians, and investors.

FIGURE 6

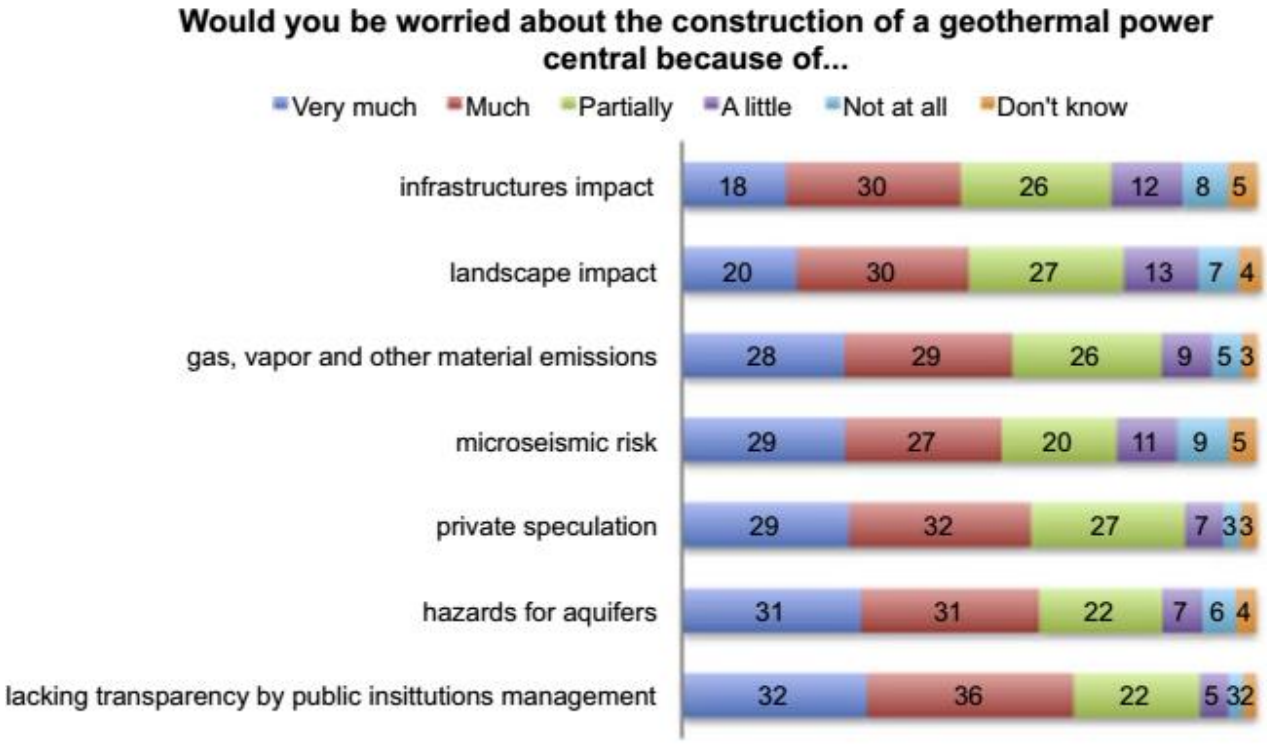

Fig. 6. Causes for concerns about geothermal power installation (data in %).

FIGURE 7

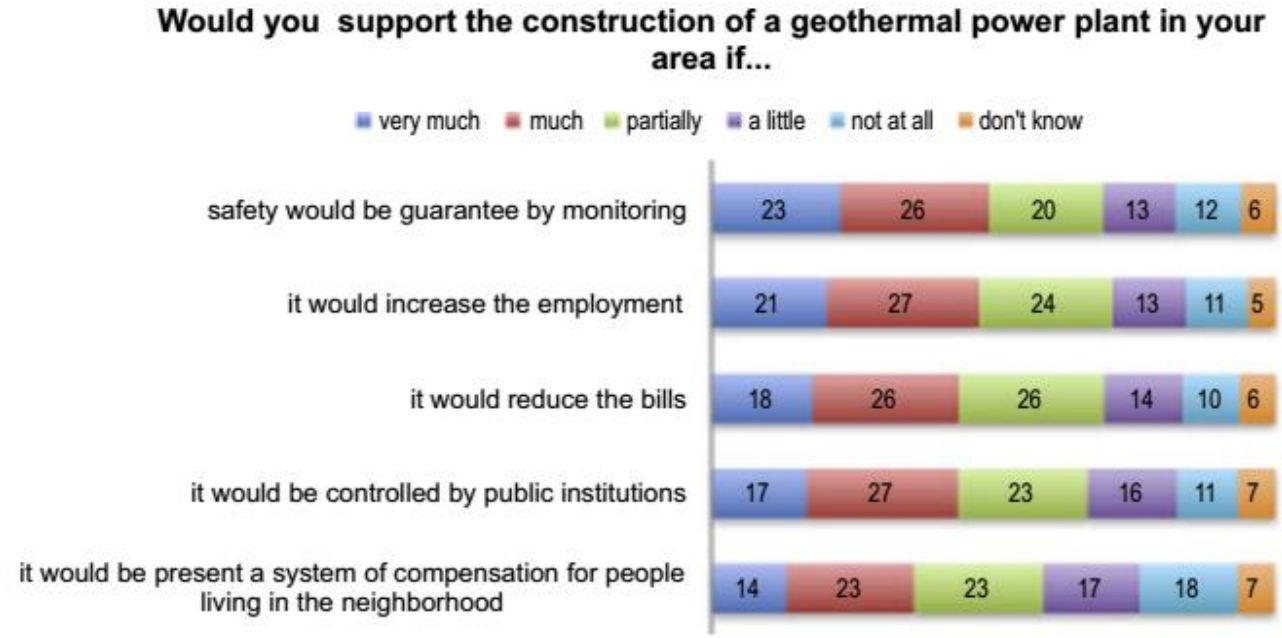

Fig. 7. Conditions for geothermal plant development (data in %).

Survey respondents were asked about the conditions that would have to be met in order to support geothermal plant construction in their area (Fig. 7). The most important turned out to be safety guaranteed by continuous monitoring, followed by increasing employment, reduction of utility bills, and control by public institutions. Compensation for people living in the neighborhood seems to be less of an issue. 3.3. Geothermal resources: past, present and future Some comments during the focus group show that the economic fabric of the area has strongly changed in the last years and that the local identity is in a crisis. “Viterbo used to be an agricultural, rural, city. Today it may be different. It has become an industrial city, but with the crisis some industries have declined. Concerning the touristic sector I don’t think there is the will to pin on tourism, it is enough to see how scruffythe roads are” (Citizens focus group). Some participants explicitly asked about the “mission” of the area: “Where do we want to go? We don’t know. We would have the resources: the mountains are close, the sea, the lake, the enviable climate condition…”(Citizens focus group). However, according to the focus group discussion a clear vision for the future is absent and the local government is not perceived as oriented towards a precise goal. The local University (Università della Tuscia) is also mentioned as a potential interesting sector for the future of the area. “Viterbo has several problems… It is a town for old people, but maybe the university is opening a new route”. And the development of specific courses in order to understand the potential of geothermal resources, its pro and its cons, is also encouraged. “I do not know how much the geothermal resources are considered by the local administrations. Maybe we also lack a geothermal curriculum in the scientific faculties of the local University… There are agrarian studies, economic studies… But there isn’t a geothermal course”. The formation and training of a new generation of researchers is seen as important havinga fair and ‘super partes’ information: “I would trust the new generation of recently graduated researchers” (Citizens focus group). However, an academic formation in the geothermal sector is not always considered a motivation for trust and the common conflict between experts of different disciplines was also discussed: “If you talk with an engineer studying the nuclear energy, you here that renewables cannot respond to the energy demand of the Country, if you talk with someone else, which is working in the renewables sector, you hear that they can” (Student focus group).

Local and distributed knowledge is also mentioned as an important resource for energy choices. The formation of experts that are both educated and local people could form competent, conscious and reliable people that can be consulted in case of necessity: “In my opinion, we should collect information from experts and people living here that have a local knowledge. This could be strategic” (Environmental focus group). Many participants are aware of thehydrothermal features of the area and encourage a sustainable cultivation of the renewable resources of the Province and of the Country as a whole.“Our Country has a very important position from the geographical point of view: we have the sea, the sun, the wind…” (Student focus group). The archeological, architectural and historical heritage of Italy is also mentioned as a resource: “Southern and Central Italy could live of arts and beauty” (Students focus group). In this general framework, on the one hand geothermal energy is partially describedas an intrinsic component of the environmentaland culturallocal heritage, interconnected with local tradition and promising for the development of new economic initiatives.“We live in a volcanic context, propaedeutic to geothermal studies and investments” (Stakeholder focus group); “Our land is full of hot underground waters, but it is not exploited, at least in the Viterbo Province, except from thermal baths” (Students focus group). Given the local thermal resources, several participants underline that the touristic development of spas is also underdeveloped if not neglected. “I wonder why they don’t renew the old baths. For sure it would be reasonable for the Viterbo”(Students focus group). Some participants considered the eventual development of geothermal power plants as a potential obstacle to the touristic attractiveness of the Viterbo Province. In particular, therisk of contamination is a source of concern: “A completely safe Bolsena lake can attract tourism, support the local economy and redevelop the territory. This is a land that points at the environmental conservation and on agricultural activities, if you destroy the water, you destroy everything” (Environmentalist focus group).

3.4. Responsibility, accountability and the narrative of common good

The discussion about geothermal technologies in all groups spontaneously moved toward information, communication and trust-related issues. Geothermal development is perceived as a very relevant issue that requires numerous considerations and a complex approach. Energy policy is linked to issues like land management, risks management, environmental and public safety that affect the everyday life of citizens and call for a higher sense of responsibility from stakeholders as well as more efforts in citizens' involvement.

A considerable crisis of public trust in political institution and disaffection towards politicians emerged in the discussions: "I'm very pessimistic, there are too many interests (Citizens focus group); "There is no political will to put to good use the competences that are present" (Students focus group); "I do not want to get interested in politics anymore" (Students focus group); "I did not vote: if you do not give me the food, I do not vote you" (Citizens focus group).

Distrust in political institutions emerged also in the survey: when asked about the competence of a series of actors in the energy choice policy, respondents show high level of trust in researchers and scientist (71% of them think that they are very much or very competent), while trust in public institution (European Union, National Government and Local Administrations) is considerably lower. Low levels of competence about energy choice are also associated with citizens (Fig. 8).

Focus group participants seem rather diffident towards the public authorities and strongly encourage the direct engagement of the public. The qualitative data that we have collected highlight a very interesting narrative that underpins the focus group debate: the individual responsibility of all stakeholders, whatever their role in the society, is invoked in order to pursue the common good, in this case, the development of renewable energies. Students contrasted the concept of common good with the private interests of oil, gas and carbon lobbies, or big companies to single individuals.

Environmental activists also focused the debate on the issue of public interest as the achievement of common good requires a longterm vision and widespread information actions. They also mentioned expert conflicts and about the contrast between individual and collective interests.

FIGURE 8

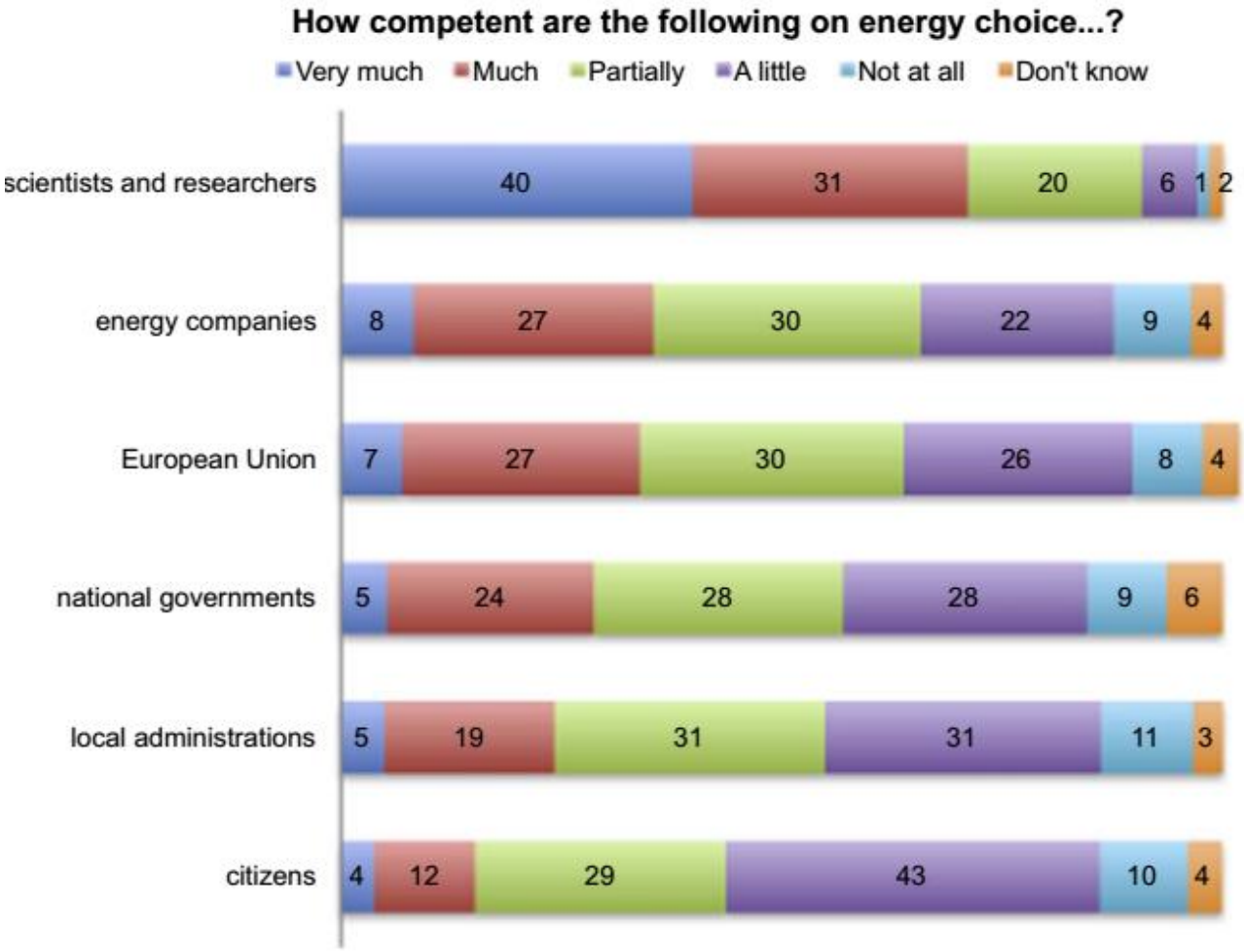

Fig. 8. Level of competence of different actors about energetic choices (data in %).

In focus group with citizens, the participants in appealed to the responsibility of individuals as controller of private and public actions that impact on the environment and they plead for high levels of care for land use. Citizens also showed high levels of trust towards experts “super partes”, but at the same time they think that public participation should be encouraged. However, they do not feel informed enough in order to express opinions and take decisions: “Citizens should be involved, but should be informed first”. Participants in stakeholder focus group also mentioned the need for informed public engagement and discussed the relevant role of individual responsibility. For them, the crisis of the Italian system requires a long-term vision towards the development of a new energy paradigm.

While participants ask for more information, they appear quite suspicious towards newspapers, magazines and TVs: “In Italy we have the problem that media are not independent” (Politicians focus group). The web seem to be considered the best platform to provide information: “Internet [is better], because the newspapers can’t say the truth since editors are under political pressure” (Citizens focus group). Some interesting proposal also emerged for improved communication: “Reliable information could be attested by some form of certification: the web site could be marked by scientists or experts” (Citizens focus group).

In this scenario, experts (researchers and scientists) are perceived as the most trustworthy sources for information: “I would trust a new generation of young researchers” (Citizens focus group). Universities are perceived as rather free from interests: “Universities could at least be impartial” (Environmentalists focus group). However, and without any apparent contradiction, there was also a preference of local expertise: “In my opinion we should approach experts and local people because they are more informed about the area” (Environmentalist focus group).

Trust in scientists as reliable sources of information was also evident in the survey results. When we asked "How much do you trust the following as information sources", 76% of respondents answered that they trust very much or much universities and research councils, and 39% answered the same for non governmental organizations (NGO). Public institutions at different levels (local, national, European) were less trusted and respondents showed low levels of trust in energy companies and the media, (Fig. 9).

We also investigated on which issues respondents would want to have more information: 72% would have "much" or "very much" information on micro-seismic risk, 68% would do the same on environmental and landscape impact, and 66% on economical consequences (Fig. 10). Issues concerning geothermal resource exhaustion, plant management, and impact on the electrical grid have also high rate of interest, but lower than the others (Fig. 10).

FIGURE 9

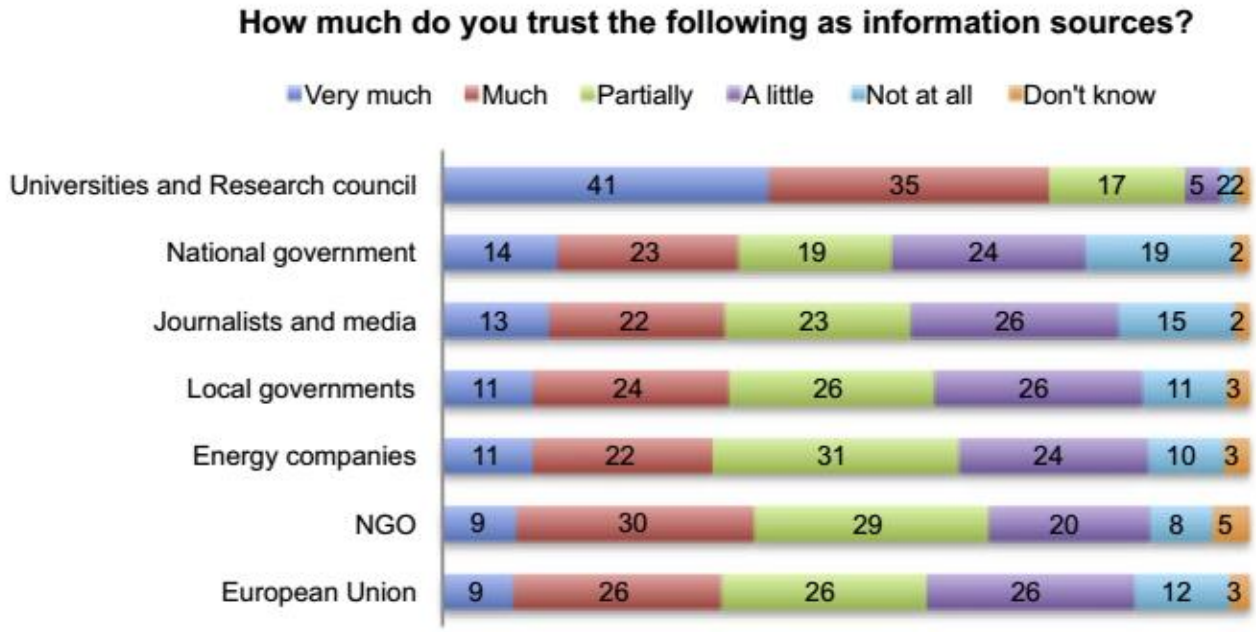

Fig. 9. Trust in information sources (data in %).

FIGURE 10

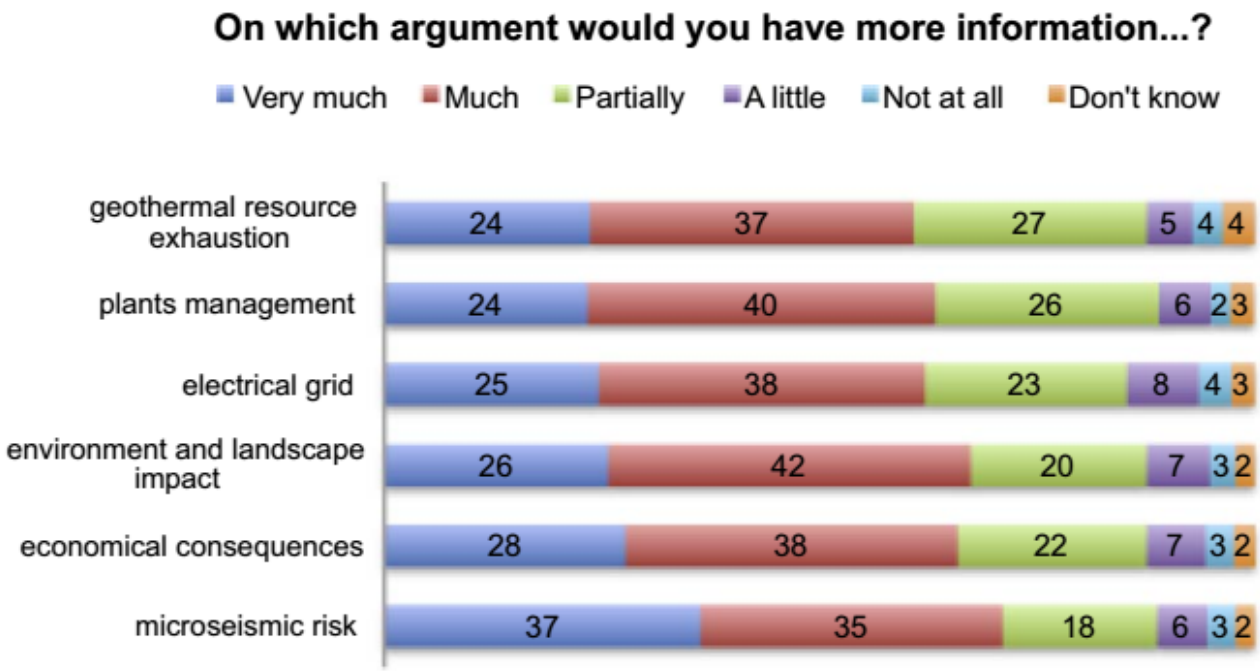

Fig. 10. Information required (data in %).

4. Discussion

4.1. The complexity of energy issues and Responsible Innovation

Our results show that energy issues are perceived as very urgent, politicized and in need of innovation. Renewable energies are considered with optimism but the public calls for more sense of responsibility by developers on land management and risks assessment. According to our results, energy is perceived as a very complex issue characterized by both (1) technical aspects (i.e. potential impacts on land, air, water, climate, health) and (2) social, philosophical and political questions (i.e. land management, facilities siting, distributional justice, geopolitics) Fig. 11.

Participants seem to demand that stakeholders in energy innovation become mutually responsible to each other, in other words that the views and concerns of all stakeholders are taken into account in decision making during innovation processes. “Conventional governance focuses on product questions, particularly those of technological risk” (Stilgoe et al., 2013, p. 1570), but innovation is also a matter of the processes and purposes of science and technology. The “how” and the “why” are to be considered as important as the “what”. The question here is if the current regulatory and scientific framework can respond to the need of responsible innovation. According to Callon et al. (2009) science and technology “overflow” the boundaries of the current scientific and normative institutional frameworks and require “new hybrid forums” for complex, democratic and enriched discussion on innovation. Forums that have not been fully developed yet but are on the horizon.

FIGURE 11

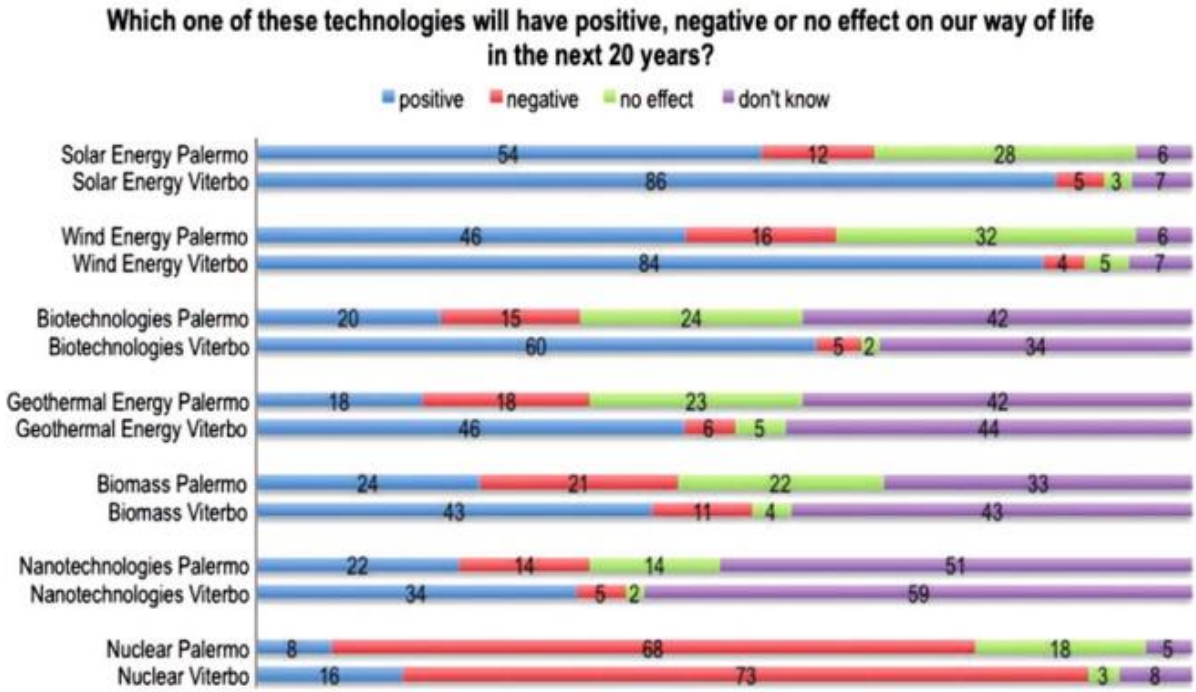

Fig. 11. Effects of a series of technologies on our way of life in the next 20 years (Viterbo and Palermo, data in %).

During the focus group discussion the assumption of a collective and individual responsibility for the common good (which is, in our case, a carbon lock-out system) is indicated as the only possible solution towards a more sustainable world. For an academic discussion on the notion of "the common good" see Dietz et. al, 2003 but it is worth exploring this lay notion of "the common good" further in the future.

4.2. Information as a pre-requisite for public engagement

Public engagement is based on the assumption that "diversity in research and innovation is vital for enhancing creativity and improving scientific quality". [7]The expression of this valuable diversity requires a shift from a one-way communication model, where the information move from experts to the public to a multidirectional exchange of knowledge between all stakeholders and collective reasoning. The importance and the capacity attributed to the web to gather information is probably due to the web being perceived as an independent and multidirectional source of knowledge. Perhaps this might be something of a myth or wishful thinking at the moment, but it certainly indicates forward thinking.

However, public engagement faces many challenges: as we found in our previous case study in Sicily, the first step required by focus group participants towards a fruitful citizens involvement is a distributed and concerted information action (Pellizzone et al., 2015). Even if people have a lot to say, they also don't feel competent or informed enough to play a strategic role in determining the innovation priorities and energy choices, or to evaluate the pros and cons of a given technology implementation. The lack of confidence expressed by the Viterbo citizens is mainly related to the Italian political scenario. Further, we found that participants in the focus groups live with an uneasy sense of diffidence and pessimism about the liability of the Italian system at a more general level and some of them identified as a problem the "philosophical crisis of the individual": low levels of knowledge, lack of responsibilities for common goods, absence of a trustworthy ruling class, and diffused corruption (see also Gennaioli and Tavoni, 2016), are all elements that seem to discourage people and distance them from the political stage. This leads to both the unwillingness to cooperate with public institutions (expressed also in high voter abstention rates) and the

[7] Rome Declaration on Responsible Research and Innovation, November 2014.

demand of a more direct role of the public in the decision process (i.e. in our case, the eventual cultivation of geothermal energy).

4.3. The social acceptance of geothermal energy

According to our study, renewable energies are in general perceived as a good option for a sustainable life, but their recent large diffusion has also opened new controversies mainly related to financial speculation and land use. Extensive use of arable land for solar parks in the vicinity is strongly contested and the same holds for wind farms. This perception is linked to environmental sensibility but also to bad Italian experiences related to unfortunate speculative use of public incentives. In particular, geothermal energy is perceived as a potentially positive technology, but questions about risks are mainly related to water contamination and potential micro-seismicity. Monitoring activities are perceived as positive in order to reduce risks and make geothermal technologies acceptable. The public also invokes equity in the local distribution of economic advantages as a condition for acceptance of geothermal innovation.

Emerging technologies typically have intrinsic levels of uncertainty but eventual knock-on effects and values-related controversies could be anticipated by public dialogue. The high level of complexity emerged from the insights of our research confirms that energy management needs public engagement for both (1) risks evaluation and (2) ethical considerations. These two aspects of energy management find their corresponding elements in the dichotomization of trust into confidence related to competence, and into social trust related to values (Greenberg, 2014). The importance of trust should not be underestimated: several literature studies (Bell, 2005, Gross, 2007) show that the nature of the decision process can strongly affect social acceptance and that the opposition to single facilities can be determined by the perception of an unfair and technocratic decision making process. Our findings support the claims of these authors. The notion of social trust in case of uncertainty is intimately linked with the issue of sense of place and identity The importance of local knowledge and history in the management of energy choices was a recurrent theme in all the focus group discussion across a range of issues.

The four focus group discussions were very animated and showed that value-related considerations (i.e. human and environmental health, social justice, equity in the distribution of benefits and risks, solidarity between generations, sustainable growth, transparency and accountability of decision makers) should be considered as key components of the innovation process. The participants in the focus groups all expressed appreciation for the chance they have been offered to debate on these issues and showed great interest in the further development of research on community engagement with geothermal energy.

5. Conclusions and policy implications

5.1. Conclusions

This study shows a general support for renewable technologies, wind and solar energy are thought to have a positive impact on our lives by a large majority of the population of the Province of Viterbo. Further, we observed a strong interest towards geothermal technologies, even if the debate around this energy resource is still shrouded in uncertainty. The discussion around the geothermal technology development regarded both (1) technical and (2) ethical issues. Probably because of local experiences (i.e. high arsenic concentration in the local waters), the technical concerns are mostly related to the eventual exposure to water contamination, but participants also ask for more information around the eventual risk of micro-seismicity. However, the main concerns that emerged from the discussion regard social and ethical issues. A general distrust towards the decision makers colored the whole debate and questions were raised about the distributional justice of risks and benefits, the exposure to corruption and the willingness to collaborate for a sustainable future. All the abovementioned issues - information, trust, environmental and benefits/risk arguments – were interrelated by the leitmotiv of “the common good”, which means here to take care of the natural environmental, aiming at a desirable future for human (and not only human)

beings. At a general level, the Viterbo participants ask for a sustainable, just and honest path that, according to their views, should be freed from private and corporate interests and oriented towards the needs of the community. A poignant contrast emerged between what respondents perceived as the common good for responsible harnessing of local sources of geothermal energy for sustainable community development and corporate and private interests of power actors and stakeholders.

5.2 Policy implications.

The two case studies on public engagement are the first such research activities in Italy in the geothermal sector. The general lack of trust towards the decision makers and confusion over adequate communication processes that emerged in this study makes citizens' engagement in the innovation process a high priority for the future of the development of the geothermal energy sector.

According to the European Strategic Energy Technology Plan, our research can provide important insights and ideas towards delivering of best practice guidelines for future socially sustainable developments in the geothermal sector. Together with other analysis of a series of deliberative democratic engagement exercises with renewables, the Viterbo case study can contribute to the definition of a toolkit for responsible and culturally responsive innovation in the energy sector. These efforts can be considered as a first step towards a systematization of the participation policies and recommendations that should be accompanied by concerted information campaign and mutual learning exercises. Although this research is focused on geothermal energy, the same approach could be applied for the public engagement with other energy technologies. The outcomes of this research could have significant impacts on future developments in the energy sector and to foster socially sustainable approaches to future policy making to ease the transition to low carbon societies. The energy transition requires an intense, widespread and continuous social dialogue and our results represent an important step towards the provision of new tools and practices for opinion exchange, stakeholders engagement and mutual learning are therefore needed in order to reinforce knowledge, awareness and collaboration between all societal actors and across countries.

5.3. Further research

This case study carried out under the ATLANTE project was designed to be directly comparable to a previous case study conducted in Sicily (Palermo Province, Sicily), carried out under the VIGOR project, funded by the Italian government. The presentation of both cases has been primarily descriptive in order to provide an overview of social acceptance of geothermal energy in different parts of Italy. This approach has shown that participant' sceptical positions in the two case studies are conditioned by two different frames of the same narrative, which is the narrative of a lack of common responsibility in the name of collectively desirable benefits. In the Viterbo case study the prevalent views were related to the contrast between the common good and private/corporative interests, while in the Sicilian case study the distrust was mainly associated with the issue of corruption. Further research will focus on conducting new case studies, also outside Italy, using the same framework and elaborating more on public discussions about everyday or lay notions about "the common good" that so strongly framed the discussions in the focus groups.

Acknowledgements

The AtlanteGeotermico (Geothermal Atlas) is a research project aimed at assessing conventional and unconventional geothermal resources for power production in southern Italy. The projects refers to nine regions, and is related to medium-high temperature resources for power production, providing maps related to the distribution and favourability of territories to host hydrothermal systems, as wells as EGS, magmatic, supercritical and geopressurized conditions. The project is funded by the Italian government and carried out by CNR and focused on the characterization, classification and imaging of conventional and non

conventional resources of southern Italy for power production. The authors gratefully acknowledge the considerate and helpful comments of anonymous reviewers on earlier version of the manuscript.

References

Baiocchi, A., Lotti, F., Piscopo, V., 2013. Impact of groundwater withdrawals interaction of multi-layered aquifers in the Viterbo geothermal area (central Italy). Hydrogeol. J. 21, 1339–1353.

Barbier, E., Bellani, S., Musmeci, F., 2000. The Italian Geothermal Database. Proceedings of the world geothermal congress, 28th May – 10th June 2000, Kyushu-Tohoku, Japan.

Batel, S., Devine-Wright, P., 2015. Towards a better understanding of people's responses to renewable energy technologies: insights from the Social Representations Theory. Public Underst. Sci. 24, 311–325.

Bell, D., Gray, T., Haggett, C., 2005. The 'Social Gap' in wind farm siting decisions: explanations and policy responses. Environ. Polit. 14, 460–477.

Bertani, R., 2015. Geothermal power generation in the world 2010–2014 update report. In: Proceedings of the World Geothermal Conference, Melbourne, Australia, 19–25 April 2015.

Borzoni, M., Rizzi, F., Frey, M., 2012. Social-multi criteria evaluation of alternative geothermal power scenarios: the case of Mt. Amiata in Italy. In: Bi-annual Conference for Ecological Economics, Rio De Janeiro, Brazil. ⟨http://www.isee2012. org/anais/pdf/680.pdf⟩ (accessed 22.04.13).

Bravi, M., Basosi, R., 2014. Environmental impact of electricity from selected geothermal power plants in Italy. J. Clean. Prod. 66, 301–308.

Breukers, S., Wolsink, M., 2007. Wind power implementation in changing institutional landscapes: an international comparison. Energy Policy 35, 2737–2750.

Buonasorte G., Cameli G.M., Fiordelisi A., Parotto M., Perticone I. Results of geothermal exploration in Central Italy (Latium-Campania). In: Proceedings of the World Geothermal Congress, vol. 2, Florence, Italy, May 1955, pp. 1293–1298.

Callon, M., Lascoumes, P., Barthe, Y., 2009. Acting in an Uncertain World: An Essay on Technical Democracy. MIT Press, Cambridge, MA.

Carr-Cornish, S., Romanach, L., 2012. Exploring community views toward geothermal energy technology in Australia. CSIRO, Pullenvale, Australia ⟨https://publications. csiro.au/rpr/download?Pid=csiro:EP129117 & dsid=DS5⟩.

Cartlidge, E., 2014. Human activities may have triggered fatal Italian earthquake, panel says. Science 344, 141.

Cataldi, R., Mongelli, F., Squarci, P., Taffi, L., Zito, G., Calore, C., 1995. Geotherm. Rank. Ital. Territ. Geotherm. 24, 115–129.

Chiocchini, U., Castaldi, F., Barbieri, M., Eulilli, V., 2010. A stratigraphic and geophysical approach to studying the deep-circulating groundwater and thermal springs, and their recharge areas, in Cimini Mountains–Viterbo area, central Italy. Hydrogeol. J. 18, 1319–1341.

Della Vedova, B., Bellani, S., Pellis, G., Squarci, P., 2001. Deep temperatures and surface heat flow distribution. In: Vai, G.B., Martini, P. (Eds.), Anatomy of an Orogen, The Apennines and Adjacent Mediterranean Basin. Kluwer, Dordrecht, The Netherlands, 65–76.

Devine-Wright, P., 2011. Place attachment and public acceptance of renewable energy: a tidal energy case study. J. Environ. Psychol. 31, 336–343.

Dietz, T., Ostrom, E., Stern, P.C., 2003. The struggle to govern the commons. Science 302, 1907–1912.

Dowd, M., Boughen, N., Ashworth, P., Carr-Cornish, S., 2011. Geothermal technology in Australia: investigating social acceptance. Energy Policy 39, 6301–6307.

Gaskell, G., Stares, S., Allansdottir, A., Kronberger, N., Hampel, J., Mejlgaard, N., Castro, P., Rammer, A., Quintanilha, A., Esmer, Y., Allum, N., Fischler, C., Jackson, J., Revuelta, G., Torgersen, H., Wagner, W., 2010. Europeans and Biotechnology in 2010: winds of change. European Commission, Brussels.

Gaskell, G., Allansdottir, A., Allum, N., Castro, P., Esmer, Y., Fischler, C., Jackson, J., Kronberger, N., Hampel, J., Mejlgaard, N., Quintanilha, A., Rammer, A., Revuelta, P., Stares, S., Torgersen, H., Wagner, W., 2011. The 2010 Eurobarometer on the life Sciences. Nat. Biotechnol. 29, 113–114.

Gaskell, G., Allum, N., Bauer, M., Durant, J., Allansdottir, A., Bonfadelli, H., Boy, D., de Cheveigné, S., Fjaestad, B., Gutteling, J.M., Hampel, J., Jelsøe, E., CorreiaJesuino, J., Kohring, M., Kronberger, N., Midden, C., Nielsen, T.H., Przestalski, A., Rusanen, T., Sakellaris, G., Torgersen, H., Twardowski, T., Wagner, W., 2000. Biotechnology and the European Public. Nat. Biotechnol. 18, 935–938.

Gennaioli, C., Tavoni, M., 2016. Clean or dirty energy: evidence of corruption in the renewable energy sector. Public Choice 166, 261–290. Geothopica, 2009.⟨http://geothopica.igg.cnr.it/⟩.

Greenberg, M., 2014. Energy Policy Res.: Under. Trust. Energy Res. Soc. Sci. 1, 152–160. Gross, C., 2007. Community perspectives of wind energy in Australia.The application of a justice and community fairness framework to increase social acceptance. Energy Policy 35, 2727–2736.

Hagendijk, R., Irwin, A., 2006. Public deliberation and governance: engaging with science and technology in contemporary Europe. Minerva 44, 167–184.

Jasanoff, S., 2004. The idiom of co-production. In: Jasanoff, S. (Ed.), States of Knowledge. The Coproduction of Science and Social Order. Routledge, London, 1–12.

Krueger, R.A., Casey, M.A., 2009. Focusgroups: Apractical Guide For Applied Research 4th edition. SAGEPublicationsInc., ThousandOaks.

Kubota, H., 2015. Social acceptance of geothermal power generation in Japan. Proceedings World Geothermal Congress, Melbourne, Australia, 19–25 April 2015.

Lehmann, P., Creutzig, F., Ehlers, M.H., Friedrichsen, N., Heuson, C., Hirth, L., Pietzcker, R., 2012. Carbon lock-out: advancing renewable energy policy in Europe. Energies 5, 323–354.

Morgan, D.L., 1997. Focus Groups as Qualitative Research: planning and Research Design for Focus Groups. SAGE Publications Inc, Thousand Oaks.

Owen, R., Macnaghten, P., Stilgoe, J., 2012. Responsible research and innovation: from science in society to science for society, with society. Sci. Public Policy 39, 751–760.

Pellizzone, A., Allansdottir, A., De Franco, R., Muttoni, G., Manzella, A., 2015. Exploring public engagement with geothermal energy in southern Italy: a case study. Energy Policy 85, 1–11.

Pidgeon, N., Demski, C., Butler, C., Parkhill, K., Spence, A., 2014. Creating a national citizen engagement process for energy policy. Proceedings of the National Academy of Science of the United States of America 111,13606–13613.

Polyzou, O., Stamataki, S., 2010. Geothermal Energy and Local Societies - A NIMBY Syndrome Contradiction? World Geothermal Congress, 25–29 April, Bali, Indonesia ⟨http://www.metal.ntua.gr/uploads/4245/855/Gothermal_energy⟩⟨-⟩

Romanach, L., Carr-Cornish, S., Muriuki, G., 2015. Societal acceptance of an emerging energy technology: how is geothermal energy portrayed in Australian media? Renew. Sustain. Energy Rev. 42, 1143–1150.

Sovacool, B., K., Ryanb, S., E., Stern, P., C., Janda, K., Rochlin, G., Spreng, D., Pasqualetti, M., J., Wilhite, H., Lutzenhiser, L., 2015. Integrating social science in energy research. Energy Res. Soc. Sci. 6, 95–99.

Sovacool, B.K., 2014. Diversity: energy studies need social science. Nature 511, 529–530.

Stauffacher, M., Muggli, N., Scolobig, A., Moser, C., 2015. Framing deep geothermal energy in mass media: the case of Switzerland. Technol. Forecast. Soc. Change 98, 60–70.

Stilgoe, J., Owen, R., Macnaghten, P., 2013. Developing a framework for responsible innovation. Res. Policy 42, 1568–1580.

Stilgoe, J., Lock, S.J., Wilsdon, J., 2014. Why should we promote public engagement with science? Public Underst. Sci. 23, 4–15.

Stirling, A., 2014. Transforming power: Social science and the politics of energy choices. Energy Res. Soc. Sci. 1, 83–95.

Van den Hoven, J., 2013. Options for Strengthening Responsible Research and Innovation.Report of the Expert Group on the State of Art in Europe on Responsible Research and Innovation.doi: http://dx.doi.org/10.2777/46253. <http://ec.europa.eu/research/swafs/pdf/pub_public_engagement/options-forstrengthening_en.pdf⟩ > .

Von Schomberg, R., 2013. A vision of responsible innovation. In: Owen, R., Heintz, M., Bessant, J. (Eds.), Responsible Innovation. John Wiley, London, 51–74.

Williams, L., Macnaghten, P., Davies, R., Curtis, S., 2015. Framing ‘fracking’: exploring public perceptions of hydraulic fracturing in the United Kingdom. Public Underst. Sci., 1–17.

Wilsdon, J., Willis, R., 2004. See-through Science: Why Public Engagement Needs to Move Upstream. Demos, London, 1–69.