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DOI
10.1016/j.enpol.2018.08.020

Publication date
2018

Document Version
Final published version

Published in
Energy Policy

Energy Policy 122 (2018) 639–648

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

A values-based approach to energy controversies: Value-sensitive design applied to the Groningen gas controversy in the Netherlands

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ARTICLE INFO

Keywords:
Energy controversy
Value-sensitive design
Values hierarchy
Groningen gas case
Social acceptance

ABSTRACT

Many energy cases suffer from social opposition. It is increasingly asserted that paying due attention to the moral values involved in controversial energy cases may increase social acceptance. Value-sensitive design (VSD) has been recommended as a promising approach for addressing moral values in controversial energy cases. This paper aims to empirically explore the applicability of VSD in controversial energy cases by investigating the extent to which it is possible to identify the relevant values, norms and design requirements in the Groningen gas controversy (the Netherlands) using values hierarchies. It was found in this case that the relevant values, norms and design requirements could be retrieved, but that two conditions need to be fulfilled to avoid underexposure of relevant values. Firstly, data should be collected using a variety of data sources. Secondly, these sources should be analyzed through both top-down approaches and bottom-up approaches. We find that 'Safety' is a critical value in the Groningen case, while other critical values are related to securing 'Procedural Justice'. Strikingly, the important procedural values 'Trust' and 'Honesty' did not translate into concrete policies. Policy makers can use values hierarchies to address moral values in energy cases and to translate these values into concrete measures.

1. Introduction

Energy cases often suffer from significant social opposition. In the Netherlands, for instance, numerous initiatives of this type have been aborted or significantly delayed due to major social opposition. For instance, underground CO_2 storage near Barendrecht and shale gas production near Boxtel have been aborted because inhabitants were concerned about safety (Cuppen et al., 2016; Feenstra et al., 2010) and the roll-out of smart energy meters was blocked due to citizens' privacy concerns (Cuijpers and Koops, 2013). Other countries have faced similar challenges. The Scottish government declined permission for a wind farm consisting of 181 turbines to be built on the Isle of Lewis following severe resistance from local interests (Jenkins et al., 2016). Similarly, a general lack of social acceptance seems to be a key factor for explaining the lack of developed wind farms in France (Enevoldsen and Sovacool, 2016; Nadaï, 2007). The lack of social acceptance can lead to delays, escalating costs, and failure risk for energy cases (Enevoldsen and Sovacool, 2016).

There is a vast body of literature in the social sciences investigating the conditions under which people are likely to accept or oppose energy cases (e.g. Batel et al., 2013; Huijts et al., 2012). Within this literature, there is increasing attention for the impact of ethical considerations (e.g. Cowell et al., 2011; Gross, 2007; Wüstenhagen et al., 2007). Various scholars argue that low social acceptance for energy cases might result from having neglected relevant ethical issues in the design of these cases (Hannis and Rawles, 2013; Van de Poel, 2016). Hence, it is increasingly argued that moral values should be more carefully integrated throughout the design of energy cases (e.g. Cuijpers and Koops, 2013; Demski et al., 2015; Kostyk and Herkert, 2012; Ligtvoet et al., 2015).

In this literature, energy cases are commonly conceived of as *socio-technical* systems, entities which consist not only of technical infrastructure, but also of people and institutions (e.g. Bauer and Herder, 2009; Berkhout, 2002; Geels, 2004; Molina, 1999; Kern, 2012; Sovacool, 2009; Verbong and Geels, 2010). Socio-technical systems need actors and social/institutional infrastructure (in short: 'institutional arrangements', Williamson, 1998) to be in place in order to perform their functions (Kroes et al., 2006). Indeed, the institutional arrangements in which the technical infrastructure is embedded can facilitate or constrain feasible design alternatives (Wüstenhagen et al.,

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https://doi.org/10.1016/j.enpol.2018.08.020
Received 22 October 2017; Received in revised form 28 June 2018; Accepted 8 August 2018

2007). The actors and institutions maintain and/or transform the socio-technical system by a broad range of decisions and procedures: How are the revenues distributed? Who is allowed to make certain decisions? These are value-laden questions and the institutional arrangements thereby reflect certain values. The argument that values should be more carefully integrated throughout the design of energy systems therefore also applies to the institutional arrangements that are part of the system.

A promising approach to addressing values in a structured and comprehensive manner throughout the design process is value-sensitive design (VSD) (Flanagan et al., 2008; Friedman, 2004). VSD was originally developed in the context of information and communication technology (Friedman et al., 2002), for example in the development of an online tool that provides technical functionality while at the same time addressing privacy concerns (Xu et al., 2012), or in the creation of Braille-based applications that provide information about buses and bus stops to the visually impaired, thereby promoting the values of accessibility and inclusiveness (Azenkot et al., 2011).

In principle, VSD could be extended to the context of socio-technical systems and its design (Künneke et al., 2015). Dignum et al. (2016) and Oosterlaken (2015) discuss the possibility of adopting a VSD approach towards socio-technical energy systems. Oosterlaken (2015) provides a theoretical basis for its use in the design of wind turbines and wind parks, but does not apply VSD to a concrete wind energy case nor does she address empirical or practical details related to potential application. Dignum et al. (2016) take a first step in identifying relevant values empirically by analyzing policy documents from NGOs, the National Government and industry groups regarding the exploration and exploitation of shale gas in the Netherlands. From these documents, they first infer arguments/norms which they subsequently reduce to a set of underlying values. Although Dignum et al. (2016) represent an important first step in the empirical investigation of the extent to which VSD can be applied in the context of a socio-technical energy systems, their analysis did not concern an existing socio-technical energy system with concrete users and a concrete technology, but was instead a general exploration of the possibility of shale gas extraction in the Netherlands. As such, while the authors were able to make an inventory of possibly relevant values, they did not consider explicit *design* aspects. The authors were not able to do so because the Dutch government decided to prohibit the exploration and exploitation of shale gas in the Netherlands in response to large-scale societal opposition (Metze, 2014).

To the best of our knowledge, there are no studies which empirically investigate the extent to which VSD can be applied in the context of an existing controversial socio-technical energy system.[1] Hence, the main objective of our study is to explore the applicability of VSD in an existing controversial energy case: the Groningen gas case. A prerequisite for the applicability of VSD is that values, norms and design requirements that are relevant in the project can be identified (e.g. Manders-Huits, 2011; Pesch, 2015). Hence, we primarily investigate the extent to which it is possible to identify the relevant values, norms and design requirements in the Groningen gas case. This is being done by analyzing newspaper articles, political debates and conducting interviews with stakeholders. Since our study also focuses on the identification of norms and concrete design requirements, we contribute to making VSD for socio-technical energy systems more concrete and tangible. Moreover, we provide recommendations for policy makers that aspire to use VSD in the analysis of energy controversies.

[1] An existing socio-technical energy system is controversial when the case is subject of public and political debate and suffers from significant social opposition. For reasons of readability, we will use the label 'controversial energy case' as shorthand to refer to a controversial socio-technical energy system. The term 'energy controversy' is used to refer to the controversy itself pertaining to a specific controversial energy case.

The outline of the paper is as follows. Section 2 discusses the method of value-sensitive design. In Section 3 we present the case study. Section 4 outlines the methodology we used in our study and Section 5 discusses the results. Section 6 provides conclusions and policy recommendations.

2. Value-sensitive design from a top-down and bottom-up perspective

To explicitly design for values, value conflicts, and trade-offs between values, Friedman and colleagues developed VSD in the early 1990s (Friedman et al., 2002). VSD builds on an integrative methodology that combines conceptual, empirical and technical investigations (Friedman et al., 2002). The investigations that require the least context-dependent knowledge are conceptual investigations. Through a philosophically informed analysis, the fundamental issues raised by the project under investigation are clarified and the relevant values identified. Typical questions raised during this phase are: "What are the values at stake?" and, "How should we engage in trade-offs between competing values in the design?" Next, empirical investigations come into play. Often these are needed to evaluate the success of a particular design, addressing questions such as: "How do stakeholders prioritize individual values and usability considerations?" Empirical investigations often require data gathering through observation, interviews, questionnaires and other quantitative and qualitative methods (Friedman et al., 2013). The third type of inquiry is known as a technical investigation, of which, according to Friedman et al. (2002), there are two types. The first focuses on how existing technological properties and underlying mechanisms support or hinder human values, while the second concerns the proactive design of systems to support values identified in the conceptual investigation. Although empirical investigations and technical investigations have a lot in common, there is an important difference in their unit of analysis: the former often focus on individuals or groups that are affected by the technology or the socio-technical system, while the latter focus on the technology itself.

VSD was originally developed in the context of ICT to ensure that a technology's design requirements adequately reflected the values underlying its creation, but several other potential merits for the design process were observed in the literature. Empirical studies on technology-based controversies indicate the need to address values early in the design and implementation of technologies and their governing institutions because underlying ethical issues can exacerbate conflicts and undermine resolution efforts (Glenna, 2010). Furthermore, addressing moral values may secure commitment from relevant stakeholders whose involvement is needed to successfully implement these technologies (Doorn, 2016). VSD could potentially play an important role here. It could be used, for instance, to facilitate structured dialogue in which stakeholders better understand each other's argumentation lines. VSD could be of significant value by clarifying what the debate is about, and what other stakeholders' perceptions actually are. Moreover, by reshaping the discussion in terms of values and norms, VSD could help generate new perspectives, thereby providing a clear point of departure for future debates and increasing the solution space (Oosterlaken, 2015). Finally, the approach could add value to the design process by identifying value conflicts a priori, creating awareness among stakeholders as to the disagreement that may eventually emerge.

While VSD was developed to ensure that design requirements adequately reflect underlying values, it does not provide proper guidelines for the implementation of values within the design process (Harbers and Neerincx, 2014; Van de Poel, 2013). To address this, Van de Poel (2013) introduces the concept of a "values hierarchy". This approach translates values into more tangible design requirements, thereby ensuring that the design sufficiently reflects the moral values at stake. In the present study, we use the concept of values hierarchy to explore

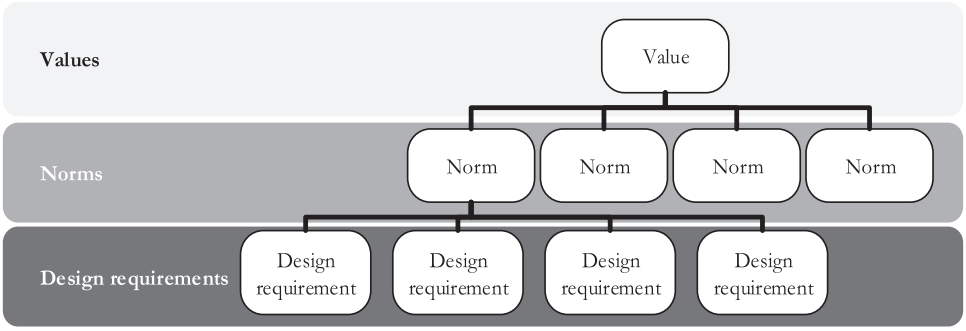

Fig. 1. Values hierarchy (Source: Van de Poel, 2013).

whether it is possible to identify the relevant values, norms and design requirements in the Groningen case.

A values hierarchy is a coherence structure consisting of three layers (see Fig. 1). The upper layer contains context-independent values. The middle layer contains norms, which could be any kind of prescription for – and restriction on – action. In contrast to values, norms are context-dependent. Finally, design requirements are obtained by further specifying the norms that are positioned in the middle layer of the structure. A design requirement can be more specific with respect to the applicability of the norms, goals or aims strived for, or actions or means to achieve these aims (Richardson, 1997).

A values hierarchy can be constructed top-down as well as bottom-up. When applying a top-down approach, the upper layer serves as the point of departure. One begins by identifying values and then proceeds towards design requirements. The original VSD approach developed by Friedman et al. (2002) followed this top-down approach, starting with conceptual work on the values, through empirical work on norms, to technical work on design requirements. In contrast, a bottom-up approach starts with a certain set of design requirements and derives general norms and values from it. In the following sections, we will discuss how values can be retrieved empirically in the Groningen case using both approaches.

3. The Groningen gas case

The main objective of this study is to explore the extent to which it is possible to apply VSD in a controversial energy case. Our study is based on a single case study: the exploitation of a major gas field in the province of Groningen in the northeast of the Netherlands. We selected the Groningen case for various reasons. First of all, the complexity of the case – as determined by the lead time, site-specificity and overall uncertainty – is considered typical for controversial energy cases. Secondly, the case has generated a lot of media attention and continues to do so. Due to its high societal impact and the fact that it is an ongoing matter, it is relatively easy to retrieve relevant information.

The Groningen gas field is the largest in Western Europe and has been commercially exploited since 1963. The gas field has played a major role in establishing a reliable and affordable energy supply as well as in generating revenues for the Dutch state. In the period 1963–2013, the government of the Netherlands received a total of €265 billion arising from gas production in Groningen (Minister of Economic Affairs, 2014a).

Out of all Dutch government bodies, the Ministry of Economic Affairs is the most closely involved with the Groningen case. It functions, for instance, as a licensing authority, approving production plans of the *Nederlandse Aardolie Maatschappij* ('Dutch Petroleum Company', NAM). The NAM is an exploitation and production company operated as a joint venture by Royal Dutch Shell and ExxonMobil, each with a fifty-percent stake. To be allowed to produce gas from the Groningen field, a production permit has to be granted by the Ministry of Economic Affairs.[2] Whether the NAM receives approval is based on the Ministry's evaluation of its production plans. Even when approval is granted, however, the NAM is responsible for damage to soil subsidence or tremors resulting from its activities (Wet Aansprakelijkheid voor personen en zaken, 2003).

In 1986, an earthquake struck the town of Assen despite its distance from any tectonic fault lines. Then-Minister of Economic Affairs Rudolf de Korte claimed it was highly unlikely that the seismic event had anything to do with gas extraction in Groningen (Tweede Kamer der Staten-Generaal, 1989). From the year 1986 onwards, however, both the magnitude and frequency of earthquakes increased. This resulted in damage to buildings and eventually led to discontent amongst local residents (van der Voort and Vanclay, 2015). Problems reached their peak on August 16th, 2012, when an earthquake that registered 3.6 on the Richter scale struck Huizinge, a small village in the northeast of the province of Groningen. This earthquake had a major impact both physically and politically. Not only did it cause damage to houses in a relatively large area, but it was the first event resulting in houses becoming uninhabitable. As a consequence, the NAM was forced to pay the claims of affected residents. Up until the Huizinge-earthquake, a total of about 1100 claims of seismic damage had been reported in the region. The Huizinge earthquake, however, resulted in over 8300 such claims (Nederlandse Aardolie Maatschappij, 2015). Furthermore, several special interest groups were established as a response (e.g. Schokkend-Groningen and Stichting Waardevermindering door Aardbeving Groningen).

Following these events, a proven relationship was established between the rate of gas extraction and the maximum earthquake magnitude (State Supervision of Mines, 2013). In the spring of 2015, the Ministry of Economic Affairs established the committee 'Omgaan met risico's van geïnduceerde aardbevingen' ("Dealing with the risk of induced earthquakes") (Commissie Meijdam, 2015) to provide advice on induced earthquakes, safety standards, and strengthening buildings. Starting from the principle that safety standards must be the same throughout the Netherlands, the committee recommended an individual risk[3] of 10^{-5} per year with respect to new buildings and an individual risk of 10^{-4} with respect to existing buildings (Commissie Meijdam, 2015). In the same period, a consulting body (Dialoogtafel) was established, consisting of – among others – government representatives, private citizens, companies and NGOs (Minister of Economic Affairs, 2014b). The main objective of this group was to regain the trust of stakeholders. Finally, the Dutch Safety Board (2015) published results from a study, commissioned by the Minister of Economic Affairs, into the decision-making process on gas extraction in Groningen. According to the report, inhabitants' safety had not been a factor in the decision-making process on gas extraction in Groningen till

[2] In case the NAM wants to amend their production plan a new production permit needs to be granted.

[3] The probability that someone dies as a consequence of a given risk during a period of one year.

2013. Despite the fact that their risk assessments were subject to several very relevant uncertainties, involved parties considered the safety risk for the local population to be negligible. On March 2nd, 2015, the Minister of Economic Affairs apologized for this lack of attention (e.g. RTV Noord, 2015; Trouw, 2015). Presently, the discussions center around reducing extraction activities, strengthening buildings, repairing damages, and offering compensation for harm to the region as a whole.

4. Methodology

As explained in Section 2, VSD was originally developed as an ex-ante method of designing technical artefacts so as to ensure that technical design requirements properly reflect underlying values. However, the Groningen case is an existing socio-technical system which implies that the design of the socio-technical system is more a matter of adaptation/revision of an existing socio-technical system than of completely new design (Franssen, 2015). With that being said, acceptance of the socio-technical system can be improved by *redesigning* technical, institutional and procedural artefacts. We construct values hierarchies through both a top-down and a bottom-up approach. We discuss these approaches in greater detail below.

4.1. Top-down approach

The first step in our empirical investigation is constructing values hierarchies through a top-down approach. This starts with the identification of relevant values and then proceeds towards the inference of norms and design requirements. Multiple sources were available to identify relevant values, such as transcripts of political debates, transcripts of town hall meetings, policy documents,[4] interviews with relevant stakeholders, newspaper articles, content from internet forums and (academic and professional) literature. Before we conducted our study, we analyzed the strengths and weaknesses of the sources addressed above based on literature and discussions between the authors. We particularly paid attention to the extent to which sources might lead to underexposure of values. We summarize our expectations about strengths and weaknesses of the different sources in Table 1.

Because we concluded that all sources are endowed with some weaknesses we opted to select more than one source to identify values hierarchies. We expected that this mixed method strategy (Bryman, 2006; Creswell, 2009) would allow us to obtain a more comprehensive understanding of relevant values in the Groningen case. More importantly, this allows us to investigate whether using a single approach would result in underexposure of relevant values. We selected the following sources: academic literature, newspaper articles, transcripts of political debates and interviews with stakeholders. We excluded transcripts of town hall meetings, because we were not able to find enough transcripts to have confidence in. We excluded content from internet forums and policy documents because, in our view, these sources did not provide reliable new information that could not already be retrieved via the other sources.

The most important reason for selecting 'scientific literature' is that we expected that an analysis of relevant scientific literature would provide a good starting point for the analysis of other sources. We selected newspaper articles as our primary source because this source posits various benefits compared to other sources (see Table 1). One advantage of newspaper articles compared to political debates is that newspaper articles are more likely to present opinions from a range of relevant stakeholders, whereas political debates only reflect politicians' perceptions. Obtaining values hierarchies solely from political debates might therefore lead to underexposure of values. In order to select articles that properly represented the Groningen case, we included three national newspapers in our analysis (*NRC Handelsblad*, *De Telegraaf*, and *De Volkskrant*). Collectively, the newspapers sufficiently cover the political spectrum (Ardıç et al., 2013). Ardıç et al. (2013) classify the *De Telegraaf* as 'Popular right-leaning', *De Volkskrant* as 'Quality left-leaning', and *NRC Handelsblad* as 'Quality right-leaning' (which, interestingly, does not fully align with the latter's self-reported 'progressive-liberal' stance). Since a substantial portion of the gas fields' impact is confined to the North of the Netherlands, we included a local newspaper – *Dagblad van het Noorden* – to ensure full coverage of relevant news items. We selected articles from these publications by searching the digital newspaper archive LexisNexis using, among others, the following keywords: 'Earthquake Groningen', 'Gas Groningen', 'Damage Groningen'. As a result of the substantial growth in media coverage of the case study following the earthquake near Huizinge, 282 out of the 299 articles included in our analysis were published after this event. Table 2 shows the distribution of articles with respect to their timing, length and the newspaper they were printed in.

To gain insight into the political elements of the broader societal debate we selected transcripts of parliamentary debates as the third source in our analysis. We decided to focus on three recent debates, each covering different aspects of the issue, in order to develop a clear picture of the current situation. Although newspaper articles constitute the primary source to obtain data, these debates provided about the same amount of raw content due to their comparatively lengthy transcripts. In order to avoid overlooking relevant values which do not materialize in paper, we conducted nine interviews with key stakeholders. Doing this had the further advantage of validating the inferences drawn from the content analysis of newspaper articles and political debates. The interviewees were selected in such a way that both stakeholders involved from a professional point of view as well as from personal interest and both stakeholders concerned with decision-making and not concerned with decision-making were represented. The interviews have been, with permission of concerned respondents, recorded. Subsequently, all audio material was transcribed making use of the online tool 'Transcribe'. Table 3 provides more information about the nine respondents.

4.2. Bottom-up approach

Using the bottom-up approach, we again attempted to obtain the upper layer of our values hierarchy. In this approach, however, we began by identifying the norms being referred to in newspapers and debates. Following this, we determined which values were related to which norms. We consider applying this bottom-up approach alongside the top-down approach previously discussed to be an important research step. It is conceivable, for instance, that some values will receive less attention in the public debate than others. Underexposure of values could occur when values are less appealing to the actors participating in the debate, or when stakeholders are less aware of them. If we were to focus solely on the values that had been explicitly stated, then we might overlook others that had only been implied by the requirements and norms put forward.

4.3. Coding methodology

In order to analyze the newspaper articles and political debates in a reliable manner, we made use of content analysis. This approach has been defined as a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding and categorizing (Weber, 1990). In the field of transport policy, content analysis has been increasingly applied by researchers because the method is regarded as a structured approach for decoding

[4] The Dutch government composes various documents in which, amongst others, the future development of the Dutch energy demand and supply are explored (ECN and PBL, 2015) and in which the short term vision and long term vision of the Dutch Government regarding energy supply are discussed (Minister of Economic Affairs, 2015).

Table 1
Strengths and weaknesses of different sources.

	Strengths	Weaknesses
Academic literature	– Good starting point for determining potentially relevant values for controversial energy cases.	– No concrete design requirements can be obtained; – The extent to which values are relevant in a specific case needs to be verified through other sources.
Newspaper articles	– Time efficient. Possible to analyze vast amount of data in short period of time; – Newspapers report the opinions of all kinds of stakeholders (Ardıç, 2015); – Easy to reproduce for other researchers.	– Potential underexposure of values which do not attract media attention and values which do not materialize in paper.
Transcripts of political debates	– Covers political dimension of a case (Ardıç, 2015); – Relatively time efficient. However, politicians generally discuss a plethora of topics during one debate and not all topics are relevant for our study.	– Potential underexposure of values of other stakeholders than politicians and values which do not materialize in paper (Ardıç, 2015).
Interviews with stakeholders	– Enables identification of values which do not materialize in paper; – By asking follow-up questions it is possible to better understand a stakeholder's line of reasoning regarding values, norms and design requirements. – Stakeholders might be willing to share 'real viewpoints' on topics that are too sensitive to discuss in newspapers and political debates.	– Time consuming (Ardıç, 2015); – Not sure whether key stakeholders are willing to contribute to an interview (Ardıç, 2015); – Difficult to reproduce for other researchers; – Data from interviews with retrospective questions about actor opinions regarding events (or issues) several years earlier might suffer from recall errors and hindsight bias (Krouwel and van Elfrinkhof, 2014; Vaart et al., 1995).
Transcripts of town hall meetings	– Covers opinions of local citizens and interest groups. – Relatively time efficient.	– Not sure whether local citizens discuss concrete design requirements during town hall meetings.
Policy documents	– Policy documents might discuss a variety of (arguments underpinning) policy options regarding a controversial energy case. – Time efficient. Possible to analyze vast amount of data in short period of time.	– Policy documents tend to focus on discussing norms and arguments, with concrete design requirements largely being ignored (Dignum et al., 2016; Okereke and Coventry, 2016). – Policy documents might focus on the policies and arguments that are preferred by incumbents.
Internet forums	– Relatively time efficient. Possible to analyze vast amount of data in short period of time. However, discussions on internet forums can go in all directions.	– Moderators can explicitly (through the deletion of posts) and/or implicitly (through attempts to steer the conversation) shape what is visible to researchers.

Table 2
Time-frames and length of newspaper articles, by newspaper.

	Newspaper				
	Dagblad van het Noorden	NRC Handelsblad	De Telegraaf	De Volkskrant	**Total**
Time frame					
Period between first earthquake in Assen (1986) and earthquake in Huizinge (mid 2012)	7	7	1	2	**17**
One year after earthquake in Huizinge mid (2012–mid 2013)	17	18	3	12	**50**
Mid 2013–2015	77	75	23	57	**232**
Total	**101**	**100**	**27**	**71**	**299**
Length					
0–250 words	24	11	8	5	**48**
250–500 words	56	37	11	19	**123**
500–750 words	16	28	7	28	**79**
750–1000 words	2	13	1	10	**26**
More than 1000 words	3	11	0	9	**23**
Total	**101**	**100**	**27**	**71**	**299**

Table 3
Overview of respondents.

Respondent 1	Employee of a national political party, working for a Member of Parliament who acts as spokesperson for the Groningen case.
Respondent 2	Program Assistant, Gas Extraction for the province of Groningen (provincial level)
Respondent 3	Project Secretary for Gas Extraction for the municipality of Loppersum (local level)
Respondent 4	Employee of the NAM (the exploitation and production company)
Respondent 5	Resident
Respondent 6	Representative of local interest group Groninger Bodem Beweging
Respondent 7	Representative of environmental interest group
Respondent 8	Representative of organization concerned with preservation of cultural heritage
Respondent 9	Employee of construction company

texts as free from inferences as possible (Ardıç et al., 2013; Mouter et al., 2013a, 2013b; Vonk Noordegraaf et al., 2014). A feature of the methodology is that the researcher starts with a theory or relevant research findings as guidance for initial codes. Hence, we started our content analysis with identifying potentially relevant values for contested energy cases in ten scientific papers on similar topics. We did not conduct a systematic literature review, as the only aim of the analysis of the ten papers was providing a starting point for coding the newspaper articles. In the coding process of newspaper articles and parliamentary debates, statements were coded when they concerned one of three elements: values, norms or design requirements. Together, these elements form the basis of a values hierarchy as discussed by Van de Poel (2013). To make the process transparent and replicable, we developed a 'coding and categorizing protocol' in which the rules for coding are described. To verify the reliability of our coding, a second coder processed ten newspaper articles using this protocol.

Table 4
Initial values identified in ten relevant scientific papers.

	Bidwell (2013)	Hall et al. (2013)	Heffron and McCauley (2014)	Walker (2009)	Greenberg (2014)	Dignum et al. (2016)	Oosterlaken (2015)	McCauley et al. (2013)	Gross (2007)	Wolsink (2005)
1) Procedural justice	x	x	x	x		x	x	x	x	x
2) Trust					x		x		x	
3) Honesty					x	x	x		x	
4) Integrity			x							
5) Democracy	x		x	x	x	x	x	x	x	x
6) Transparency			x	x		x	x	x	x	
7) Informed decision-making						x			x	
8) Responsibility				x		x				
9) Legal justice						x		x		x
10) Impartiality					x	x		x	x	
11) Intergenerational justice		x		x		x	x	x		
12) Intragenerational justice	x	x	x	x		x	x	x	x	x
13) Safety		x			x	x		x		
14) Precautionary principle					x					
15) Duty of care					x					
16) Fair compensation				x						
17) Sustainability	x			x		x	x	x		
18) Animal welfare	x								x	x
19) Economic wealth	x					x				
20) Affordability		x		x		x		x		
21) Security of supply	x	x	x			x	x			
22) Liveability							x		x	
23) Traditionalism (place attachment)	x			x			x			
24) Aesthetics	x					x	x	x		x
25) Justice as recognition		x	x	x		x		x	x	

5. Results and discussion

Table 4 provides the list of 25 initial values we identified in the literature and the papers in which these values were identified. The top row presents the references to the ten articles.

After the identification of the initial values, we analyzed the newspaper articles and debates using both top-down and bottom-up approaches.

5.1. Newspaper articles and debates

Table 5 indicates the number of times values, norms, and design requirements were recognized in the newspaper articles and parliamentary debates.

A first observation that can be found in Table 5 is that values were cited more frequently than norms or design requirements in newspaper articles. By contrast, parliamentary debates saw norms and design requirements discussed far more often. A possible explanation for this discrepancy is that the electorate expects politicians to show decisiveness. Especially when a situation calls for speedy solutions as is the case of Groningen, debating norms and design requirements, and even ready-made solutions, might be more appealing than speaking about values. A possible explanation for the focus on values in newspapers is that claims regarding the government breaching values such as *Safety*, *Honesty* and *Trust* might attract much more attention than a discussion of a concrete – and possibly rather technical – design requirement.

Table 5
Number of occurrences of values, norms and design requirements in newspapers and debates.

	Newspaper articles	Parliamentary debates
Value	326	50
Norm	127	219
Design Requirement	188	112

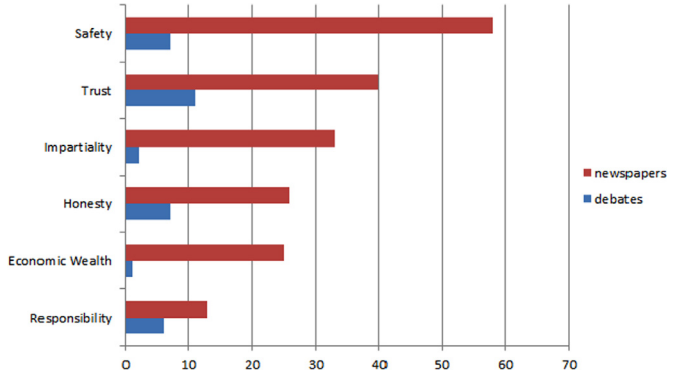

Fig. 2. Number of occurrences of values in newspaper articles and parliamentary debates.

5.2. Results from applying top-down approach

Out of the 25 values we identified in the literature, 22 were subsequently found in the newspaper articles and debates. Some of these were recognized far more often than others. Fig. 2 provides the number of occurrences for each value that was recognized a total of at least 25 times in the newspaper articles or at least 5 times in parliamentary debates.[5] As many as 56% (182 instances) of the identified values in the newspaper articles concerned either *Safety*, *Trust*, *Honesty*, *Impartiality* and *Economic wealth*. The values that were coded most frequently in debates largely mirrored those of the newspaper examination.

From Fig. 2, it can be inferred that *Safety*, *Trust* and *Honesty* were

[5] The intercoder reliability was very good for the coding of the norms, but slightly less so for the coding of the values, which suggests that there is relatively more room for interpretation regarding the identification of values than the identification of norms.

among the most recognized values in both sources. An interesting observation is that, while the earthquakes caused by gas extraction could potentially affect significant infrastructure such as water defenses, roads and network infrastructure, virtually all of the safety concerns expressed in the public and political debate were related to damage to buildings.

After the earthquake in Huizinge, over 67,000 claims were reported, of which over 50,000 have been settled for a cumulative payout of at least €400 million. From the analysis of the newspapers and debates, it became clear that the value *Trust* was particularly relevant because residents and interest groups felt as though their trust had been breached multiple times in the past. A recurring viewpoint, for instance, was that the NAM and the Dutch government had waited too long to acknowledge the relationship between gas extraction and earthquakes despite clear evidence.

The reasons for *Honesty* being mentioned so often appears to be closely related to those concerning *Trust* and *Safety*. In the view of inhabitants and special interest groups the NAM and the responsible Minister on the one hand argued that *Safety* had top priority, however, on the other hand, the same institutes did not appear to make any substantial efforts to follow through (such as by significantly reducing production levels).

5.3. Results from applying bottom-up approach

In our analysis, we identified 716 norms and design requirements. For reasons of manageability, we clustered these into 64 categories. These categories were then used to determine the relevant values. An interesting observation is that the lion's share (over 40 of the 64 categories) of the identified norms and design requirements either directly or indirectly related to *Safety,* which was also the most frequently identified value in the top-down analysis. Prescriptions for gas production levels, along with the strengthening and repair of buildings, were by far the most frequently observed norms in the debates and newspaper articles. Fig. 3 presents the values hierarchy that was composed for the value *Safety*. The purple boxes represent the norms. The blue boxes represent the design requirements. Abstract (specific) design requirements are visualized in dark (light) blue.

Although the values *Trust* and *Honesty* were among those most commonly recognized in the top-down analysis, we found almost no norms or concrete measures which directly related to them. For instance, there was little discussion of specific actions or standards that would help rebuild *Trust*. This observation lines up with findings by Okereke and Coventry (2016), who analyzed value considerations in the Paris climate agreement, specifically focusing on justice considerations. They found that, although value considerations are a central aspect of international politics of climate change, they often do not translate into concrete policy measures.

Interestingly, several values were identified through the bottom-up approach which had not – or only to a limited extent – been identified through applying the top-down approach. These included, most prominently, the values *Clarity*, *Livability*, *Impartiality* and *Transparency*. The first of those, in particular, was frequently referred to by identified norms, such as '[to] provide clarity regarding damage handling/compensation' and '[to] provide long term clarity regarding production limits'. However, we did not identify the value *Clarity* in the top-down analysis. *Clarity* was also not included in the list of initial values identified in the ten scientific papers (Table 4).

5.4. Validating the results using interviews

In general, respondents underscored that the most recognized values in the content analysis were also the most important values in the Groningen case. The importance of *Trust* in particular was confirmed in clear terms like, "There is a lot of mistrust regarding the minister, partially due to him having two agendas" (Respondent 3) and, "Within the region, you are better off not showing up with papers that say 'NAM' or 'commissioned by NAM', because no one will trust you."

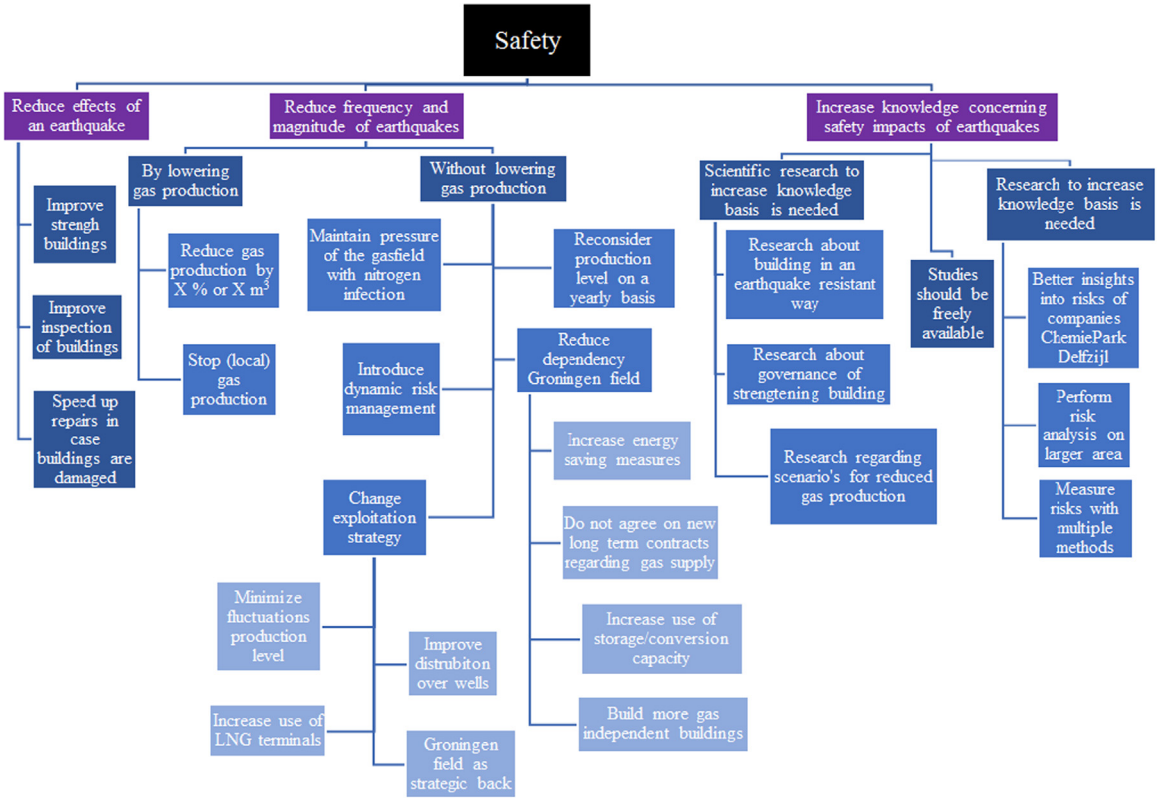

Fig. 3. Values hierarchy for Safety.

(Respondent 2)

Conversely, several respondents pointed towards values such as *Impartiality*, *Geographical equity*,[6] and *Clarity* as having, in their view, a more important role in the public and political debate than the content analysis had indicated. Of these, *Geographical equity* is perhaps the most striking example. In general, interviewees identified it as a core value in the Groningen case, focusing on the idea of ensuring fairness across regions: "The feeling that we are being treated differently than the rest of the Netherlands is very strong here. If you look at it factually then you can see that Groningen only received 1% of the benefits of the gas exploitation. The rest all flows to the West of the Netherlands. We face the costs but never the benefits" (Respondent 5); "Geographical equity is one of the most important things. People from Groningen want to be treated the same as the rest of the people of the Netherlands" (Respondent 7). By contrast, newspaper articles only made reference to *Geographical equity* in a handful of cases, such as, "There has always been discontent regarding the gas exploitation: the financial benefits go to [the national government in] The Hague[7] without the province [of Groningen] getting anything in return" (Van Es, 2014) and "When a couple of buildings subsided in Amsterdam as a result of constructing the North/South Line,[8] the project was put on hold. In Groningen, after 114 induced earthquakes and over 10,000 claims of damage, exploitation of the gas field still continues" (De Veer, 2013).

5.5. Reflection on embedding Safety and Procedural Justice

So far, we have discussed how VSD could be used as an analytical tool to reconstruct how values are (not) embedded in the Groningen case. Below, we illustrate how a VSD approach could work in practice if it were used in the actual redesign of the energy system. A key insight arising from our study is that *Safety* is a critical value in the Groningen controversy, while many of the other critical values expressed are related to securing *Procedural Justice*. As such, we discuss two situations in which VSD might have contributed to better embedding these two critical values.

Safety was not only one of the most frequently recognized values in both newspaper articles and political debates, it also accounted for the lion's share of identified norms and design requirements. An observation that followed from the content analysis was that virtually all of the safety concerns expressed in the public and political debate were related to the strengthening and repair of buildings, as well as norms regarding gas production levels. Surprisingly, the discussion did not focus on standards regarding the maximum allowable safety risk until very recently: these were established for the first time by the Meijdam committee in late 2015 (Commissie Meijdam, 2015). Applying VSD in an earlier phase of the Groningen case might have triggered the discussion concerning the level of risk that is acceptable for the affected community. Relating this to Van de Poel's values hierarchy, this 'higher level element' helps us understand why it could be useful to include 'lower level norms' such as reducing the frequency and magnitude of earthquakes, as doing so might have provided more structure in the discussion regarding acceptable safety standards. Safety norms in the form of maximum acceptable risk could provide a clear point of departure for future debates regarding the translation of such norms into concrete safety measures.

Second, our analysis shows that many of the critical values in the Groningen controversy are related to *Procedural Justice*. This echoes the literature which establishes that the acceptance of socio-technical systems does not only depend on the technical artefacts of the system, but also on its institutional artefacts (e.g. Oosterlaken, 2015). We find *Procedural Justice* in this case to be a multidimensional concept which consists of, among others, the values of *Honesty, Trust, Clarity, Impartiality* and *Transparency*. If *Procedural Justice* were to be reduced to only one of these values, some stakeholders would probably experience this as a breach of *Procedural Justice*. This was indeed what happened in the design of the consultation body, the 'Dialoogtafel' ('Dialogue Table'). The Dialoogtafel was explicitly implemented to regain *Trust*. Consequently, some 'rules of the game' (or, in VSD terminology, design criteria) were established to foster *Trust*. One of these design criteria was the rule that participants were not allowed to communicate positions presented during the discussion to the outside world. However, after some time, the closed character of the consultation body resulted in dissatisfaction and a lack of *Trust* among the people not involved in the consultation, partly due to a lack of involvement and *Transparency* (Stoker et al., 2015). Consequently, a value conflict arose between, on the one hand, *Trust* and *Honesty* as experienced by participants in the Dialoogtafel and, on the other hand, the breach of *Transparency*, *Trust* and *Impartiality* as experienced by those not taking part in the dialogue themselves. If the rules of the game had been established through the VSD methodology, the rules of the Dialoogtafel would also have been validated 'bottom up' to evaluate to what extent the rules did indeed match the most important values. This would likely have resulted in a revision of the rules so that those not taking part in the consultation would not feel excluded, and would have allowed decision makers to investigate whether the discussion format could be designed in accordance with the values *Transparency*, *Trust*, *Honesty* and *Impartiality*. Doing so could have entailed, for instance, adding public meetings where interim results were communicated.

6. Conclusions and policy implications

This paper aimed to empirically explore the applicability of value-sensitive design (VSD) to existing controversial energy projects. We investigated the extent to which it would be possible to identify the relevant values, norms and design requirements in the Groningen gas controversy using values hierarchies. We conclude that in the Groningen case values, norms and design requirements could be retrieved on the condition that newspaper articles and political debates were analyzed using both a top-down and bottom-up approach. Combining these approaches was needed for identifying all relevant values, since the values *Trust* and *Honesty* were only identified through the top-down approach, whereas *Clarity* was only identified through the bottom-up approach. We also established the importance of complementing the analysis of newspaper articles and political debates with stakeholder interviews to avoid underexposure of important values in a VSD. Although *Geographical equity* was mentioned only a few times in newspaper articles and political debates, interviews revealed a view among stakeholders that *Geographical equity* was one of the most important values relating to this case.

A key insight arising from our study is that *Safety* is a critical value in the Groningen controversy, while other critical values such as *Trust* and *Honesty* are related to securing *Procedural Justice*. Although the values *Trust* and *Honesty* were among the most commonly recognized values in the top-down analysis, we found almost no norms or concrete measures which directly related to them. For instance, there was little discussion of specific actions or standards that would help rebuild *Trust*. The lack of translation of values into concrete policy measures lines up with the literature (e.g. Dignum et al., 2016; Okereke and Coventry, 2016). A strength of VSD is that it responds to the need – expressed in the energy justice literature – for moving beyond conceptual accounts of justice and towards the development of practical applications which can better inform and influence energy practices (e.g. Sovacool et al., 2016). Although investigating the added value of VSD for policy-making was not the purpose of our study, the values hierarchies

[6] Geographical equity is a specific type of intragenerational justice (fair distribution of burdens and benefits within a generation). We used the label *Geographical equity* because respondents specifically highlighted this type of intragenerational equity.

[7] The residence of the Dutch Parliament.

[8] An urban subway infrastructure project in the country's capital Amsterdam.

provided concrete recommendations on embedding the values *Safety* and *Procedural Justice* into the socio-technical design of the Groningen controversy. Hence, we believe that our study provides some first evidence that policy makers can use values hierarchies to address moral values in energy cases and to translate these values into concrete policy measures.

Our study shows that it is not only possible to apply VSD in the design of technical artefacts of a new technology, but also in an existing socio-technical energy system. We did not, however, explicitly look into the generalizability of our findings to other energy cases. To better understand the conditions under which this approach can be applied in other cases, we recommend experimenting with different methodologies to obtain relevant values, norms and design requirements. For instance, it might be useful to investigate how VSD would work out in practice when sources other than newspaper articles (e.g. interviews with stakeholders or minutes of town hall meetings) are used as a primary source to obtain values hierarchies. This can illuminate whether our conclusion on the applicability of VSD – that it can only be applied when data is retrieved from both interviews and newspaper articles and then analyzed using both top-down and bottom-up approaches – is a generalizable result, or whether it arises from the use of newspaper articles as a primary source or the complexity of the Groningen case.

Another avenue for further research involves determining under which conditions the results of a VSD study are actually adopted in a real-life policy context and/or translate into real-life policy actions. In our view, the efficiency of a VSD is an important driver for a wide adoption of the method. High efficiency is realized when the costs of applying VSD are low and the positive impacts of the method (e.g. increasing social acceptance, facilitating a structured dialogue, creating awareness of potential value conflicts or generating useful insights to improve the socio-technical energy system) are high. We advise policy makers to carefully weigh the costs and benefits of the VSD. In our case, we observed that a sizable time investment was required to avoid overlooking relevant values. We made use of different data sources, analyzed these using content analysis, tested the reliability of the coding process and employed both a top-down and bottom-up approach. When further research establishes that VSD's application adds substantial value in decision-making processes regarding energy controversies – and does so at reasonable costs – it will be possible to provide more forceful recommendations to policy makers regarding its broader use. If and when that happens, it might be even possible to argue that VSD should be obligatory in consultation processes for energy cases. Because the potential merits of VSD are particularly applicable in (complex) multi-stakeholder decision-making processes we hypothesize that the adoption of VSD will be particularly high in contexts in which the commitment of a large number of stakeholders is necessary to take action. On the other hand, we believe that the attractiveness of VSD for policymakers will be relatively limited in cultures and contexts in which one actor dominates the decision-making process and the consent of other stakeholders is not needed (by which we do not want to suggest that values are not important in those situations). Finally, apart from investigating the conditions under which VSD is adopted in real-life, it is also important to study its institutionalization, including questions about the actors that are – or should be – responsible for commencing the study, the independence and impartiality of the analysis and the role of stakeholders in the analysis.

Acknowledgement

We thank two anonymous reviewers for their useful suggestions to improve our paper. Thanks to Matthew Pentecost for proofreading the manuscript.

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