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Participatory repertoires for aligning policy and society: An analysis of Dutch stakeholder views on deep geothermal energy

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ABSTRACT

In a transition to a sustainable energy system, governmental actors initiate participatory processes to gain better insights in questions and concerns of stakeholders, or to create support for decisions. Those participatory activities are embedded in institutionalized and formal decision making procedures. Participatory approaches promise to function as alignment mechanisms between those policies and society. The aim of this paper is to contribute to more successful alignment mechanisms. Based on a thematic analysis of 18 interviews and approximately one hundred policy documents, we relate stakeholders' uncertainties about ultra-deep geothermal energy to their preferred modes of participation. These stakeholders were (in)directly involved in the Dutch Green Deal program, in this case the Green Deal Geothermal Energy in the province North Brabant. Based on the analysis, we identify four participatory storylines and develop a more systemic view on different participatory activities: 'participatory repertoires'. We conclude that unproductive power-politics between different political-administrative levels, and emerging local and wider publics that hamper alignments, may be prevented. This can be done by prioritizing societal dialogue on normative uncertainties in a range of combinations with local dialogue on normative, conceptual uncertainties, and with national or local joint fact finding on informational uncertainties.

1. Introduction

Despite growing consensus about the need to decarbonize the energy system [1], the planning of renewable energy infrastructures often faces public opposition and contestation [2–4]. Such siting controversies have occurred for all kinds of technologies, such as transmission lines, and solar parks, with wind farms being most prominently documented [5,6]. Such controversies can be traced back to multiple causes. A core cause refers to the wicked or unstructured nature [7] of renewable energy planning, which implies a range of uncertainties with respect to knowledge and values. This means that actors typically hold different problem definitions, i.e. understandings of what the problem is and how it should be solved. In such cases of different normative appraisals, conflict can easily arise [8–10].

In response to such conflicts, there is increasing emphasis on participation in energy policy and planning [11–14]. The literature on participation generally assumes three arguments for participation of stakeholders and citizens: empowerment, learning and legitimacy [15,16]. The idea is that successful participatory approaches add to formal governmental procedures by including societal norms, values and concerns in policy decisions [6,17,18], and to cocreate knowledge that is more usable for policy making [19]. In that sense, participation can be considered a mechanism to better align formal planning procedures with societal needs and values.

This paper aims to contribute to better alignment mechanisms by development of participatory repertoires - a coherent set of different participatory activities at different political-administrative levels that better include different types of local and wider publics. This is necessary, as the literature indicates that participation does not always lead to this alignment, and runs the risk of becoming too instrumental [19–21], or too academic [22]. In addition, there are many questions about the role of the public, the scope and openness of public participation [23].

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Studies also indicate that "participatory storylines" [24] play a role in a successful alignment between planning procedures and societal needs and values. Participatory storylines are "narratives that circulate around an issue on who constitutes 'the public,' and whether and how 'the public' should participate in the policy process" [24] (p.2). In recent literature, this public has also been referred to as an 'imagined public' that forms around issues [2,25]. One may expect different participatory storylines to exist, as stakeholders can have preferences for various combinations of (1) more open or closed stakeholder-participation, which may be (2) situated at different geographical or administrative levels, (3) that can address a decision at the policy level or the project level, and (4) can be initiated at different stages of decision making, for example in a planning or implementation stage. Hence, participatory storylines are foundational to actors' perceived appropriateness and legitimacy of participatory processes [24] (p14). For example, when participatory storylines of residents contradict those of a project developer, residents are likely to consider the proposed process in-appropriate [26].

The organizing question in our study was: what are the preferred participatory approaches in the case of (ultra) deep geothermal energy, and can they be combined into a set of participatory repertoires? Empirically, our focus was on a case in which stakeholders explored the possible implementation of an emerging zero-carbon energy technology: (ultra) deep geothermal energy ((U)DGE). Within the Netherlands, we studied the Green Deal Geothermal Energy North Brabant. As part of a European and National program, the province North Brabant, in the South of the Netherlands, created stakeholder engagement in which governmental actors, industrial partners and citizens' groups signed an agreement to collaborate by sharing knowledge and expertise in the development of five local geothermal energy projects[1] [27]. Geothermal energy is generated by natural radioactivity and by radiating heat from the core of the earth to its mantle. Shallow depth variants (from 100 m to 3 km underground) are typically used for heating homes and greenhouses. Deep and ultra-deep geothermal energy involves the pumping of hot water from undergrounds deeper than approximately 3 km. Some forms of (ultra) deep geothermal energy can be used for electricity generation. This is depending on accessibility to higher temperatures water, and with the application of enhanced geothermal systems [28] (p20). On the one hand geothermal energy is considered a promising sustainable energy source that may be used for heating, electricity production or a combination of both [29,30], and is considered stable and reliable [31]. On the other hand, (ultra) deep geothermal energy has also led to controversies in various countries due to the possible environmental risks [29,32]. As such, (U)DGE is exemplary of an emerging energy technology that comes with different questions and concerns in society, and possibly also with differences in preferred participatory approaches.

Based on a thematic analysis [33] of policy documents and 18 interviews with industry, governments, NGO's, citizens' groups, a journalist and two Dutch geothermal energy experts, we categorized their problem definitions, concerns and questions into four different types of uncertainties (informational, normative, conceptual and institutional, see Section 3). In addition, we inductively categorized their preferences for participation in three elements of preferred participatory processes (timing, scope and organizer). By combining the results from the analysis of uncertainties and preferred elements of the participatory process, we deduced four participatory storylines. These four storylines disclose possible 'participatory repertoires' - a combination of different types of participatory processes - for (U)DGE in the Netherlands.

We conclude that, in order to deploy participatory processes that do not contribute to power-politics between national and local administrative levels and better include emerging publics, it is important to develop participatory repertoires. These repertoires provide a more systemic approach to participation since they are well-argued combinations of societal and local dialogues in case of normative, conceptual and institutional uncertainties. Or combinations of dialogues with joint fact-finding processes in cases of informational uncertainties. This increases the likelihood that participatory processes will function as a mechanism to better align policy and society.

In section two, we present a conceptual framework for understanding stakeholder participation as an alignment mechanism. Section three describes the methods. The results of our analysis are presented in section four. The participatory storylines and repertoires s are discussed in section five. Section six offers a concise conclusion.

2. Stakeholder participation as an institutional alignment mechanism

Institutions play an important role in the development of (ultra) deep geothermal energy. Institutions can be defined as the rules of the game that restrict and enable actors' behavior, or as "humanly devised constraints that structure political, economic and social interaction" [34] (p.97). Institutions can be formal and informal. Formal institutions refer to rules and regulations, such as permitting procedures, legal division of roles and responsibilities between actors, and procedures for assessing proposed policy plans (such as an Environmental Impact Assessment, Cost Benefit Analysis). Informal institutions refer for example to routines, traditions, or codes of conduct.

Institutions provide stability and structure to a system and serve to align the domain of politics and policy with the societal domain. For example, the energy sector in the Netherlands is heavily regulated. When it comes to deep geothermal energy development, there are rules and regulations regarding subsurface activities and legal procedures for the planning of infrastructural projects. Yet, in the energy system that is in transition, existing institutions are constantly challenged. This can take different shapes and forms. First of all, technological development may raise questions about the appropriateness of formal institutions, such as rules and regulations. For example, hydraulic fracturing for shale gas in the Netherlands raised questions about the appropriateness of the Dutch mining law and European rules and regulations [8,35]. Another Dutch example is the dispute about the pricing of heat via district heating, which is currently linked to the price of natural gas. This makes it hard to develop business models for new sustainable modes of district heating using residual heat and geothermal energy to replace natural gas for residential heating, which is currently a widespread policy ambition in the Netherlands. Second, different publics, including lower tier governments may dispute national regulations [36,37]. Often these protesters argue that the decision-making procedures are unfair or intransparent [38,39], or for example, the scope of an Environmental Impact Assessment is too narrow [10,17].

In these situations of apparent institutional mismatch, the formal and informal institutional arrangements do no longer function as effective alignment mechanisms between the political, policy and the societal domain. These situations will time and again occur as institutions are relatively stable and often only slowly co-evolve with the development of new technologies and public norms and values. Emerging technologies and new emerging publics will permanently challenge current institutional arrangements. When this includes societal debate, it can be described as a process of "overflowing", in which existing rules and norms, that guide expectations and define the spaces in which interactions may take place, are no longer sufficient in guiding these interactions [18].

One way in which politicians and policymakers respond to these "overflows" is by organizing participatory processes, for example of stakeholder or public engagement. Participation takes place in many shapes and forms. The approaches ranges from institution led to citizen led, and from participation in deliberations to participation in actions with material commitments [40]. The approaches have different levels

[1] https://www.greendeals.nl/green-deals/geothermie-brabant accessed 23-6-2022.

of influence for participants ranging from communication, consultation to deliberation and coproduction [21,41], and vary in their geographical or administrative scale. Participatory processes as developed in practice also have many different objectives. They are frequently proposed as a policy instrument to clarify perceived problems and possible solutions in order to foster societal embedding of, and raise support for technologies [42]. The idea is that successful participatory processes add to formal governmental procedures by including societal norms, values and concerns in policy decisions [17] other processes aim to cocreate knowledge that is more usable for policy making [19], to delegate decision making [14], or to better include local expertise or empower citizens in order to participate in democratic decision making [6,21,43]. Participation can therefore be regarded as a mechanism that aligns formal planning procedures with societal needs and values [8], by including societal norms, values and concerns in policy decisions [11], and by cocreating knowledge that is better taking into account local interests and expertise for policy making [19]. Ideally, participatory processes lead to more inclusive democratic decision making, better knowledge-integration, provide otherwise undisclosed information, unlock deadlock, and may lead to adaptation of the formal alignment mechanisms, in such a way that these are regarded as adequate and fair by a majority of the involved social actors [20,21,44].

Participatory processes, however, do not always foster a better alignment between politics and society. It may even increase societal resistance and enlarge the gap between formal decision making and societal needs [20,45]. Invited public or stakeholder engagement can lead to less trust in governing actors or less acceptance of proposed technologies. Studies show that public influence matters for the acceptability of projects and public perception of the type of energy technologies but that full influence is not necessarily preferred [3]. This can be due to different expectations about the political decision making or planning process and the role of public participation within it, the technology, or about the design of the infrastructure project. Very often, participatory processes are merely a consultation process, rather than one of coproduction [22]. If stakeholders have different problem definitions, it is likely that they will also hold different ideas about what stakeholder participation in the planning process should look like. For example, if one sees planning of renewable energy technology as a techno-economic issue, participation may be seen as a means to reduce planning risks by gaining societal support [45], whereas if one sees energy planning as an opportunity for energy citizenship, participation may be seen as a vehicle to promote empowerment and ownership.

A mismatch between stakeholders' appreciation of participatory processes and that initiated by governing actors is well thinkable [46–48]. These different appreciations may discredit participatory processes that attempt to align formal decision making with society, as they may be perceived as "support machines" [49] and too instrumental [22,50], rather than genuine attempts to contribute to institutional alignment. Actors involved can have different participation rationales, which may vary from instrumental, to normative and substantive [21,51]. A typical example of a mismatch between these rationales relates to the so-called Not In My Back Yard (NIMBY) phenomenon in siting issues for energy production. When an actor – government or industry for example – expects local publics to be driven by NIMBY motivations, for example the prevalence of private interests over the public interest, participation processes are likely to be geared towards rebalancing private and public interests [5]. This is done by compensation and emphasizing the importance of the project for the energy transition (i.e. the 'common good'). However, the NIMBY argument often overlooks other concerns that stakeholders may have, for example procedural, distributive, or normative and ethical concerns [52,53]. The participatory process based on the first NIMBY rationale will likely not be appropriate to address the latter concerns, and may even lead to more resistance rather than alignment. Something similar may happen with existing formal institutional arrangements, such as compensation measurements by governments that may well be perceived as attempts of bribery [54,55]. In order to improve the alignment mechanisms between society and policy, it is important to better understand what different problem definitions, concerns and questions there may be among different groups of stakeholders, and particularly how these are related to preferred types of participatory approaches.

3. Methods

3.1. Case study

Our research is an exemplary case study [56,57] into deep and ultra-deep geothermal energy in the South of the Netherlands. We focused on the province of North Brabant that signed a Green Deal with industrial and societal actors to explore and promote options for (U)DGE at five locations [58]. Involved stakeholders were: three municipalities, the province of North Brabant, a semi-public energy fund, two drilling engineering companies, three industrial stakeholders, a provider of heat networks, one agricultural stakeholder, non-profit housing corporation, a citizens' initiative that produces local energy, and a citizens' group. The case was studied upon request of the province of North Brabant to inform national and regional political decision-making and public debate about (ultra) deep geothermal energy. This case is exemplary of an emerging energy technology that currently is considered promising in the sustainable energy transition, but has the potential to develop into a controversial energy technology due to on the one hand its promise and potential, and on the other hand the wide range of uncertainties associated with it. The (U)DGE case is one case, and still evolving. This study should thus be considered a snapshot of a very dynamic playing field of which plausible conjectures ([59], p31) can be made, but no generalizable claims. New participatory storylines may develop over time and may be different, in other energy cases, which may also give new insights in participatory repertoires.

3.2. Data gathering

The case study is based on the analysis of approximately one hundred policy documents about (ultra) deep geothermal energy in the Netherlands. These consistent of the relevant national, regional and local policy documents. This included documents by the municipalities, the province and national government, the state supervision council on mining activities (SODM), for example the Green deals, the Energy deals, national energy policies and the national zoning instrument, the structure vision for the underground provided a source of information. These documents used to gain insights in the policy ambitions, concerns and the state-of-the-art knowledge about the technical features of (U)DGE production.

Second, a team of five interviewers conducted a total of eighteen interviews. Interviewees were selected based on their participation in the Green Deal agreement on geothermal energy. We selected at least one representative of each of these stakeholder categories: industry, government, NGO, and citizens' groups, and experts. In order to include a broad variety of perspectives, we also interviewed other stakeholders not directly involved in the Green Deal but possibly affected by it, such as protest groups and environmental and nature conservation organizations (NGO's). We complimented the interviews with two expert interviews in order to gain in-depth knowledge about the technical issues, the risks and uncertainties (see Appendix 1). A first round of semi-structured interviews was held in the autumn of 2016. After the first round of interviews it became apparent that several interviewees had rather unclear definitions of ultra-deep and deep geothermal energy. In the spring of 2017, we therefore used a second round of interviews to add clarification. Based on semi structured interviews, we asked the interviewees about their definition of deep and ultradeep geothermal energy (U)DGE, the role of geothermal energy in the energy system, the questions and concerns they have about (U)DGE, and their preferred participatory process. The interviews lasted about an hour and were

recorded and transcribed. All the interviewees were orally asked for consent and permission to record the interview. The interviewees received both the interview report and a description of their views on geothermal energy and the appreciation of a stakeholder dialogue, and they were asked to check this for inaccuracies. We agreed to include direct quotes anonymously. Therefore, the examples in the results section are anonymized. Upon request, we can share the list of respondents. A limitation in our data may be that we miss some of the stakeholders. We selected one representative of each stakeholder category; however, there might be different perspectives within one stakeholder category.

3.3. Data analysis: identifying participatory storylines

We conducted a thematic analysis [33] which is "a method for identifying, analyzing and reporting patterns (themes) within data"(p.79) of the policy documents and transcribed interviews. This meant that in step 1 of the analysis one of the researchers went through all the documents without a theoretical conceptualization. The researcher coded the documents and interviews manually and themes were inductively identified and categorized when comparing different problem definitions, concerns and questions, and the preferred participatory processes proposed by interviewees and in the documents. In step 2, with the research team, the three interviewers and two researchers, we discussed the themes and patterns that had been inductively identified in step 1, and established main themes and patterns. At this stage we were able to identify types of uncertainties and preferred elements of participatory processes. In step 3 we related those patterns between types of uncertainty and elements of participatory approaches to those known in academic literature. This thematic analysis is of an explorative nature, and this limits the generalizability to other cases. However, the results can be used in further research to verify if similar patterns between types of uncertainties and preferred participatory processes are present in other cases of (U)DGE.

4. Results: perceived uncertainties and preferences for participatory process

This section presents the analysis of uncertainties and preferences for participatory process of stakeholders in the Dutch case of (U)DGE.

4.1. Types of uncertainties

In the categorization and clustering of the themes emerging in the data, we categorized those in four types of uncertainties: informational, normative, conceptual and institutional.

4.1.1. Informational uncertainties: three technical issues related to safety and risks

Informational uncertainties are the knowledge gaps and knowledge controversies which lead to disputes about the validity and applicability of claims to relevant knowledge. These uncertainties for stakeholders can be related to scientific, technical and economic uncertainties [28,60]. In the interviews and policy documents, many technical questions and uncertainties were raised about ultra-deep geothermal energy. We identified three sources of informational uncertainty.

First of all, interviewees identified uncertainties about the geological structure of the underground. These questions range from determining the best location – what location is best accessible and has the best temperature, and address possible issues with faults, seismic issues, and water pressure. These questions were raised by NGOs and industry, and most of the experts. As one local stakeholder remarked "The risk that I foresee in the Netherlands is that potentially interesting areas for geothermal energy are located around faults. And then perhaps an earthquake caused, you get the same discussion as in Groningen [where earthquakes are induced by decades of natural gas extraction]" (Interview#1-17). This is in line with studies into risk perception that indicate that induced earthquakes raise more negative emotions; but also that acceptability of those risks was higher when citizens had a voice in decision making about the implementation of GE [61].

Second, in both the interviews and policy documents, uncertainties about the drilling techniques were raised. These uncertainties are about failure rates of a drill that are now up to 90 % and how to reduce these to 20 % or a maximum of 50 %. Uncertainties also relate to the question whether there will be a need to apply fracking. For example, another local interviewee said: "I cannot say at this stage whether it is necessary to apply fracking. I happen to know, because of course I was in the offshore industry that it did happen there, but 'Brabant Water' [a public drinking water company] is included" (Interview#1-13). In addition, specific questions were raised about the casings of the drills and if these were strong enough – or could be made strong enough – to avoid spills and blow outs. The same interviewee mentions: "But that doesn't mean you destroy those layers. But that's also a matter of using the right techniques in the right way. And that is not necessarily the case. Whether this should be applied in this case needs to be examined in more detail" (Interview#1-13). These informational uncertainties were most of all raised by industry, governmental actors and experts. A third group of uncertainties concerned safety for the environment, for example the impact of drilling on the environment, and more specifically also risks of drinking water contamination or earth quakes. Most of these uncertainties were asked by NGOs, industry and governmental actors. As one governmental actor said (Interview#1-17): [there are questions about] "the impact is on the environment, drinking water". Will there be leakages, heat radiation, or earth quakes? We do have some knowledge, but we lack insights from monitoring real time cases.

The informational uncertainties stem partly from lack of knowledge, but also expert-stakeholders, such as the drilling companies and governmental experts, raised these uncertainties, indicating that they lack data for the specific locations and techniques.

4.1.2. Normative uncertainties: desirable and necessary

In the analysis of normative uncertainties, we included all the statements in policy documents and interviews about the desirability and necessity of applying (ultra) deep geothermal energy production techniques in order to produce more renewable heat and electricity. All consulted stakeholders were in general positive about the potential contribution of geothermal energy to a more sustainable energy system. They consider (ultra) deep geothermal energy as necessary and desirable. The majority of the interviewed stakeholders was committed to further explore this emerging technology, including a national environmental protest group: "Geothermal energy can certainly play a role, but the question is whether it is an important source of energy. This depends also on the application. It is now most of all being used to replace natural gas for heating green houses. This is a good application. But, the question behind this is: does the Netherlands need to produce tropical agriculture on such a large scale?" (Interview#1-08). However, there are some notable differences between the actors.

First of all, stakeholders vary in their appreciation of the necessity of ultra-deep geothermal energy. They all were positive about further investigations to establish what role ultra-deep geothermal energy in the overall sustainable energy supply could play. However, stakeholders had different opinions about the necessity and affordability of this energy source. Second, stakeholders mentioned three different objectives for (ultra-)deep geothermal energy production. One group – mainly local actors including local government and citizens' groups – had doubts about the necessity, but they believed that geothermal energy may be a way to realize an *affordable* heating system for people living in low-income neighborhoods. For example, one citizens' group emphasizes: "we have three goals: (1) improve the heating network in our neighborhood (2) make energy cheaper (3) ensure free choice of warmth supplier" (Interview#2-13). A second group – mainly industrial actors – considered deep geothermal energy as a means to reach their sustainable energy targets (as a business), for example CO2 reduction. "We are

collaborating with other [industrial partners] that also want to become more sustainable […] and can make money out of this" (Interview#1-10). A third group – including two governmental organizations and one of the NGO's – was especially concerned about the potential negative impact on the landscape and the drinking water supply and if those risks would outweigh possible benefits (Interview#1-02; Interview#1-08; Interview#1-15).

Hence, the normative differences about the desirability and necessity of (ultra) deep geothermal energy production were often closely related to the different interests and values of stakeholders. These varied for (1) those directly financially investing in drilling projects; (2) for those that considered (U)DGE necessary in the energy mix; and (3) for those stakeholders with more doubts about this necessity most of all due to concerns about the environment.

4.1.3. Conceptual uncertainty: ultra-deep or deep or geothermal energy?

In the thematic analysis, we came across conceptual confusion about what Ultradeep GE is, and to what extent it differs from deep geothermal energy. This is in line with studies on public perception that show that the general public confuses shallow and deep forms of GE [62]. Our results show, that also in the academic literature and among other experts there is no consensus about the definitions, let alone that Dutch stakeholders understand and speak in similar and precise ways about deep, normal or ultra-deep geothermal energy. Different definitions were used, based upon depth, temperature of the water extracted, or techniques used. As one governmental organization said: "What I understand now, is that enhanced, is not only extra deep – this is what I thought before – but it has to do with fracking […] and a form of fracking that requires chemicals – and that evokes the shale gas discussion, and what does that mean?" (Interview#2-15). The Dutch institute of applied sciences (TNO) defines ultra-deep geothermal energy as 'sources characterized by a combination of great depth (approximately 3.5 km and deeper) and a temperature higher than 120 °C' [63]. TNO makes a distinction based on the application (heat or electricity), the depth and the temperature for the different types of geothermal energy. The Dutch State Supervision of the Mines (SSM) [64] speaks of ultra-deep geothermal energy for drillings deeper than 4 km, a depth at which heat of more than 180 °C can be extracted for industrial applications. The Dutch state-owned company involved in exploration and production of gas and other subsurface energy sources (EBN) defines ultra-deep geothermal energy based on the following characteristics: depth greater than 4 km, temperature of 100–250 °C, application in industry and cascading to other end-users.[2] EBN and SSM mainly use the 4 km limit because there is knowledge of the subsurface to that depth in the Netherlands (Fig. 1). EBN and SSM also include the type of application of heat in their definition: namely for industry. Yet another definition is provided by Platform Geothermal Energy – a network of organizations with an interest in geothermal energy production. They consider geothermal energy production deeper than 3.5 km as ultra-deep if indeed there is a steam temperature of 120 °C used for electricity generation. In the literature, the application of an enhanced geothermal system that converts steam into electricity is described as one of the more efficient systems to do so (e.g. [65]).

Conceptual uncertainty – the lack of a common (expert) definition of deep or ultra-deep geothermal energy – is also evident in the results of the interviews with stakeholders. Their understanding of the differences between deep and ultra-deep also ranged between shallow forms, and 3 km onwards, or even five, six, or 8 km deep. For example, a semi-public organization defined 'normal geothermal energy' in an interview in relation to the warmth of the water (Interview#2-15): "Normal geothermal energy has a temperature of about 80 to 90 °C and if you go deeper than it will around 110, 120, 130 °C which has other effects" And in the same interview: "all things said are about normal geothermal energy until 3 km." While others refer to that as deep or ultra-deep geothermal energy. For example, one of the drilling engineers explained (Interview#1-04): "the moment you want to use it for high temperature, for industrial applications than the 85–88 °C is useless". For industry, that is almost residual warmth." Hence the different use of deep and ultra-deep, seems related to the different wishes stakeholders have for application of the energy sources. Some define ultra-deep geothermal energy in relation to a district heating systems, and understand it most of all as a way to provide a local and affordable heating system (Interview#1-13). Those who consider it as an opportunity to make their local industrial firms greener, define ultra-deep geothermal industry based on industrial heat applications and refer to the temperature. For example, one of them explained (Interview#1-10): In this area we have the Trias formation that you need to go under to get enough heat: above 100 °C or more." From a national government perspective the distinction is a gradual one: "The result is that there is heat everywhere in the subsurface, but that it depends on the depth whether you can efficiently raise those costs or not. Where exactly is the boundary between ordinary or ultra-deep, I don't think we realize that there is a boundary somewhere. I think that limit is very gradual. The fact that geothermal energy is generally spoken of is generally from 3 to 4 km, maximum 5 km and ultra-deep goes to 7 or 8 km" (Interview#2-14). These types of conceptual uncertainties about the meaning of concepts to categorize the new technology can obscure the social issues related to it (cf. [60]).

4.1.4. Institutional uncertainties

An emerging energy technology such as ultra-deep geothermal energy comes with questions about the regulatory landscape. As described above, the energy sector in the Netherlands is heavily regulated, and especially the Mining law provides a relevant regulatory framework for (U)DGE. Next to that, national and local planning and zoning instruments are in place, and fairly recently also STRONG (a zoning instrument for the underground) has been issued.

A first set of uncertainties raised by the stakeholders and in policy documents relates to the mining law. This law regulates, among other activities, drilling for gas and oil. However, oil or gas fields on average are at a depth of 3 km, and ultra-deep geothermal wells can go much deeper. Particularly governmental actors, but also a drinking water company, and one expert questioned this regulatory appropriateness. One of the Ministries was also aware of the questions this raised (Interview#2-07): "According to the law, there is no distinction. The mining law states that everything deeper than 500 meter is geothermal and should be treated the same. But, the difference is that application. It was only applied in green houses, but now people want to apply it for the processing industry and it needs to be transformed into steam. That is different."

A second set of institutional uncertainties we identified, is related to the prevention or monitoring of environmental risks, specifically the risk of induced earthquakes and drinking water contamination under current regulatory frameworks. One of the national Ministries and one of the NGOs pointed out this issue. For example, the Ministry in an interview explained (Interview#1-14): "the core question is what we should allow for the mining sector, for geothermal energy. Do we think that geothermal energy can be retrieved in the areas with ground water – reservoirs for drinking water. Do you want to be stricter there?" There are differences: some stakeholders consider risks to be unacceptable under any circumstance. Others consider the use of specific techniques, such as hydraulic or chemical fracking, unacceptable because they find them too risky for the environment and drinking water quality (Interview#1-08). Other stakeholders take a more procedural stance. They want the risks to be managed properly and weighted against other interests by national, provincial and local governments – but are not sure about whether these procedures are in place (interview#1-17;Interview#1-15).

[2] EBN (2022). https://www.ebn.nl/energietransitie/new-energy/programma-udg/over-ultradiepe-geothermie/ Accessed 28-01-2022.

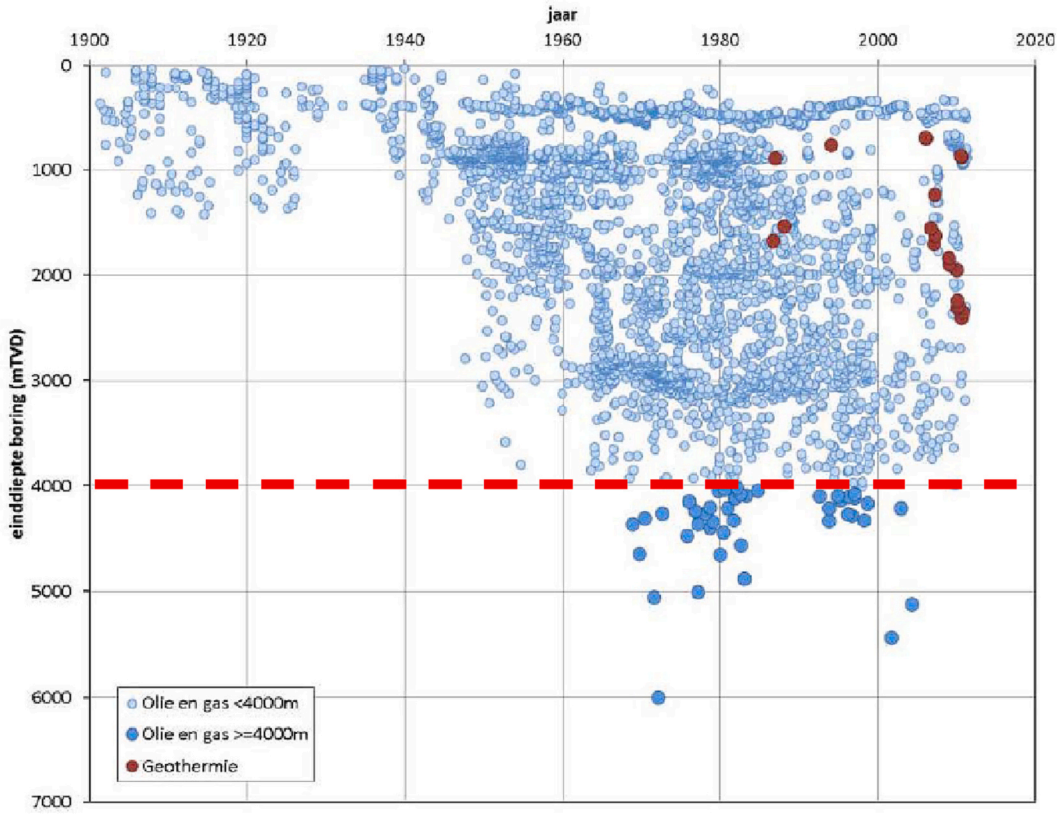

Fig. 1. Depth of oil and gas drilling in the Netherlands (TNO 2016).

A third set of uncertainties has to do with what stakeholders see as an appropriate role of different levels of government in investing in the energy production (Interview#1-12). In the Dutch case, SSM is responsible for overseeing gas and oil drillings. Energie Beheer Nederland (EBN) participates and invests 40 % in new oil and gas drilling project on behalf of the Dutch government, and in return also receives about 40 % of the revenues. Gas revenues are an important source of income for the Dutch state. At the time of this research, it was unclear if this investment would also be the case for (ultra) deep geothermal energy. Most of all investors in (ultra) deep geothermal energy projects express institutional uncertainties about the role of EBN. For example, one agriculture representative (Interview#1-05) expressed: "If this is a source for the Netherlands, we need to have different licensing and operators, and a sound financial base. Perhaps government should play a role. May be EBN?" Also, two interviewees raised questions about possibly conflicting roles of the Dutch government as state-supervisor through SSM and that of investor by EBN (Interview#1-10; Interview#1-11; Interview #1-17).

Our analysis shows that, despite the general consensus that the possibilities of (U)DGE need to be explored, it also opened up uncertainties about the regulatory framework and a broader institutional context (Table 1).

Table 1
Overview of stakeholders' uncertainties about deep geothermal energy.

Type of uncertainty	Uncertainties with regard to (ultra) deep geothermal energy raised by stakeholders
Informational uncertainty	• Geological structure of the underground • Drilling techniques • Environmental safety
Normative uncertainties	• Necessity of ultra-deep geothermal energy • Different objectives with regard to deep geothermal energy production
Conceptual uncertainties	• Unclear distinction between deep and ultra-deep geothermal energy
Institutional uncertainties	• Appropriateness of the Mining law • Prevention and monitoring of environmental risks • Role of different levels of government investing in energy production

4.2. *Preferences for participatory processes*

In the analysis of the interviews three themes, or aspects of a participation process, emerged: 1) timing of participation: what is the right moment to involve stakeholders, 2) scope: who is the public that should be involved and what do they get to talk about, and 3) organizer of the participation process: who is considered credible?

Before going to the more detailed descriptions, it is good to point out that all interviewees were open to the idea to engage in dialogue with other stakeholders and societal actors. In fact, some of the stakeholders were already communicating and discussing (U)DGE with societal actors. For example, the Ministry of Infrastructure and the Environment and the drinking water companies had started a consultation process to determine the relationship between geothermal energy and drinking water. One of the drilling companies, Hydreco, organized several walk-in evenings about their seismological campaign, where local residents received information and could ask questions.

4.2.1. *Timing of participation*

First, interviewees have different ideas about the timing of a dialogue: early or not too early. There is a group that argues that before meaningful participation could take place, first informational uncertainties need to be solved. For that reason, they argue that participation should not take place too early. One of semi-public organizations indicates that more technical knowledge about the risks is needed: "First more knowledge is needed (Interview#2-15)" Others argue that both the informational and the normative uncertainties need to be solved, for

example one NGO indicates that the desirability of (U)DGE needs to be decided upon, and informational uncertainties need to be solved before a dialogue with society can be organized (Interview#1-06). Another governmental organization argues that "citizens should be involved as early as possible. When there are plans at the local level those living in the area should be included (Interview#1-18)".

Whether interviewees think participation should be early or not too early depends on how they think about participation in relation to solving the different types of uncertainties. There are two different understandings among our interviewees about participation as a way to deal with uncertainties. One part of the interviewees thinks that uncertainties should be solved before meaningful participation can take place. Within this part some actors focus on informational uncertainties, and others on normative uncertainties. Another part of the interviewees sees participation as a way to solve specific uncertainties. While some of these actors focus on solving informational and conceptual uncertainties through participation, others focus on normative uncertainties.

4.2.2. Scope of participation

Second, we found different preferences for the scope of the participation process. A local municipality, and three actors from industry all preferred a *local participation process* around a particular (U)DGE project. Other stakeholders, such as one industrial actor and a NGO, had a preference for a more *general dialogue* about (U)DGE. One governmental actor (The Ministry of Infrastructure and Environment), a governmental drinking water supplier, two industrial actors, and two NGO's indicated that a broader societal dialogue on (U)DGE is needed to discuss the usefulness and necessity of geothermal energy. Some actors suggested both types of participation processes should be organized: one of the Ministries, for example, saw the usefulness of a societal dialogue in addition to a dialogue about concrete projects (Interview#1-07). They emphasized that dialogues on concrete projects must seek to connect with national discussions and investigations. The different preferences for scope also result in different ideas about who should participate. For participation at the local level, interviewees considered those directly engaged such as financers, beneficiaries, neighbors as relevant participants. For a societal dialogue, a broader representation of societal actors was suggested. Some interviewees also explicitly mentioned the involvement of (independent) experts. Some of the interviewees were hesitant about inviting parties who are considered not 'constructive' (people without expertise but a strong opinion), which was described by one interviewee as 'inviting only experts, in order to prevent people without expertise from determining the discussion' (Interview#1-09). This role of expertise was debated by other interviewees as well, and there were various actors that suggested to involve independent experts in a societal dialogue to present information about geothermal energy.

Moreover, we observed that the preferences for the scope of participation relates to stakeholders' identification of uncertainties. Interviewees who preferred participation at the local level tended to focus on informational uncertainties, for example those related to the geological structure of the underground. Whereas, a preference for participation at the societal level was considered as a way to address normative uncertainties, meaning those related to the necessity of (U)DGE.

4.2.3. Organizer of the participation process

Third, we identified different preferences for who should be the organizer of a participation process. These preferences coincided with the preference for a local project-oriented or for a broader societal dialogue. Those who preferred a local dialogue, also thought that the organizers should be local and preferably financed by those with direct interests in investing in ultra-deep geothermal energy. For example, one of the national governmental stakeholders (a ministry) argued that those companies who want geothermal energy should organize it: "the message should not come from government, but from those who want it. Those who take the initiative should also communicate it. They are the best messengers (Interview#2-07)." In contrast, stakeholders that preferred a broader societal dialogue, thought national government should be the initiator of such a dialogue. For example, one stakeholder from the agricultural industry preferred a societal debate organized by the Ministry of Economic Affairs: "If you want that, it should be nationwide. But it might be a too far from my bed story. Will people participate? If this is organized, it should be a project of the Ministry of Economic Affairs (Interview#1-05)." There was a clear preferences among different stakeholders for either 'private participation' [66] or government-led dialogues (Table 2). Interestingly enough, the interviewees did not often mention the need for independence of the organizers, which is something often called for in the literature [67].

Table 2
Interviewees preferences on the three participatory elements.

Preferred participation process	Theme	Description
	Timing	- Not too early (first uncertainties need to be solved) - Early (uncertainties can only be solved in the participation process)
	Scope	- Concrete local desirability issues - Concrete local informational issues on specific project - More general societal fact finding (including solving uncertainties) - More general societal discussion
	Organizer	- Initiating (public or private) organization - Independent organization - Government

5. Discussion: from a collection of storylines towards participatory repertoires

5.1. Four participatory story lines

The analysis of the combinations of stakeholders' perceived uncertainties and participatory preferences about (U)DGE enables the identification of four participatory storylines. The four storylines are (1) a local dialogue about usefulness and necessity of (U)DGE in the area/region (2) a local joint fact-finding process about a specific (U)DGE project (3) a societal joint fact-finding process on (U)DGE in general (4) a societal dialogue about the usefulness and necessity of (U)DGE in the energy mix. The components of each storyline are listed in Table 3 and described in the following paragraphs.

5.1.1. Local dialogue

This first storyline combines the notions that deep geothermal energy is still including many informational, institutional, conceptual and normative uncertainties with the argument that national experts and policy makers first need to create more informational, normative, conceptual and institutional certainties before a meaningful local participatory process can be started. A dialogue about the local desirability (the normative dimension) should therefore not be started too early in this process and should be organized by a local public or private partner. In this participatory storyline a local and broad dialogue with local actors, including unorganized citizens, about the desirability and necessity of deep geothermal energy production should take place. Such a dialogue, according to this storyline, is only meaningful in areas in which projects with (U)DGE are planned for.

5.1.2. Local joint fact finding

In this second storyline the starting point is that there are no normative uncertainties in the sense that deep geothermal is considered necessary as part of the local energy mix. However, informational and institutional uncertainties need to be further explored. Therefore, a local joint fact finding process should be organized by a public or private

Table 3
Four participatory storylines.

Participatory storylines	Local dialogue	Local joint fact finding	Societal joint fact finding	Societal dialogue
Uncertainties	Informational Normative Conceptual Institutional	Informational n/a Conceptual Institutional	Informational n/a Conceptual Institutional	Informational Normative Conceptual Institutional
Timing	Not too early (first uncertainties need to be solved)	Not too early (first uncertainties need to be solved)	Early (uncertainties can only be solved in the participation process)	Early (uncertainties can only be solved in the participation process)
Scope	Concrete local desirability issues	Concrete local informational issues on specific project	More general societal fact finding (including solving uncertainties)	More general societal discussion
Organizer	Initiating (public or private) organization	Initiating (public or private) organization	Independent organization	Government

organization within a strict framework and with limited participants and not too early in the planning process. The main issue to be deliberated in the joint fact finding is how to implement geothermal energy so that it will be locally acceptable, both from a social and technical point of view. In particular, care should be taken that benefits for local businesses, neighbors and producers are optimized and downsides are mitigated.

5.1.3. Societal joint fact finding

The third storyline combines the starting point that there are no normative uncertainties and that deep geothermal energy is needed in the energy mix. A timely (not too late) societal joint fact finding process at the national level is needed in order to address the many generic conceptual, institutional and informational concerns about the implementation of deep geothermal energy: what type of (U)DGE exactly is at stake, on what specific location, with what technologies, and with as little as possible nuisances for citizens. According to interviewees, an independent organization should organize this process.

5.1.4. Societal dialogue

Similar to the first storyline, in this fourth storyline all four types of uncertainties play a role. The normative question is if (U)DGE is indeed one of the energy sources needed in the Dutch energy transition. An answer to the normative concern can only be given if the conceptual, informational and institutional uncertainties are explored in a timely fashion, in a broad societal dialogue including many stakeholders, including a broad range of societal actors. A more generic conversation about the necessity and desirability of (U)DGE should be organized by an independent organization to find out what perspectives there are on the role of (U)DGE in the energy transition.

The four empirically grounded participatory storylines demonstrate that there are combinations of uncertainties and preferred participatory approach. This indicates that next to different problem perceptions and uncertainties about (U)DGE, participants have different preferences for the type of participatory processes. Even though this study is based on one case of stakeholder participation in (U)DGE in the Netherlands, and additional case studies are necessary to draw more general conclusions, the four storylines indicate what is important in a more systemic approach of energy participation.

5.2. Towards repertoires of participation

The four participatory storylines each provide specific alignment mechanisms between policy and society, and aim to address a particular set of uncertainties. With one specific participatory processes, it is impossible to address all sets of uncertainties. Therefore, coordination between policy and society requires several participatory processes, i.e. institutional alignment mechanisms. This raises the question of how the different participatory story lines relate to each other, and whether a coordinated set of participatory processes - so-called participatory repertoires - can contribute to a more systemic view on participation [13,20], and address issues of "overflowing" in which existing rules and norms, that guide expectations and define the spaces in which interactions may take place, are no longer sufficient in guiding these interactions [18,68].

By comparing the different participatory storylines, we were able to detected differences in understandings of stakeholder participation, which may contribute to misalignments [26]. Our analysis of these differences also offers insights to develop participatory repertoires in which forms of participatory processes are prioritized and combined in relation to different types of uncertainties about the renewable energy source. First of all, both local and societal joint fact-finding storylines that are coming from stakeholders, assume an absence of normative uncertainties, and consensus about the usefulness and necessity of, in this case (U)DGE. Both the local and societal dialogues storylines, propose participatory processes to deliberate and explore the usefulness and necessity of (U)DGE. Hence, in cases of normative uncertainties, a local or national dialogue must be prioritized. If this leads to consensus about the usefulness and necessity, than joint fact-finding processes can be organized. This combination of two different types of stakeholder participation in case of normative uncertainty - can lead to a productive participatory repertoire that functions as an alignment mechanism, and is timely enough to ensure that citizens' have a voice which increases acceptability [61]. This also means that partially-productive or even counter-productive alignment mechanisms exist. For example, denying the normative uncertainties for (U)DGE and opting only for a joint fact-finding process can be a sign of power politics that hampers alignment with society. This is a way to identify participatory processes that are too instrumental which may raise resistance [21,22,67], as well as to better contextualize different participatory processes across levels in an administrative system and as such 'ecologize' participation [20].

Second, the participatory storylines differentiate between appropriateness of the local and national political-administrative levels. This indicates that a participatory repertoire needs to include aspects of multi-level governance. Prioritization of dialogue about the usefulness and necessity of (U)DGE at the national level, including decisions about regulatory frameworks may be necessary. When there are numerous normative and other uncertainties at the national level, a productive participatory repertoire prioritizes a participatory process at the national level before the local level. This is necessary to prevent power struggles between different administrative layers, for example when national explorations licenses are issued that overrule the inclusion of local public interests.

Third, in the participatory storylines a distinction is made between the local and wider public, which in the policy practice often leads to exclusion of the wider particular public [43]. This might be an unproductive bias, because those less directly involved might become more and more direct stakeholders. For example, publics can take on active roles as energy producers (the so-called prosumer) – but the public can also consists of activists that might become influential agents that force energy producers and others to make their technologies more societally and environmentally responsible [20,69]. In addition, very often these publics are already involved, but often overlooked in literature that

consider participation as one-time events [13,21,69]. Our results suggest that participatory repertoires that combines different types of participatory processes, this wider public can be better acknowledged and included.

6. Conclusions

In this paper we studied the emerging storylines about appropriate participatory processes in the case of (U)DGE in the Netherlands. Based on a thematic analysis of 18 interviews and approximately hundred policy documents, we found four combinations of types of uncertainty and preferred characteristics of participatory process: 1) local dialogue; 2) local joint fact finding; 3) societal joint fact finding; and 4) societal dialogue. In case of normative and conceptual uncertainties, a societal dialogue at the national level should precede local joint fact finding in order to prevent (unintended) power politics between administrative levels, and between governments and a wider group of citizens that may become active stakeholders in the near future. These insight can be used to understand and prevent unproductive combinations of participatory alignment mechanisms or even the abuse of power of certain participatory processes. With this systemic view on participation, we hope to stimulate much-needed further research in this complex political and societal area.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix 1. Interviews

First round: August–October 2016.

Stakeholder	Number
Government (municipality)	Interview#1-03
Government (national)	Interview#1-07
Government (public investment instrument)	Interview#1-09
Government (regional)	Interview#1-17
Government (public water provider)	Interview#1-15
Government (national)	Interview#1-14
Citizens group	Interview#1-13
Citizens' initiative (energy cooperation)	Interview#1-16
Industry (geothermal)	Interview#1-04
Industry (beer brewer)	Interview#1-10
Industry (lobby/information group) of geothermal industry	Interview#1-11
Industry (textile)	Interview#1-12
Expert	Interview#1-01
Expert	Interview#1-18
Journalist	Interview#1-02
NGO: farmers' representatives	Interview#1-05
NGO: environmental organization	Interview#1-06
NGO (protest group)	Interview#1-08

Second round: March–May 2017.

Stakeholder	
Government (municipality)	Interview#2-03[a]
Government (national)	Interview#2-07
Government (public funding instrument)	Interview#2-09
Government (national)	Interview#2-14
Government (water provider)	Interview#2-15
Industry	Interview#2-04
Citizens' group	Interview#2-13

[a] Last number corresponds with the number assigned to respondent in round #1.

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