



## Review

# Value-sensitive design under ground? Exploring the community-based monitoring of a geothermal project in the Netherlands

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## ABSTRACT

The transition towards a carbon-free energy system necessitates societal changes, next to technological and economic transformations. For geo-energy projects, these societal changes relate to difficulties in achieving local support for subsurface initiatives. Societal acceptance of geo-energy projects entails more than a one-way perspective in which project initiators and experts try to convince society. To increase societal acceptance, an approach that broadly includes public values is imperative to locally embed geo-energy technologies. Value sensitive design of geo-energy systems requires deliberative processes of actor involvement in defining public values. One of the methods, known for its deliberative quality, is community-based monitoring (CBM), often implemented to assess long-term impacts of new technologies on its (social) environment. Research on value-sensitive design of CBM is lacking. This paper explores opportunities for value-sensitive CBM for geo-energy projects by examining 1) how public values could become part of CBM, and 2) how value-sensitive design of CBM could contribute to the project development strategy. An in-depth case study of a geothermal energy project in the Netherlands was conducted. This project has been developed as 'black box', similarly as most geo-energy projects in the Netherlands, causing anxiety and suspicion at local communities and stakeholders that are neither directly involved, nor evidently benefit from it. A practical mitigation of both inadequacies is to include local communities, stakeholders and local government, in monitoring the project's impacts. The case study shows that CMB 1) might address the imbalance in the distributive justice by including costs and benefits for local actors, and 2) might mitigate lacking procedural justice by organizing the structured and structural participation of local actors in setting up the monitoring system and in collecting and interpreting data.

Collaborative monitoring broad arrays of values, as an integrated part of the project development strategy, can address the needs and expectations of local communities and stakeholders, creating better preconditions for their societal acceptance. An adjacent benefit might be that by informing local communities and stakeholders, local governments and legislators can be put at ease, preventing current negative sentiments around geo-energy projects with 'contested' technologies from occurring, that often lead to the termination of these projects without well-informed dialogue between actors involved.

## 1. Introduction

The transition towards a carbon-free energy system is just underway. The gap between carbon-high and carbon-free societies is not only a technological and economical gap, but also requires societal changes. Especially in the case of geo-energy projects,<sup>1</sup> the required societal change becomes apparent, as many authors conclude that achieving local support is crucial in continuing subsurface initiatives [1–3]. Roovers

and Duijn [4] describe some examples of recent troublesome geo-energy project initiatives in the Netherlands, including the induced seismicity problems with gas extraction in the Groningen field. Based on these examples they observe that subsurface interventions for geo-energy systems in the Netherlands often tend to turn out as "win-lose" situations [5]. The financial benefits are largely reaped by (inter)national private sector initiators and national government, whereas local communities and stakeholders suffer the nuisance and safety risks. This unequal

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<sup>1</sup> Such as underground gas storage (UGS), underground hydrogen storage (UHS), enhanced geothermal systems (EGS) and compressed air energy storage (CAES).

distribution of benefits and burdens is rather problematic because the desired development and use of sustainable energy sources may necessitate considerable interventions in the subsoil, such as the exploitation of geothermal heat and the storage of hydrogen and compressed air. As such, it is clear that geo-energy systems will only become mainstream if people are willing to accept new sustainable technologies including their negative externalities, like nuisance, seismic risks and pollution risks.

In the Netherlands project initiatives for geo-energy systems, as part of the energy sector, are heavily regulated [6]. They are largely planned and implemented by a limited cluster of organizations: the national government, the national supervisor on mining activities, the international private sector and the designated knowledge institutes for technical and financial expertise. After the decision by elected public officials, the project is managed within the boundaries of budget and time, to ensure efficient and effective realization. The limited number of actors follows almost directly from the formal institutional framework, based on rules and regulations in the Dutch Mining Law [4,5], in which policy and decision making about geo-energy projects takes place, culminating in granting or rejecting the necessary permits. The permitting process is solely oriented towards (technical) safety, economic feasibility and environmental impacts [1,7,8]. As a consequence, geo-energy projects are too often perceived by local communities and stakeholders as ‘black boxes’ which are deliberately closed off from them, negating their interests. The limited focus of technical, economical and (physical-) environmental of geo-energy project design too often leads to what Ducsik [9] calls a decide – announce – defend strategy. One of the main characteristics of this strategy is that strong opposition tends to arise immediately after a project initiative is announced [5,10] because it raises suspicion at non-directly involved actors, such as local governments, local communities and stakeholders, putting the initiative on the wrong foot right from the start.

We argue that one of the main reasons for this is the strong divide between what we call here project actors and non-project actors. This divide refers to the literature on energy justice [7,11,12] that explores and discusses the fairness of intended renewable energy projects for actors who initiate and benefit from this project and actors who undergo and suffer from them. Project actors have a direct stake in the intended project and vary from project developers, operators, investors, legislators and consultants and knowledge institutes. Non-project actors do not have a direct stake in the project but are likely to be affected by its preparation, construction, exploitation, maintenance and operation and future abandonment. For example, in the Netherlands, the planning and preparation of a geothermal project usually takes place within the limited circle of the initiator (operator, energy firm or mining company), its investors, the national government as legislator, and support from national knowledge institutes [1,8]. The planning stage is often finished by a formal procedure on applying for and granting an exploration permit for the selected site. In this procedure, local governments only have an advisory role. Non-project actors such as local governments, let alone local communities and stakeholders, have only limited access to the development process. Their participation is often restricted to receiving information and providing advice at the formal end of this stage. Project actors often consider local participation to be disadvantageous [1], perceiving them as actors that need to be convinced of the necessity of the project by the provision of adequate information as the only obligation. Their considerations sharply contrast with observations of many scholars [13–16] that involvement of the (local) public is a vital precondition for social acceptance of new (energy) technologies.

The consequence of this approach is to work with a (more or less self-created) divide between project actors and non-project actors, which may lead to three major categories of resistance. First, the costs and benefits of the intended geothermal project are not equally divided between project actors and non-project actors. The former collects the benefits, leaving the latter with the costs, in the broadest sense of the word, including nuisance, safety and health risks and less attractive living environments. Second, the access to the decision-making process

and formal procedures such as permit granting is often limited for non-project actors and restricted to project actors only. Even local governments are often not fully, timely and/or formally included in the decision-making, not even as democratically chosen representatives of other non-project actors, such as local communities. Third, the potential impact of the geothermal project on the physical-spatial and the socio-cultural environment are often assessed to the degree that is necessary to acquire relevant permits for exploration and exploitation of the geothermal heat. However, especially the impact of subsurface interferences cannot entirely be known nor predicted over time, making the environmental impact assessment always suboptimal and thus unsatisfactory for non-projects actors that might be affected by the project. However, like other (physical-spatial) projects, geothermal energy projects should follow the principles of good governance [17] that include transparency, participation, accountability and effectiveness. These principles indicate an inclusive dialogue with all stakeholders involved, in which the relevant public values are deliberately determined.

The previous deliberations make clear that both substantive and procedural interests of local communities and stakeholders are overlooked or sometimes even ignored by project initiators and ‘their allies’. The claim could be made that the values of non-project actors are not equally represented in the different stages of project development as those of the project actors. “Opening up the energy transition to a wider group of actors, including citizens and civil society organizations” [18] would entail the inclusion of a wider variety of values as an inherent part of the design of any contested geo-energy technology, to provide them with a fighting chance of successful implementation. New standards must be set for how this technology should work, what it should achieve and how it should be governed for contributing to the energy transition in an acceptable and balanced way.

In the next section the theoretical perspectives are discussed, starting from the societal trends and their consequences for governance, resulting in more value-oriented approaches in policy and decision-making, especially in case of contested technologies, such as geothermal systems. Next, we will elaborate on monitoring, as an approach that might be capable of accommodating these aspects, and as such, enables the inclusion of diverse values in policy and decision-making processes, from the preparation stage to exploitation and evaluation. After the methods section, the case study and its systematic analysis are presented. We end the paper with reflections on the case study results, by examining the potential that community-based monitoring bears for the societal embeddedness of geo-energy technologies needed for a carbon-free society.

## 2. Theoretical framework

The introductory paragraph refers to three related theoretical concepts that together frame the line of reasoning in this paper: 1) technology assessment and insights from science and technology studies for geo-energy technologies, 2) societal acceptance of geo-energy projects using new technologies and 3) the representation of public or societal values in geo-energy projects. These three concepts are further discussed in the paragraph below.

### 2.1. Technology assessment and insights from STS for geo-energy technologies

Over the last decade the transition towards a sustainable energy system on a global scale has witnessed an increased implementation of renewable energy sources to replace fossil fuels [12]. Next to familiar renewable energy technologies, such as wind and solar power, also technologies that are not self-evident need to be implemented to reach the objectives of the 2015 Paris Agreements. One of them is geothermal energy which has only been implemented until now on a small scale. For many renewable energy sources, technology assessments have been

conducted to evaluate a) their promise of producing sustainable energy in significant amounts [20], b) their potential impacts on the energy system [21], and c) on the physical-spatial and socio-economic environment [22,23]. To assess their potential contribution to the transition towards a carbon-neutral energy systems, renewables energy technologies are often compared by taking their entire life cycle [24,25] into account. In order to benefit from the potential of geothermal energy systems for 'greening the energy supply', scaling up the societal uptake must be guided by an integrated and comparative technology assessment [26]. For geothermal energy systems, assessing their potential impact on the location at which they are situated is of vital importance, often referred to as siting controversies [6], following from one of their most impactful negative side effects, and that is the occurrence of induced seismicity [26,27]. Of course, this potential impact will evidently have significant influence on the degree of local acceptability of this specific renewable energy technology. This observation strongly refers to emphasis on the social aspects in technology assessment [28,29]. Many authors have studied the social or societal uptake of new (energy) technologies [23,30]. Research on the social aspects in technology assessment focuses on questions as "to what extent is society willing and prepared to accept new (energy) technologies, as replacement of familiar, well-known technologies-in-use (with regard to energy mainly based on fossil or nuclear fuels)?", and, "to what extent are these new technologies perceived as 'controversial' because they might negatively affect existing interests?", and, "to what extent are the expected impacts of the new technologies, beneficial and recognizable for society at large and directly involved stakeholders in particular?" Wolsink [31] indicates that the introduction of new energy technologies necessitates that science and technology studies address all levels of abstraction, all relevant actors and all process dynamics, as a foundation for their social acceptance.

## 2.2. Societal acceptance of geo-energy projects using new technologies

The topic is examined through a wide variety of related theoretical concepts, such as 'social license to operate' [8,32], 'social acceptance' [31,33], or 'acceptance readiness level' [34,35], and 'societal embeddedness level' [36]. Of course, the extent to which new (energy) technologies are accepted or acceptable from different actor perspectives at different levels of abstraction. Common distinction is made between global and local, or national and local levels [37].

The societal change related to geo-energy systems is often framed as 'societal acceptance'. People must be informed about an energy project and the technologies attached to it first, as a basis for the potential acceptance of the project and supporting technologies. A sufficient level of support must be reached to realize the project [38,39]. This is however criticized, because societal acceptance should entail more than a one-way perspective in which project initiators and their supporting experts want to convince society. This criticism is supported by Duijn et al. [40], arguing to take the complex interactions between subsurface, technology and society into consideration in the development of geo-energy projects. Paukovic et al. [41] found that the inclusion of values that local communities and stakeholders hold regarding the interference of geo-energy projects on their direct living environment, goes beyond the simplistic notion of being convinced to accept them. Convincing the general public cannot overcome the biggest obstacle for CCS in the Netherlands, namely the perceived unsafety of the initiative.

## 2.3. Representation of public and societal values in geo-energy projects

The relevance of value-oriented policy and decision-making is substantiated by two ongoing trends in current society. At the one hand, there are global trends like globalization, the rise of world-wide communication technologies and individualization. At the other hand, there is a trend to the local level where communities engage in collaborative networks to create integrated public values [42–44]. In response

to these trends, a shift from government to governance is witnessed [45], in which steering efforts in society depend on the capacity to coordinate the actions and resources of actors involved around a collective issue [46]. Governance acknowledges the broadly accepted observation that steering efforts in society are no longer reserved for governments but are also performed by other actors, often acting in inter-organizational networks.

In a government setting, elected officials and technical experts decide on projects and policies that will create public value. Once decided, the focus is on implementing the decision in an effective and efficient way [47,48]. In a governance setting, public values are determined by deliberation and realized by cooperation between public, private and societal actors [47,49]. Bozeman [50] defines public values as "providing normative consensus about the obligations, rights and benefits of citizens and of the state, as well as on the principle on which the government is based". Taking public values as starting point for organizing steering in society Bryson et al. [47] have coined the concept of public value governance, which is characterized by a "common good determined by broadly inclusive dialogue and deliberation informed by evidence and democratic and constitutional values". Of course, this perspective on public values has consequences for understanding public perceptions on new technologies and their level of acceptance in society. It leads to more attention for public values as important precondition for governing the energy transition. Mitchell et al. [51] calls for 'public value energy governance' as an approach to that should incorporate more involvement of stakeholders, in order to gain social legitimacy of new energy technologies. The shift from government to governance also influences the way in which new, sometimes contested geo-energy technologies will be accepted by society at large and communities and stakeholders in specific. Societal embedding through active involvement of the social environment will become a key factor for the acceptance and uptake of new geo-energy technologies, in the sense that they become a self-evident part of the energy system. Societal embedding hinges on a value-sensitive design approach to technology implementation in which public values are taken fully into account [52,53].

Value sensitive design assumes that public values, in this case related to geo-energy systems, can be known. Although some scholars argue that public values can be objectively measured and analyzed [50,54], more and more evidence is found that public value is intersubjective and actors develop their own, contextually specific definitions of public values [48,49,55]. New geo-energy technologies should productively and positively relate to the values held by society at large and local communities and stakeholders in specific. Ruef and Ejderyan [18] use the term anchoring that "implies identifying the public values upon which a public policy should base itself". Anchoring applies to any geo-energy project aimed at operationalizing public policy for a sustainable energy system. Public values behind the public policy objectives for developing renewable energy systems must also guide geothermal projects aimed at implementing them.

Renoth et al. [33] indicate that seismicity is an acceptance factor that is 'geothermal-specific', although other geo-energy projects such as natural or shale gas extraction can also cause (severe) tremors in the subsurface. Cousse et al. [56] suggest that providing information about geothermal technologies and approaches to control potential induced seismicity might limit negative impact on social acceptance Chavot et al. [57] indicate the project initiators' approach to avoid and/or mitigate seismic risks will be perceived a crucial factor for its acceptance by the local social environment. They mention two additional factors for enhancing social acceptance based on local public values: 1) the question whether the project is developed by a local public organization or an international private entity, and 2) the coordination with local development objectives. The latter is also substantiated by Ruef et al. [58] and TNO [59] indicating that the underground geothermal potential should be coupled with spatial and socio-economic developments on the surface level.

## 2.4. Identifying societal values in geo-energy projects

Including a wider variety of actors in policy and decision-making processes calls for the subsequent inclusion of a broader array of values that these actors hold in their orientation on geo-energy technologies. Based on the values that are closest to their heart, actors will estimate whether the implementation of geo-energy technologies will harm their interests, oppose their beliefs and/or influence their societal preferences. But what can be considered as values? Values are basic and fundamental beliefs that guide or motivate attitudes or actions. They help us to determine what is important to us. Values are the motive behind purposeful action and serve as guiding principles that underlie our behavior and steer a certain course of action. Values can also be perceived as qualities or characteristics of a system that people deem important. Values are defined in a general sense as fundamental normative guiding principles for changes in a society that are shared intersubjectively [60]. Values influence the design of formal institutions [61,62]. Values express social preferences [63]. Values are considered as principles that influence human behavior [64].

The values that are attached to geo-energy technologies, however, do not always reflect the values as shared by the broader public. They predominantly reflect the rationales and interests of the project actors, that is the consortium of initiators and its allies. Failing to take into account public or societal values may lead to public opposition and contestation, as non-project actors will experience and perceive unfairness when geo-energy projects are prepared, developed and exploited without including their values. The idea of unfairness connects to Rawls [65] concept of social justice as a form of fairness, referring to an impartial distribution of goods in society, and as an equal access to basic liberties, such as freedom of speech, thought and assembly, the access to the political system, the right to have and maintain personal property and freedom of unreasonable arrest [66]. Atteberry-Ash [67] indicates that social justice concerns “the proposition of social equity by reducing barriers to services and goods”. In Rawls' view a just society meets the basic requirements of all its inhabitants, stimulates the use of people's capabilities and minimizes risks and uncalled for pressures to them.

Advocating the identification of the societal values at stake makes it possible to cater to them adequately in a (more) fair design of technologies. Dignum et al. [52] indicate that such values include both substantial and procedural values: what makes technologies acceptable does not only have to do with the substantial characteristics of the technology itself, but also relates to the procedures through which the technology is developed and implemented. With regard to the values attached to geo-energy projects Iwińska et al. [68] made an inventory of approaches to substantiate them. Various authors [69–72] propose three justice categories to identify the values that are inherent to geo-energy projects and their development and exploitation: 1) distributive justice, 2) procedural justice and 3) environmental justice. Narrowing the nuanced approaches to energy-related values of the authors mentioned above, enables a more practical use for assessing and monitoring the inclusion of values in actual geothermal projects. These categories convey the values that geo-energy projects must address to be perceived as fair as a basis for societal acceptance and embedding:

- Distributive justice: how are costs and benefits of the project distributed among different stakeholders?
- Procedural justice: are all stakeholders well- and equally informed? Is the decision-making process fair and transparent?
- Environmental justice: are all the stakeholders recognized and their perspectives respected? In what way are the environments people live in impacted? Who is responsible for the risks?

Consequently, value-sensitive design of geo-energy technologies must be ‘reasoned back’ to policy and decision-making processes that decide on their development and implementation, including a broad range of values as a basis for assessing whether they will strengthen or

harm the interests at stake. In addition, we argue that an instrument should be put in place to inform and support all actors involved in the actual project in which the geo-energy technology is implemented. This instrument must mirror the broad range of values in order to continuously assess the impacts of the project on the values at stake.

## 2.5. Community-based monitoring to guide the implementation of geo-energy technologies

The line of reasoning above indicates the need for an instrument for informing value-inclusive policy and decision-making about geo-energy projects. Here the hypothesis is that monitoring can deliver this information. Following the observation that the inclusion of local communities and stakeholders is imperative to enhance societal embeddedness of new energy technologies, community-based monitoring [73–77] should be the default approach for following and assessing their long-term impact on local communities. Consequently, the monitoring geo-energy projects must follow a value-sensitive design to be able to assess these often, contested technologies, from all relevant value orientations. Although the link between value-sensitive approaches and monitoring is conceivable, research on value-sensitive design approach for community-based monitoring is lacking. This observation calls for exploration of the opportunities and limitations of value-sensitive community-based monitoring.

Our hypothesis here is that to enhance societal embeddedness of contested geo-energy technologies, monitoring that included values and knowledge of local communities and stakeholders, should be implemented to continuously assess the impacts of these technologies on them. Much of the concerns of local governments, local communities and stakeholders center around the uncertainties and risks that characterize many geo-energy project initiatives. Uncertainty and negative risk perceptions are often fueled by a lack of knowledge on their part or by knowledge that is not tailored to their needs and interests but is mainly serves the knowledge needs of operators, investors and legislators. Knowledge production, exchange and use that incorporate the knowledge needs of ‘non-project actors’ is as a first important step to address uncertainty and negative risk perception, on the pathway to increased intelligibility of the proposed geo-energy project initiatives for all actors concerned, calling for a participation-based approach to monitoring and evaluation [78–80]. Community-based monitoring (hereafter abbreviated to CBM) has been applied for collaboratively following and assessing environmental issues and ecosystems [73,80]. We argue that participation of local communities and stakeholders in the monitoring activities around new developments, such as geo-energy projects, can be organized and facilitated [74,75]. Whitelaw et al. [76] define it as follows: “A process where concerned citizens, government agencies, industry, academia, community groups, and local institutions collaborate to monitor, track and respond to common community (environmental) concern”.

In this paper, CBM builds upon approaches that advocate socially justified and reflexive ways of science that acknowledge the social context of research in which other, non-scientific experts are involved. These reflexive perspectives ‘on doing research’ include knowledge forms, knowledge producers, ‘knowledgeables’, and knowledge users beyond purely academic and/or expert knowledge sources, producers and users. Many different methods describe the coproduction (or co-creative, or participatory or engaged) of knowledge to inform policy processes; participatory monitoring and evaluation [78], citizen science [81], citizens observatories [82], joint fact finding [83], action research [84] and many more. For environmental issues, environmental impact assessment and environmental monitoring, used to inform policy processes, are more often organized in co-productive ways [85,86].

Based on Whitelaw et al. [76] and Khair et al. [77], CMB is well-capable to 1) organize and facilitate the active participation of many different actors that are (potentially) affected by the geo-energy project initiatives, and 2) to do so in every stage of the project. In our view, the



five rationales behind public participation, identified by Van Houwelingen et al. [87], also apply to CBM. First, CBM is an end in itself, as a basis for (more) legitimacy for a decision, policy and/or project. If local communities and stakeholders have a say in what needs to be monitored in a project that is likely to affect them, they can represent their interests in a more profound way. Second, CBM improves the quality of decisions, policies and/or projects by tapping into local knowledge and experiences. This contributes to effectiveness and efficiency by making measures better tailored to the local context. Third, CBM allows for good citizenship, challenging local communities and stakeholders to act as ‘citizens’ and to think about the collective interest, instead of their own individual ones solely. Fourth, through CBM citizens can become knowledgeable and empowered, as a basis for demanding more influence on the decision-making process and/or project development. And if they cannot contribute in a meaningful way, they can challenge the decision, policy and/or project, by appealing in court. And fifth, CBM stimulates citizens to actively engage in monitoring activities themselves and collect, analyze and interpret data.

Especially rationale 4 has great relevance for implementing CBM in geo-energy projects. The inclusion of the values (e.g. concerns and interests) of local communities and stakeholders in the design of a monitoring system, as well as allowing them an active role in its implementation, will strengthen the acceptance and embeddedness of geo-energy projects in its societal context. This increases the level of understanding by local communities and stakeholders for the necessity of the geo-energy project initiative. The next question would be how their values can be included in the monitoring system that guides policy and decision-making for the implementation of geo-energy technologies? This must resonate in the policy and decision-making processes around the choice and implementation of new technologies, surpassing the well-known values of economic progress, employment and competitive advantage. The pursuit of value sensitive design of the monitoring system, aimed at including a more diverse range of values in the design and development of technologies [78,79]. Originally, value sensitive design (hereafter VSD) was developed for the assessment of information and communication technology [89]. Currently, the concept is also used in the context of energy technologies [52,53]. Oosterlaken [53] argues that “a distinguishing feature of VSD is that it does not focus on a single value- such as ‘design for sustainability’ or ‘privacy by design’ does - but rather provides a general overarching framework to address a range of values throughout the design process”. When referring to the three types of justice as a basis for VSD of CBM, we can witness the following relations. Distributive justice relates to the ‘what’ of monitoring: it would entail monitoring the costs and benefits incurred to people (does the project influence real estate values for instance?). Procedural justice relates to the ‘how’ of monitoring: procedural justice presupposes that stakeholders are well informed about the decisions taken, in terms of what and how to monitor. Iwińska et al. [68] conceptualize environmental justice, relating to both the ‘how’ and ‘what’ of monitoring: it is about the environmental impacts incurred on local communities, but also about who is responsible to respond to environmental risks. Next to the three value categories, there is, of course, the aspect of time. Timely and broad availability of geo-energy supply for current generations is referred to as intragenerational equity [69]. The impacts of geo-energy projects for future generations can be perceived as component of distributive justice, referring the availability and costs and benefits of geo-energy projects for current and future populations.

3. Methodology: in-depth case study research

3.1. Research question and data collection methods

For this study we formulated a twofold research question: How can public values become part of CBM, and how might a value sensitive design approach to CBM monitoring become part of the overall project

development strategy? More specific, we explore (a) how public values could become part of a participative monitoring strategy, and (b) how this value-sensitive design approach to CBM could become part of the project development strategy as a whole.

To explore public values as part of CBM, we conducted explorative, longitudinal case study research.<sup>2</sup> The focus on CBM in this study must not be confused with the research strategy; we study public values as part of CBM, by an in-depth, mixed method case study research. Our main criteria for the case selection where the presence of pressing value dilemmas in an ongoing project, so we could actively explore the potential added value of a value-sensitive approach to CBM in an actual, ‘live’ case study. Based on these criteria, we selected the geothermal project initiative in the province Utrecht, the Netherlands. The subsurface in this area in the center of the Netherlands is suitable for geothermal energy. It is also an area with a dense concentration of housing areas, road and railway infrastructure, the busiest canal of the country and many power lines, making the societal acceptance of another significant spatial project, challenging. However, at the same time the proximity of energy-consuming human activities, provide for the opportunity of a feasible business case for geothermal energy. For example, some of the cities in the nearby area already have a district heating network to which the intended project for geothermal heat generation could serve as an additional source [90].

In the case, a mixed method-approach for the collection and analysis (see Table 1) of available primary and secondary data [90] was conducted Firstly, we analyzed relevant public documents about the project initiatives, such as policy and project plans, permits, technical reports and meeting reports. Secondly, eight in-depth interviews were conducted with the key stakeholders: project manager, stakeholder man-

Table 1  
Overview of primary and secondary collection and analysis of data used.

| Perspective(s) / representative(s)                                                      | Collection and analysis of primary and secondary data                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Project management: overall project manager <sup>a</sup>                                | Primary: interviews and reflection meetings<br>Secondary: participative observation of conduct and reaction in information meeting.<br>Secondary: their reactions (Answers) in the Q&A-function of the project website |
| Stakeholder management: stakeholder manager and process consultant                      | Primary: idem.<br>Secondary: idem.                                                                                                                                                                                     |
| Expert knowledge institute: geological experts                                          | Primary: idem.<br>Secondary: idem.                                                                                                                                                                                     |
| Government                                                                              | Primary: idem.                                                                                                                                                                                                         |
| Local: two municipalities                                                               | Secondary: participative observation of conduct and reaction of one municipality                                                                                                                                       |
| Regional: province                                                                      | Primary: idem.                                                                                                                                                                                                         |
| Independent committee for geothermal energy:                                            |                                                                                                                                                                                                                        |
| Chairman and expert                                                                     | No secondary data.                                                                                                                                                                                                     |
| Local communities and stakeholders: residents and entrepreneurs of nearby neighborhoods | No primary data.<br>Secondary: participative observation of conduct and reaction in information meeting.<br>Secondary: their remarks and comments (Questions) in the Q&A-function of the project website.              |

<sup>a</sup> The overall project manager was the representative of the energy company that was to be the primary investor in the project initiative.

<sup>2</sup> The research approach and the case study in this paper were part of the Horizon 2020 project SECURE; an acronym for Subsurface Evaluation of Carbon capture and storage and Unconventional risks (grant number 764531). The research presented in this paper belonged to SECURE's WP6, Task 6.3 Participatory Monitoring.

ager, process consultant, civil servants of two local governments, the project manager of the regional government and two members of the independent committee for geothermal energy.<sup>3</sup> Building on concerns about the potential controversial nature of their project initiative, grounded in unfavorable experiences with around recent previous geothermal projects in the Netherlands [4,5], the initiators were initially fearful of giving publicity to the intended project in its exploratory stage. Researchers had to agree to refrain from direct access to local communities and stakeholders. This refrainment was deepened by an emerging conflict between the project consortium and the local communities and stakeholders. It was decided by the consortium that researchers were not allowed to interview local community members nor NGOs at the intended location (other than the independent organization of geothermal energy). As a consequence, resorting to use secondary data for describing and analyzing the perspective of local communities and stakeholders on the project initiative was needed. The secondary data comprised participatory observation of an information evening with local residents and NGO's, analysis of video footage of city council meetings in which community members presented their opinions and interests and an analysis of the Q&A-function on the project's website, covering many concerns and fears about the project initiative. In this way, reliable data could be obtained about the perspective of the local communities and stakeholders. Thirdly, reflection workshops were organized with the representatives of key stakeholders; the project actors that had an actual stake in the project initiative, such as energy company, legislators, geological experts and stakeholder manager and process facilitator. Over one and a half years, we reflected in four workshops on the struggles they had experienced over the past period, mainly concerning the challenge of how to embed their project initiative in the local social environment. The collected data was coded for the values of the different stakeholders, the way these values are represented in the project, and the way monitoring was envisioned.

### 3.2. Description of the case study; a Dutch geothermal energy project initiative

The study case can be characterized by three decision-making rounds: (1) exploration license, (2) feasibility study for specific locations, and (3) assessment framework and decision-making.

#### 3.2.1. Round I. Exploration license

In 2017 knowledge institutes, companies related to geothermal energy, and the national government, with the collusion of regional and local government agencies, joined in pursuing an initiative for developing geothermal energy in the province Utrecht, in the heart of the Netherlands. They mobilized several grants for the project initiative. Although, the project initiative is framed as research project but also includes the realization and exploitation of geothermal energy. For its development, the project consortium, a collaboration of knowledge institutes, energy companies and engineering consultancies, was established. The first step in the project development process was the application for the exploration license, comprising of the permit to explore for geothermal energy (deep and ultra-deep) in a larger area in the province. During this process step, the focus was on technical studies and location studies. On 29 October 2019, the exploration license was granted [92].

#### 3.2.2. Round II. Feasibility study for specific locations

Within the large area mentioned in the exploration license, the geothermal potential was further studied, which led to a focus on an area around the south of the city of Utrecht. At the end of 2019, the project consortium informed local stakeholders about their geothermal project initiative. During the information meetings, early 2020, it became clear

that support for the project initiative could not be taken for granted. Stakeholders worried especially about nuisance, the risks of drilling and the choice of the location. The local community and stakeholders also felt taken by surprise by the project and organized themselves into an action committee. In response to the lack of immediate support by the local community and stakeholders, the project consortium agreed to take more time to study other potential locations. Moreover, the local government got involved as well as an independent advisory organization, established by the province of Utrecht, which was responsible for generating and sharing independent information about geothermal energy projects.

The project consortium organization continued their rather technically oriented process by executing a feasibility study in which 20 locations were analyzed. In July 2020, the conclusions were presented, identifying 5 locations in the area around the city of Utrecht as most feasible [91]. However, in the ongoing project development process it had already become clear that the location south of the city was preferable. The action committee had fundamental questions about the feasibility study and started a petition against the project initiative [93] and sent a list of question to the city council [94]. The local government was also critical about the study, partly inspired by an investigation into the perceptions of citizens on geothermal energy that it had carried out in the same time span [95]. Both the project consortium and the local government were advised by the independent committee [96] to put the project initiative on hold and to first develop an assessment framework, in which local interests were better operationalized and then applied to assess the potential locations.

#### 3.2.3. Round III. Assessment framework, planned decision-making and project termination

The local government followed the advice and started developing the assessment framework, including general criteria (sustainability, safety, societal acceptance) and specific criteria about the location, permits, and realization [97]. However, the delay in the project planning became increasingly problematic for the project consortium because of the strict deadlines of the subsidy grants. To speed up the process, they communicated their preferred location, which was owned by the local government. Thus, the project consortium had to deal with the local government to 1) get formal consent for the project, through granting the necessary local environmental permits and 2) to negotiate the use of the location. The consortium urged the local government to reach a final decision on the use of the preferred location before February 2021. The local government, however, maintained its own planning process that aimed at making two decisions: a) on the assessment framework (January 2021) and b) on whether the project would be supported at the preferred location (April 2021).

In January 2021, the assessment framework was discussed in the city council. The framework consists of a wide range of criteria, including the responsible actor and relevant legal procedures. However, the city council did not approve the assessment framework. An amendment was unanimously adopted by the city council to withdraw the framework. In the amendment, an additional list of criteria was presented that the responsible alderman had to operationalize in a new assessment framework. The city council would then later on decide on the new assessment framework.

Final decision making on the location of the project initiative was expected in April 2021. If the decision would support the development of the geothermal project at the location preferred by the consortium, further studies would have to be conducted to acquire the necessary permits and for organizing more active involvement of local stakeholders. However, in September 2021 the project consortium decided to terminate the project initiative because it became clear to them that they would not be able to meet in subsidy deadlines and terms in the remaining time period, set by the Dutch agency for entrepreneurship.

<sup>3</sup> This committee was initiated by the regional government.

## 4. Case analysis: exploring the potential for monitoring value categories

### 4.1. The values at stake

In the case study, various public values were identified that are relevant for monitoring. Therefore, we analyzed the values at stake, based on the distinction as presented in Section 2.3: environmental values, distributive values, and procedural values. The identified values at stake are shown in the table below (Table 2).

In the analysis of the values at stake in the case study, some patterns could be distinguished. Firstly, some values are shared by all actors, like safety, participation and quality of the process. However, the actors disagree about the impact of the geothermal project initiative on these values. For example, ‘safe buildings’ is a value for all actors involved. However, the question whether this value is threatened by the risks of induced seismicity is totally differently answered by these actors. Another example is ‘objectivity’, which is strived for by all actors – “there is a great need for objective data, which is not related to one of the

interests”, told one of the respondents. Some actors experience the development process as an activity in which obtaining objective information is one of the key stones, while other actors have doubts about the objectivity of the studies conducted. Secondly, some values are very conflicting, like the financial values and the process values (e.g. collaboration, progress, early involvement). The biggest difference is found between the project initiator and the local residents, like the value of financial return (project consortium – “the business case is critical”) versus the value of compensation (community members – “citizens also see that the project initiators don’t have millions in case of damage”),<sup>4</sup> and the value of collaboration and early involvement (residents) versus the value of progress.

### 4.2. Incorporating values in monitoring efforts

After the analysis of the values of stake, we analyzed the way monitoring was organized in and around the geothermal project initiative, by making a distinction between different types of monitoring, serving different types of knowledge needs. This information was found in the documents as well as in the interviews. Baseline monitoring starts in the early exploration stage of the project and lasts well into the stages when the feasibility studies are conducted. It includes all relevant environmental, economic and social issues [98], taking stock of the situation-as-is at the location where the intended geothermal project will be developed. Project monitoring concerns the functional, economic and technical aspects that is the focus of project management of the geothermal project initiative. Permit- obligatory monitoring connects to the requirements that the permit application and grant process has set for operators and investors of geothermal projects. These requirements partly overlapped with and were built upon the baseline monitoring issues, as the expected impacts of the project development and exploitation needed to be charted on a continuous basis. Lastly, we explored the need for and desirability of societal monitoring as a longitudinal effort to keep track of the expected impacts the geothermal project might have on its societal environment, such as social exclusion, broad costs and benefits for local communities and stakeholders, causing physical and social barriers between community members, etc.

This summary above (see Table 3) indicates that the monitoring activities in the project initiative were mainly focused on the environmental values and finance, related to acquiring the needed permits. The permits were to be granted if the project consortium had its monitoring system in place, for instance on seismic activity, vibrations, and environmental impacts, for example on groundwater, flora and fauna. The worries of the local community and stakeholders, as well as the local government, with regard to safety and the potential environmental impacts, did not lead to changes in the monitoring system. Thus, the permit-obligatory monitoring prevailed over a more stakeholder-oriented approach. The only monitoring besides the legal requirements was on the balance between costs and benefits, and the expected financial returns; a value which was important for the project consortium, as an aspect in the project-oriented monitoring efforts.

Monitoring of environmental values and finance was executed by the project consortium solely, without collaboration with the regional and local government agencies and the local community and stakeholders. The technical and financial focus in the project strategy, aimed at meeting the preset subsidy deadlines, resulted in an emphasis on project-oriented monitoring in the preparation and first stages of the project development process in which time and budget were key, due to financing restrictions and deadlines. As a consequence, the monitoring efforts had a strong financial and legal focus and a weak orientation

**Table 2**

Values at stake in the case study.

|                       | Identified values of actors in the case study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environmental justice | <p>Safety: Important for all actors involved, but the impact of the project initiative on these values is discussed, especially the risks of seismic activity and the impact this could have on safety.</p> <ul style="list-style-type: none"> <li>- Personal safety</li> <li>- Safe buildings</li> <li>- Clean water</li> </ul> <p>Environment:</p> <ul style="list-style-type: none"> <li>- High standard environment – local community and stakeholders that are afraid of nuisance.</li> <li>- Natural environment – local community and stakeholders because of the preferred location which is close to a park.</li> <li>- Sustainability – governments involved, as part of their sustainability policy and climate agreements.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Distributive justice  | <p>Equality:</p> <ul style="list-style-type: none"> <li>- Equality of regions – local community and stakeholders, their environment is already overburdened with other infrastructures and energy projects.</li> <li>- Balance of interest – local community and stakeholders, and independent advisory organization, they signal a strong focus on technical and financial interests, without involving societal issues.</li> </ul> <p>Financial:</p> <ul style="list-style-type: none"> <li>- Financial return – the project consortium that worries about the project costs because of technical complexity and delay</li> <li>- Compensation – local community and stakeholders are concerned about compensation for possible damage to their properties</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Procedural justice    | <p>Participation: The need for participation is underlined by all actors, however the way this must be organized differs:</p> <ul style="list-style-type: none"> <li>- Dialogue – especially local community and stakeholders, independent advisory organization, some civil servants</li> <li>- Support – especially the project consortium, other civil servants</li> <li>- Inclusiveness and representation – dilemma for all stakeholders involved</li> </ul> <p>Process:</p> <ul style="list-style-type: none"> <li>- Collaboration – all stakeholders, although this value was less present at the start of the project</li> <li>- Progress – the project consortium because of the strict deadlines of the project grants</li> <li>- Early involvement – local government and local community and stakeholders, they feel involved too late in the process and are afraid decisions were already taken.</li> </ul> <p>Quality of the process: Important for all actors involved, but the way these values are secured in the project initiative process is discussed.</p> <ul style="list-style-type: none"> <li>- Trust</li> <li>- Transparency</li> <li>- Objectivity</li> </ul> |

<sup>4</sup> The inadequate and slow settlement of damage of induced seismicity to private property, caused by natural gas extraction in the province of Groningen, makes private homeowners additionally fearful of accepting geo-energy projects in their direct living environment.

**Table 3**

The monitoring of the values at stake in the case study.

|                       | Values                                                        | Monitoring                                                                                                                                                                                                                   |
|-----------------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environmental justice | Safety:                                                       | - <u>Baseline and permit-obligatory</u> monitoring by project organization. No collaboration with citizens (as lay experts) or governments around this monitoring.                                                           |
|                       | - Personal safety<br>- Safe buildings                         |                                                                                                                                                                                                                              |
|                       | - Clean water                                                 | - <u>Project-oriented</u> monitoring during the construction process                                                                                                                                                         |
|                       | Environment:                                                  |                                                                                                                                                                                                                              |
|                       | - High standard environment                                   |                                                                                                                                                                                                                              |
|                       | - Natural environment                                         |                                                                                                                                                                                                                              |
|                       | - Sustainability                                              |                                                                                                                                                                                                                              |
| Distributive justice  | Equality:                                                     | - <u>Permit-obligatory</u> monitoring related to finance. Compensation is part of discussion in a working group, although the quest for project-oriented monitoring only permit-obligatory monitoring is planned.            |
|                       | - Equality of regions<br>- Balance of interest                |                                                                                                                                                                                                                              |
|                       | Financial:                                                    |                                                                                                                                                                                                                              |
|                       | - Financial return<br>- Compensation                          |                                                                                                                                                                                                                              |
| Procedural justice    | Participation:                                                | - <u>No</u> monitoring of procedural values. The municipality monitored one time the support for and preferred participation in the project, but without collaboration with the project organization and other stakeholders. |
|                       | - Dialogue<br>- Support<br>- Inclusiveness and representation |                                                                                                                                                                                                                              |
|                       | Process:                                                      |                                                                                                                                                                                                                              |
|                       | - Collaboration<br>- Progress<br>- Early involvement          |                                                                                                                                                                                                                              |
|                       | Quality of the process:                                       |                                                                                                                                                                                                                              |
|                       | - Trust<br>- Transparency<br>- Objectivity                    |                                                                                                                                                                                                                              |

towards the inclusion of adjacent societal values in the monitoring system.

Procedural values were not monitored at all by the project consortium. Because of the discussions and increasing distrust, the local government decided to conduct a survey on the support for and preferred participation in the project. The results were used in local decision making but were not used by the project consortium to change the process or to initiate further procedural related monitoring.

The case analysis indicates that there were no plans for monitoring of procedural values and the other distributive values. This is not an informed and deliberated choice; the professionals involved just did not think about monitoring this kind of values, like these respondents: “I assume that the standard monitoring instruments will be used” and “monitoring is about the technical and economical parts of the project, the question is why, when and how we also will look at other aspects like societal aspects”. The option of participative monitoring simply did not emerge in the dialogues. This is also part of the earlier mentioned focus on technical and financial issues. The project consortium and the local government were advised several times by the independent advisory board to invest in collaboration, transparency and dialogue (procedural values), but they did not use this advice to set up their monitoring efforts differently.

During the process, we found two exceptions to this practice. Firstly, during the process, the project consortium had set up working groups around different societal issues that had been raised by the local community and stakeholders. One of these working groups, in which citizens and project partners participated, was about safety risks and (financial) compensation. Monitoring of potential damage to buildings, caused by drilling activities and the extraction of geothermal heat – a great concern of the local community and stakeholders – was part of the discussions in the working group. Their discussions mainly focused on permit-mandatory monitoring and the people involved found it difficult to predict whether this conversation would lead to community-based

monitoring efforts. Secondly, the local government only assessed at one moment in time the support for the project and the way in which the local community and stakeholders might be able to participate in the project. This assessment was however organized without involvement of the project consortium.

In this, the position of local government was crucial because it was unclear for a long time whether it represented the local values. The local government hesitated for quite some time to mark their position with regard to the desirability of this geothermal energy project initiative, as one of the civil servants stated: “we were too late, and my main concern is how to speed up as municipality and become part of the process”. The question whether the local government would support the project, as part of the necessity to make the transition towards a local sustainable energy system, hovered above the project most of the time? This same was the case for the question that if the local government would support the project, what requirements had to be met to safeguard the local environmental values in the application for the necessary environmental permits? The case study clearly indicates the lacking intermediary role of the local government, mediating between the concerns of local community and stakeholders and the opportunities the project initiative holds for making the local energy system more sustainable.

## 5. Discussion

The case study clearly indicates the limited and untimely involvement of local communities and stakeholders in the geothermal energy project initiative. This observation is substantiated in our case study that is a vivid example of the fact that the societal and public values at the location of geo-energy projects are often not taken into account from the start. At the beginning of the process, the project actors seemed to be clueless about how to involve non-project actors. They did not apply a clear strategy nor felt a sense of urgency to organize the involvement of local communities and stakeholders, as part of their development and implementation strategy. It seemed as though they assumed that the local government would take care of the societal acceptance of their initiative.

Looking at this from a more theoretical viewpoint, it seems that the debate is most of the time not about the values, but about the norms, and thus, on the impact of the geothermal project initiative on the values. Monitoring seems to be rather implicitly organized, focused on what is minimally needed for getting permits, meeting subsidy deadlines and keeping the project development process on track. This instrumental, norm-oriented approach to monitoring corresponds with other studies, in which it is concluded that the debate is most of the time not about the underlying values but about how to meet the preset norms [50].

The suggestion of developing a CBM-system to ensure the involvement of perspectives and the inclusion of values of actors that are not directly involved in the project initiative, put forward by the researchers, did not resonate with the project actors. The argument here is that when monitoring is open to participation of local communities and stakeholders, instead of being restricted to operators, engineering consultants, experts and legislators, the project will no longer be perceived as a black box as is often currently the case. This might take away one of the main reasons for almost immediate opposition that arises against any geo-energy project in the Netherlands. CBM might contribute to avoid what Cuppen et al. call [99] ‘controversy spillover’, the mechanism through unfavorable experiences with recent geo-energy projects will negatively influence the social acceptance of new projects in this domain.

The main reason put forward by the project consortium for casting aside the idea of organizing CBM, was the lack of time due to the tight subsidy restrictions. Also, reluctance to give up the money and time driven project management strategy could be observed, based on the project management's declared doubts whether CBM would guaranteed deliver the sought after acceptance at the local level.

Despite the reluctance of the project actors for allowing to start a



dialogue about the possibility of building a CBM, based on the data collected in the case study, the contours of what might entail a collaborative, value-sensitive monitoring design, can be imagined. As shown in Table 4 below, CBM starts with adding the specific aspects of local communities and stakeholders, grounded in the values they hold, to the 'standard' monitoring obligations for geo-energy projects. As such the contours of a CBM-system become evident. The CBM-system then includes societal aspects and sources for gathering monitoring data [75]. By broadening 'what', 'how' and 'who' of the monitoring system, other aspects are brought into focus (what), in a different way (how) and by different stakeholders (who), connecting to what [78] call participatory monitoring and evaluation (PM&E). In this approach those who will be (potentially) affected by an intervention (i.e. a geothermal project), proactively initiate and cooperate in the monitoring efforts.

As shown in the table, the case study provides insights to answer the first part of the research question, that is how to include public values in CBM in all stages of the development and exploitation of the geothermal energy project. First of all, baseline monitoring is mandatory. Geothermal energy projects are likely to have an impact on the current

**Table 4**  
Contours of the proposed monitoring system for this geothermal project initiative.

|      | Standard monitoring activities for project actors                                                                   |                                                                                                                                                                                                         |                                                                                                                         | Addition from non-project actors' perspective                                                                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | Baseline (natural and spatial system 'as is')                                                                       | Project-oriented aspects                                                                                                                                                                                | Permit-mandatory aspects                                                                                                | Societal aspects                                                                                                                                                                                                        |
| WHAT | Indicators, based on environmental values.                                                                          | Indicators, based on distributive (mainly financial-economic) and environmental (mainly, technical) values. For example: time & planning, budget, return-on-investment, technical progress, operational | Indicators, based on environmental values from legislation. For example: safety, nuisance, environmental risks          | Indicators, based on environmental, distributive and procedural values from the local society. For example: private real estate value, quality of living environment, personal risks (seismicity, construction traffic) |
| HOW  | Methods for data collection and analysis on different types of values<br><br>- Expert<br>- Objectified<br>- Trusted | Idem.                                                                                                                                                                                                   | Idem.                                                                                                                   | Methods for data collection and analysis on different types of values<br>- Locally trusted<br>- Joint<br><br>- Locally operated <sup>a</sup>                                                                            |
| WHO  | Experts                                                                                                             | Operators, experts, project stakeholders                                                                                                                                                                | Legislators (mainly governments both local and national), experts, knowledge institutes, applicants, local stakeholders | Local communities and stakeholders, local government                                                                                                                                                                    |

<sup>a</sup> One could think of sensors for environmental and/or seismic impacts in private homes and/or community centers at and around the designated location.

state of affairs in the natural system, both in the subsurface and at the surface level. The current status needs to be defined to enable monitoring the impacts the project might have in different stages of development. Second, project initiators themselves need to monitor the project development process to continuously assess to the progress of the construction and its adjacent risks, the financial-economic business case and reporting obligations to their business stakeholders, such as investors and boards of consortium partners. In different project stages, initiators and investors want to know what the technical and economic situation is, to be able to intervene if necessary. Third, complex geothermal project initiatives need to apply for many different permits in various stages of project development. Project initiators need to provide monitoring data in order to acquire necessary permits in different stages of project development (exploration, testing, exploitation etc.). Legislators will set specific requirements about the careful monitoring of potential impacts of the project to acquire the permits needed to proceed. And fourth, local communities and stakeholders will have their own concerns and interests [51], besides those of the project initiators and legislators, that need to be monitored, to feel (more) comfortable with the project's construction and operations activities and related risks. By taking active part in monitoring the project from the onset, local communities and stakeholders gain insight in the costs and benefits, as a starting points for dialogue with the project consortium, in case the balance between them is off in their opinion. This may also lower the suspicion among local communities and stakeholders to 'outsider' knowledge creation [2].

The second part of the research question concerns the inclusion of societal values in the design of CBM as part of the overall project development strategy. In our view, a CBM system that includes the knowledge needs following from concerns of local communities and stakeholders, recognizes a broader array of values than project actors usually acknowledge. This means that CBM starts with making the first three reasons for monitoring mentioned above, more explicit to local communities and stakeholders. This explication serves as a basis for identifying blank spots in monitoring criteria and data from the local society's point of view. It can be observed that local communities and stakeholders' account of the potential impacts of the intended project goes beyond the usual baseline, project-oriented and environmental permit-based values. As non-project actors are usually not included in designing, deciding and executing monitoring efforts, they will add new value-laden criteria and provide different types of data that will 'force' project actors to broaden their project development strategy. If these non-project actors' values are on the table, they will be less likely be neglected; or at least local communities and stakeholders will have significant arguments for making their case, improving the energy justice of the intended geo-energy project [11]. For example, in our case neither project initiators nor local government have an obvious reason to monitor the value of private local real estate during the construction and exploitation stages of the geo-energy project whereas for local communities and stakeholders, estimating the impact on private real estate property is vital. In this way, a more inclusive approach to public value energy governance [51] can be achieved that might mitigate the perceived imbalance.

## 6. Conclusion

In the Netherlands, in general, geo-energy projects are the playing field of national government and (inter)national business, often supported by national knowledge institutes. Geo-energy projects are developed and exploited too often as 'black boxes', causing anxiety and suspicion at actors that are not directly involved. The interests of local communities and stakeholders are largely neglected. Treating local communities and stakeholders, and even the local government, as incapable or even 'annoying' inevitably provokes them to apply their opposing powers for terminating these projects. An additional difficulty for the acceptance of geo-energy projects is that mining and/or storing

activities will take place at great depths and, as a consequence, their scope of action and their impact on the environment and/or humans cannot be touched or witnessed. All that can be known about these activities is ‘mediated’ by models, equations, indicators and sensors. Although monitoring activities provide ‘indirect observations’ of what is happening in the deeper subsurface, it is the best knowledge available, ‘to witness’ and/or predict the processes in the subsurface.

The foregoing indicates that acceptance of geothermal systems, as an example of often contested geo-energy projects, by local communities and stakeholders is a vital component for enhancing the distributive and procedural justice of these projects. A practical way of doing this is to jointly explore how local communities and stakeholders, including local government, could play a productive and tangible role in monitoring the project's impacts. For example, through community-based monitoring (CBM). The reason for this is quite straightforward: geothermal energy projects are situated in a certain social environment, at a certain location. And as this social environment is likely to “talk back” at the project initiators, so why not include this inevitable “conversation” in the project development from the start? Initiators will immediately start learning what it takes to embed geo-energy projects in their social environments; legislators will witness the societal responsibility that project initiators assume, and investors and other financial sponsors will gain an early insight into the social readiness and acceptability of their intended investment. Even when it becomes clear that the intended project is a ‘no go’ at the desired location, project initiators, investors and legislators will benefit from this insight because a lengthy, expensive and ultimately failed process can be avoided. As such, the valid claim can be made here that CBM should become an integrated part of the overall project development strategy of geothermal projects.

Also, the valid argument can be made the transparency of geo-energy projects might benefit from collaborative and intensified monitoring networks and efforts, further improvement of monitoring tools and data analysis, in order to gain a better understanding of the mechanisms within the deeper subsurface which, in turn enable better predictions of the safety over the long-term. Developing innovative CBM-methods can enhance the active understanding of activities in the subsurface at non-expert stakeholders, providing them with more insights into the impact on their local living environment. CMB can also provide more confidence in the way potential risks are being watched and managed.

CMB can address the challenges for the distributive and procedural justice that seems to be more or less inevitably engrained in the inherent pitfalls of Dutch geo-energy projects, largely caused by the institutional framework and recent geo-energy failures, grounded in widespread fearfulness in society at large and at local communities and stakeholders in particular. These challenges represent.

1) too limited representation of public values held by local communities and stakeholders, and 2) too limited access for these actors to actively participate in the separate stages of project development.

First CMB addresses an imbalance in the distributive justice by seeing to the inclusion of costs and benefits (in the broader sense of these terms) for local communities and stakeholders, as well as efforts to respectively mitigate and harvest them. Second, CBM mitigates an imbalance in the procedural justice by organizing the structured and structural participation of local communities and stakeholders by involving them in setting up the monitoring system (indicators, distribution of sensors, etc.), data collection and interpretation.

It is tempting to suggest that an inclusive approach to geothermal project monitoring should be made mandatory by legislators and/or supervising councils. However, based on the recent failed geo-energy project initiatives in the Netherlands, future project initiators might be intrinsically motivated to collaboratively monitor a broader array of values, attempting to address the needs and expectations of local communities and stakeholders, and create better preconditions for their societal acceptance. An adjacent benefit might be that by informing local communities and stakeholders, local governments and legislators can be put at ease as well, preventing current negative spirals around

geo-energy projects with ‘contested’ technologies from occurring, often leading to the termination of these projects without well-informed dialogue between actors involved.

## CRedit authorship contribution statement

**Michael Duijn:** Writing – original draft. **Jitske van Popering-Verkerk:** Writing – original draft. **Karliën Sambell:** Formal analysis. **Hanneke Puts:** Project administration.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Michael Duijn reports financial support was provided by European Commission.

## Data availability

Data will be made available on request.

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