The acceptability of shale gas? Values in the design of technologies, institutions and stakeholder interactions.

Aad Correljé, Eefje Cuppen*, Marloes Dignum, Udo Pesch & Behnam Taebi
Delft University of Technology, Faculty of Technology, Policy and Management
*Corresponding author: e.h.w.j.cuppen@tudelft.nl

Abstract

Shale gas is a relatively new technology that is embraced by some as the 'game changer' in energy land, and opposed by others because of its risks and other potentially negative impacts. Recent experiences in the US and Europe have shown that the technology witnesses divergent societal acceptance issues. The value-laden basis of such resistance is often ignored, whereas the method of 'value sensitive design' holds that the variety of values might be taken as a point of departure for the (re)design of a technological system so that divergent values among stakeholders are accommodated. In this paper, we will extent the scope of value sensitive design. Not only technologies may be subject of (re)design so to satisfy divergent values: as values are also embedded in the institutional context and in the processes of interaction between stakeholders, the prevention or resolution of controversy may be pursued by the redesign of the institutional context, and by taking the dynamics of stakeholder interaction explicitly into account.

Introduction

The supply of energy, today as well as in the future, is a fundamental pre-requirement for the functioning of society. And, just like in the past, this essential supply of energy is associated with a wide variety of problems. Today's principal problems can be summarized as, firstly, the fact that the use of fossil fuel causes air pollution, which directly jeopardizes human health, while the CO_2 emitted affects the earth's climate. Secondly, there is the perception that the resources that can be exploited easily and at low cost are being depleted rapidly, driving up the price of energy. the third issue at stake is that the uneven regional distribution of energy resources is causing international geopolitical and economic frictions. Just like in the past, such problems foster new initiatives and technologies to produce, store or transport energy in currently "unconventional" ways.

Such initiatives and technologies include the development of wind, solar, thermal and other renewable forms of energy, and advanced methods for exploring and producing hydrocarbon fuels, from the deep sea, tar sands, and geological layers that, until recently, were considered as too expensive and risky, or for which appropriate technologies simply were lacking. A completely new phenomenon is the underground disposal of CO_2, to reduce the amounts emitted in the atmosphere.

Traditionally, such new initiatives give rise to problems as regards their societal acceptability. This is predominantly so because their implementation and operation will always have national or local repercussions. Often, in the development of new energy supply facilities new inconveniences are created, for instance by the siting of extraction, conversion and transport facilities, or by the economic, social and environmental impact of these activities upon the population and its neighbourhood. As a consequence, controversies between local populations, government, and industry are always imminent.

In the Netherlands, new ways to dispose of CO_2 and to store and produce natural gas caused huge controversy (Wolsink, 2000, Persson, 2012). Citizens in the municipality of Barendrecht revolted against the plans of the national government and Shell to feed CO_2 into a depleted gas field underneath this town (Feenstra *et al.*, 2012). Yet, apparently, it was not only the perceived risk, but also the lack of a serious consideration of their concerns, both by the government and by the industry, that fuelled their resistance. This brought about a (temporary) cancellation of all onshore carbon capture and storage-projects in the Netherlands.

Another example concerns a half depleted gas field underneath the municipality of Bergen, which was sold by BP to TAQA from Abu Dhabi and which was selected as an underground gas storage facility. Natural gas would be injected in the summer season into the storage, so that it could be taken out in winter time and distributed among users in the Netherlands and North West Europe. Although not with the same vigour as in Barendrecht, citizens from Bergen together with local authorities and environmental organizations protested against these plans and, in the end unsuccessfully, challenged the legitimacy of the project in the Dutch Supreme Court.

A third example from the Netherlands involved the construction of an exploration facility to test the potential production of shale gas in the municipality of Boxtel. The British company Cuadrilla had obtained a municipal license to conduct drillings, but this license was successfully challenged in court by local inhabitants, together with the Dutch Rabobank, which operated a data centre in the vicinity.

These examples show that the interaction between citizens, businesses, local authorities and environmental organizations may be problematic, which makes the implementation of energy ‘projects’ a difficult enterprise. The government and the energy industry consider the antagonists in such cases as ‘showstoppers’. And policies and communication are organized accordingly. However, instead of seeing such controversies as a consequence of misinformed or bigoted citizens, we would rather maintain that they emerge from an underlying value conflict.

One might say that the value-laden basis of controversies is often ignored by national authorities and energy companies. Hence, they complain that either the public is ill-informed (Wynne, 2001), and immune to scientific information, or only concerned with its own short-term interests (Bell *et al.*, 2005, Wolsink, 2006). This is referred to as the “technocratic pitfall” (Roeser, 2011). Yet, we do not suggest that simply adhering to the desire of local communities is the preferred solution to avoid this pitfall. It would be myopic to assume that the complexity of values and interests related to such projects could be resolved this way; bringing in the “populist pitfall” (Roeser, 2011). The challenge is to overcome both pitfalls, by searching for strategies and solutions that synthesize/bridge the diversity of the variety of public values at stake. Different actors make different assessments of the costs and benefits of these projects. Gaining public acceptance not only requires a more or better dissemination of information, or a more elaborate risk assessment, but also, as we will suggest here, the acknowledgment of different (moral) viewpoints of stakeholders, which should be taken as a point of departure to identify and to construct shared solutions. In other words, a societally responsible development of energy projects requires the accommodation of the variety of stakeholder’s values.

In this paper, we sketch the contours of a methodology that will open up the black box of this variety of values. We also propose the application of *value sensitive design* (VSD) to such energy projects. Our focus is on projects that individually have a local impact through their siting, such as a wind park or gas storage or production facilities, but that - in aggregation - potentially have a wider impact on overall energy supply. VSD aims to incorporate the variety of values in the design process. Yet, most approaches for VSD specifically focus on the design of technological artefacts or systems. However, in respect of energy projects, it is not only technology design that affects the divergent sets of values. It is also the design of the *institutional context* and of the *interactions between stakeholders* that may lead to a deepening, or conversely, a resolution of value conflicts. The institutional context, constituted by formal institutions, such as laws, standards, regulations, contracts, and informal institutions such as customs, traditions, and routines, embodies values that have important ramifications for the distribution of perceived burdens and gains of a specific project. Many of these institutions, especially the formal ones, could be redesigned in order to accommodate divergent values. Also the way in which the project itself is prepared and executed, embodies values that may be of the utmost importance – especially regarding procedural justice. Indeed, we consider the interaction and communication between project ‘owners’ and stakeholders as essential for the public support of projects. Again, by considering the variety of values in the design of such processes, controversies around value sets may be prevented.

In the next section, we will explore the way values are embedded in technologies. In section three, we will examine how value specification takes place within a particular institutional context, applying the theoretical perspective of institutional economics. In section four, we will focus on processes of value specification, emerging in concrete interactions between the stakeholders, around a specific project. To describe these processes, we will make use of insights from STS and participatory theory. Section five will present the approach of value sensitive design, providing an analytical framework for a "value hierarchy", which helps to clarify the values that (should) underlie particular decisions or characteristics of a design. Based on our theoretical explorations, we will try to find out how processes of value specification can be integrated into the design of not only technology, but also into the design of the process and institutions in section six.

Values in technology

In relation to values, it is tempting to see technologies as neutral, taking the identification of technology with an "instrumental" disposition as a point of departure. However, research on the relation between technology and society reveals that this is not in correspondence with empirical reality. In many ways, technologies are strongly value-laden (Winner, 1980), as they give rise to new types of behaviour, and with that they also lead new expectations and new sets of values. In other words, technologies *mediate* perceptions, experiences, practices, and norms (Verbeek, 2006).

As a first manifestation of values in technologies, we may think of an artefact or system that invites or discourages a certain kind of normative behaviour. A clear example is that of a speed bump ("the dead policeman") which urges a driver to take up a cautious driving style. But there are also less obvious applications of value-laden functionalities in the design of technological artefacts and system, as was illustrated in Winner's article "Do artifacts have politics" (1980). In this article, Winner claimed that the famous urban planner Robert Moses designed low overpasses over the parkways on Long Island so that buses could not access the beaches. As a result, poor people, who were dependent on the buses for transport, could not reach the beaches. Since the Afro-American population generally belonged to this group, the beaches were *de facto* only available for the white, upper class. In Winner's account, values (or in his words "politics") are deliberately designed into a technological artefact. However, the value-laden aspects of technology do not always have to be the result of explicit design. Often these aspects are the outcome of *implicit* design: designers and producers often have an implicit world view that drives their technological design. Oudshoorn *et al.* (2002) showed how different artefacts, such as electric shavers, bicycles, and microwave ovens, were specifically designed with a definite idea about how male and female users relate to such a technological artefact.

It is important to realize that such an explicit or implicit inclusion of values in technologies may be hard to identify in technologies related to the production and processing of energy. This is because these technologies are part of the wider energy system, which is characterized by a long-term dynamic interplay between technology and societal behaviour. Values are not as such designed into a socio-technical system; instead they emerge as an outcome of the heterogeneous activities in and around the system. Ideas about the 'right' behaviour of users on the one hand, or the expectations of the 'right' functionality of the technology on the other hand, are values that *co-evolve* with the development of the system itself (Friedman and Kahn Jr, 2002).

For instance, in the domain of energy, the increasing density and quality of energy infrastructures have given rise to certain public values; i.e. the availability of energy is simply taken for granted (security of supply), while it is expected to be safe as well as inexpensive. At the same time, presumptions have been made about the living environment and energy resources we pass on to future generations (sustainability). Indeed, these values could not always be achieved to the fullest extent; i.e. the least expensive energy technology compromises the value of sustainability (e.g. coal power plants) and the technology that maximizes security of supply, may also jeopardize safety (e.g. nuclear power plants). Trade-offs between these values seem to be inevitable.

The explicit acknowledgment of the presence of values in technological design opens up a range of opportunities to proactively address the ethical issues at hand, and to include the variety of public values in design; this is referred to as "front-loaded" ethics (Van den Hoven, 2005). Nowadays, we see that an oil drilling installation or a gas storage facility is often considered in an isolated fashion, whereby questions are being asked about the public's acceptance of the facility. Our proposal is to consider the whole of the trajectory that has led to the realization of the facility, because right from the start of the decision-making on the realization of a project, its siting and the implementation, different values are held by different stakeholders. Only by focusing on these diverse values can we understand and assess the acceptance of the project. More importantly, by proactively including them in the design of technological artefacts and system, and also in the development of formal and informal institutions surrounding these systems, we can move towards ethically acceptable technological projects. In section five we will discuss this issue in detail.

An example of such a project is the Storm Surge Barrier in the Eastern Scheldt in the Dutch province of Zeeland. After the huge flood disaster of 1953, which killed over 1800 people, it was decided to close off the Eastern Scheldt from the North Sea. However, a conventional dam would cause the destruction of the unique eco-system of the Eastern Scheldt. Environmental groups and local fisherman protested against the original plan, thus inspiring a new design of the storm surge barrier.

In this new design the barrier would be open to allow water to pass through, but it would be closed if a flood threatened the hinterland. This new, pioneering, design accommodated both safety and ecological values (Van de Poel, 2009a).

Institutional economics and values

Despite the interference of a divergent range of stakeholders, energy projects are in principle economic activities in the market domain. Hence, the lens of economic theory appears to be the most obvious point of departure. How then does economic theory deal with private and public values regarding the energy system in its wider societal context?

Different schools of economic theory have different positions regarding the way they incorporate the notion of public values in their theory and methodology, and in their analysis what a public value is and how markets and government should safeguard these public values (Correlje and Groenewegen, 2009). Two mainstream schools of economics are *neoclassical economics* (NCE) and *new institutional economics* (NIE). NCE starts with the notion of an ideal market in which private stakeholders[1] exchange goods and services. Assuming a set of preconditions, the accumulation of all private benefits and costs are equal to the social benefits and costs. So, all values are of an individual nature. However, as is acknowledged by mainstream economists, markets hardly ever function in an ideal way. Classic cases of market failure, involving natural monopolies, public goods and externalities, justify government intervention. Environmental and safety aspects of unconventional forms of energy development – as negative externalities - could be a case in point here, as well as their potentially positive contribution to security of energy supply. In the neoclassical approach, in case of market failure through externalities, government should intervene and internalize the “external” costs and benefits, by correcting the prices through taxation or subsidies. However, in our introduction, we have proposed to open up the black box of values, while the neo-classical approach only seems to “add-up” these values into one “price”. This suggests that we have to look for an alternative approach.

NIE also recognizes that actions of stakeholders can have positive or negative consequences for other stakeholders that are not involved in the activities as such. Energy projects that, for instance, cause health risks to the people living in the neighbourhood cause such a negative externality. Essential in the NIE approach are the property rights. It is argued that if there is a setting of clear and complete property rights, private stakeholders will negotiate with each other about using those rights. Victims harmed by a project may, for example, be offered a compensation by the owner of the

[1] Although economists use the word ‘actor’ rather than ‘stakeholder’ in this context, we use the word ‘stakeholder’ throughout this paper for reasons of consistency. A stakeholder is defined as any person or party who is affected by, or can affect, the technology and/or its institutional and societal context.

facilities to accept the risk. Alternatively, the operator may take appropriate measures to minimize the potential impact of its activities. NIE proposes that all private stakeholders will negotiate about changing their behavior and should make adequate contracts and agreements. When the formal institutions are ”right”, then the conditions are set for efficient contracting, as was postulated by Coase (1960). In principle, the stakeholders will then internalize all consequences of their transactions, so the externalities will disappear. Yet, as Coase explained, full internalization of all externalities will only be the case in a world in which transaction costs do not exist. In reality, negotiations and the drafting, concluding and monitoring of the contracts can be an extremely costly affair. When transaction costs prevent private stakeholders to internalize complex externalities, this legitimizes government intervention in (re)allocating these rights and arranging compensation, if the social benefits of the intervention are higher than social costs.

Both NCE and NIE are based on an individualistic, utilitarian conceptualization of the stakeholders. An alternative conceptualization of economic stakeholders results in another view on the selection through markets and in another role for government with respect to public values. The *Original Institutional Economics* (OIE) approach starts out with heterogeneous stakeholders, with preferences that are influenced by formal (e.g. laws, property rights, bureaucracy) and informal institutions (e.g. customs, traditions, religion). It is argued that public values reflect preferences of different, sometimes competing, groups in society about what exactly constitutes welfare, well-being, safety, equity, etc. in a given society and at a given time. So, welfare is not considered to be a simple neutral aggregation of the outcome of all individual interests aiming at maximization of utility and profits, as in mainstream economics. It is a phenomenon that is identified, articulated, developed and operationalized in a socio-political process, within a specific society. Hence, public values do not result from aggregation and neutral selection mechanisms in markets, but are the product of selection processes in a politicized and institutionalized society.

The two mainstream perspectives in the economic framing of energy issues ignore micro and macro-relationships between energy production and use in society. Many positive and negative effects are external to today’s markets and they will remain so, unless they are explicitly recognized as public values of importance and deliberately internalized and institutionalized in a future energy market. The production and the consumption of energy are inextricably linked to positive and negative environmental, economic and social effects, with local, regional and global impacts. Generally, it can be questioned how and whether such effects and also the benefits of potential solutions are taken into consideration as *public values* in the current practices of the evaluation of economic transactions, investments and innovation in energy systems. OIE is concerned with the way in which individual values, like care for the environment, safety, profit-making and security of supply issues become framed and institutionalized as "public" values. OIE examines how values that are at first expressed at the level of individuals, could collectively evolve towards societal and political pressures in different societies, and how these pressures may drive political decision making and public and private strategy development, followed by subsequent processes of institutionalization as procedures, norms and incentives, guiding technical innovation (also see Veenman *et al.*, 2009). According to Commons (1936), institutions are the collective action in the control, liberation and expansion of the individual action, highlighting the dual nature of institutions in constraining and allowing or enabling (economic) activity. Achieving responsible innovation of the energy system via the "market", thus requires a re-evaluation of the prevailing practices of project evaluation, particularly in respect of security of energy supply, safety, and social and environmental aspects. This is less far away from reality than it seems: labour relations, education and social security and external safety rules are examples of direct and indirect economic, environmental, and social effects that were once fully external to market transactions, have now come to be internalized as "public values" into today's economies and markets, successfully embracing seemingly divergent and conflicting interests.

OIE provides the foundations of a framework with which we can engage in value-based research in a predominantly market-centered institutional environment. It allows us to look for values in places that mainstream economic theory will avoid. It also presents us with a wide institutional landscape, in which the activities of heterogeneous groups of stakeholders matter. In fact, we may see the establishment of an institutional environment as the outcome of a heterogeneous process, which, in turn, allows the analytical connection with the value hierarchy, as will be presented below.

It will be the task of the researchers to identify the values that are embedded in the institutional environment, which is built up from formal and informal institutions, and to identify (potential) conflicts between these values. Such an analysis implies the study of a broad empirical domain. Not only does it pertain to legal frameworks at different territorial levels (supranational, national, and regional), but it also pertains to strategies, cultures, and routines in both business and policy-making realms.

The specification of values in a project: stakeholder interactions

Above, we have focused on the technology and the institutional environment as domains that are essentially value-laden, which brings along the possibility that they can intensify or decrease the depth of the value conflict among stakeholders. Still, one important ingredient is missing, namely if we want to give a full consideration to value-laden elements that might contribute to a controversy on the implementation of an energy project, we also have to address the interaction patterns of the stakeholders that are involved. There is a rich body of literature on how the public at large and local stakeholders respond to and interact with science and technology (Wynne, 1992, Eden, 1996, Wynne and Irwin, 1996, Beierle and Konisky, 2000, Devine-Wright, 2012), which testifies that responses to new technologies are largely determined by the *process* through which publics are informed and engaged (Ellis *et al.*, 2007, Walker *et al.*, 2011). This means that the acceptability of a new energy project is determined not only by the characteristics of the technology and the institutional environment, but also by the characteristics of the decision-making procedure, such as fairness (e.g. procedural justice) (Wüstenhagen *et al.*, 2007).

Public responses to technology are produced in an interaction process between stakeholders with different backgrounds, interests, expectations and attitudes towards the technology (Devine-Wright, 2012). Walker (2011) developed a descriptive conceptual framework (see figure 1) based on multiple European case-studies that were carried out in the context of a multidisciplinary project on public engagement with renewable energy projects. This framework schematically shows how public engagement with renewable energy projects is the resultant of the interaction between project developers and public stakeholders, both having their own expectations with regard to the technology, each other, as well as to the process through which the project will be developed, in a particular context.

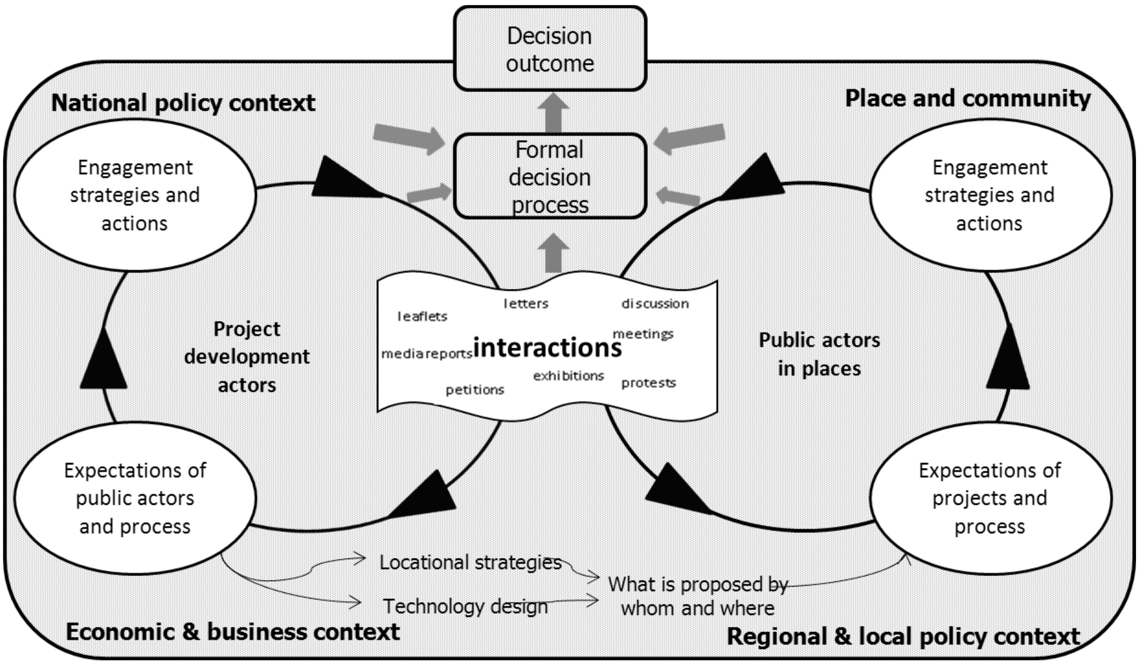

Figure 1: Public engagement with energy technologies (source: Walker (2011))

Four characteristics of this framework need to be highlighted as these are critical to understand the process of values specification in the interaction between actors.

Firstly, the framework is dynamic "in recognizing that, over time, anticipations and expectations evolve and that both the details of proposed projects and the currents of local debates can shift considerably" (Walker *et al.*, 2011). Values in relation to technology are specified in an emergent societal process in which a technology is developed and implemented, and in which multiple stakeholders act and interact in a specific context. For instance, in the Netherlands, the value of safety in respect to flooding is being reformulated in response to changes in the perceived threat and a decreasing acceptability of primarily using high dikes as the traditional means of protection (Broekhans *et al.*, 2010), but the value of safety could also be reshaped when it conflicts with another value; see the example of the Eastern Scheldt Estuary in section two. This implies that what is perceived as acceptable may change over time, depending on the interaction between stakeholders, their values, how conflicting values are been dealt with, and how all this is incorporated in the design of technology and surrounding institutions. Value specification thus takes place in an emergent and dynamic societal process, and is, or can be, similarly dynamic. The dynamic nature of value specification in stakeholder interaction points to an essential difference between the way in which values are specified in the interaction processes between stakeholders, on the one hand, and the way values are specified in technologies and institutions, on the other hand. A characteristic of these latter two elements is their relatively fixed nature, they embed and, with that, they solidify certain values in their design. This dynamic character is an important addition to the theoretical reflections that have been presented in the previous two sections. It emphasizes that values cannot be taken for granted, but that that these may pop up during the implementation of the process itself. Ignoring this emergent nature of values might lead to a deepening of the antagonism between different stakeholders, potentially leading to an escalation of the conflict. This implies that it is not possible to fully specify *ex ante* which values need to be taken into account, which has to be acknowledged in the application of value-sensitive design.

Secondly, the framework describes public engagement as a symmetrical process (Walker *et al.*, 2011). It gives equal attention to the stakeholders involved in promoting the project – who can be seen as the project stakeholders – and to the local community, i.e. the "public". This symmetry is considered crucial for value sensitive design of energy projects. Most research on public acceptance has focused on the way local communities form their opinions, how they process information, and how they can be involved in participatory processes. This one-sided focus ignores the values, interests, and expectations that project stakeholders have, while these will have a severe impact on the way these stakeholders engage with local communities – which will be illustrated later in this section by the way the "NIMBY" label is often used by project stakeholders to explain public responses to technology projects.

Thirdly, the framework identifies expectations and anticipations as shaping local acceptance of projects (Walker *et al.*, 2011). These expectations help to unravel the complex social dynamics in controversial energy projects. Walker *et al.* (2011) identify four types of expectations that public stakeholders may have: 1) expectations about the form and impact of a project: 2) expectations about the project developer; 3) expectations about the process;, and 4) expectations about what a proper and appropriate distribution of benefits from a project should be. The project stakeholders have: 1) expectations about the public stakeholders and their responses to the project; and 2) expectations of development and decision processes (how they (ought to) operate, how they can and should engage with the public, etc.). These expectations articulate specific values, and therefore need consideration in the value-sensitive design of energy projects. For instance, a project developer announces his plans in a local newspaper, and citizens may respond to that plan based on their expectations of what such a project means for them (*distributional* justice issues) and whether they would get a voice in the decision-making and how the project will be realized in their community (*procedural* justice issues). They may attend a public hearing, voice their ideas and concerns, to which, in his turn, the project developer will respond. Stakeholders' expectations regarding the technology, other stakeholders, and the decision-making procedure shape the values that are to be specified by this stakeholder. This specification takes place in a dynamic process. This implies that neither the specified values nor the operationalization of the values are fixed in the design process. Consider, for instance, a project developer who expects the public to be ill-informed and risk-averse (which are deeply rooted beliefs about the public (see Wynne, 1993, Wynne, 2001). Interaction is then likely to be geared at providing technical facts and ensuring the safety of a project. Yet, actually, the public may be more concerned about procedural issues (e.g. fairness and transparency) (Walker *et al.*, 2010), or the distribution of costs and benefits. These concerns are not addressed by providing more information on technology and risk. This mismatch may frustrate the process, leading to the paradox that preventive efforts (e.g. by providing "the hard facts") may actually provoke public opposition. The NIMBY label is a well-known example of a frame that might increase the experienced gap between project stakeholders and local communities. This label is often used to explain public responses to (local) technology projects. The NIMBY notion implies a social dilemma: it suggests that citizens have a favourable attitude towards a specific technology (e.g. wind energy), but this becomes a negative attitude when it comes to the siting of that technology "in their backyards". This understanding of public responses is too simplistic and proves to be invalid in many cases (Wolsink, 2000). The NIMBY label frames the public as concerned only with their own short-term interest. As such, the NIMBY label influences the dynamics of the debate, steering towards a conflict between the public good versus individual interests.

Fourthly, the framework acknowledges the influence of contextual factors on public engagement (Walker *et al.*, 2011). Four types of context are distinguished: 1) characteristics of place and community, 2) regional and local policy, 3) national policy, and 4) business. Tapping into the meanings that are assigned within these contexts suggests that different values may be at stake in different contexts. An example (from Walker *et al.*, 2011) from the context of place and community illustrates this. An offshore wind farm was planned in Llandudno, a Welsh village in the UK. The more people felt attached to this village, the more they opposed: "Tapping into place meanings provided contextual information as to why this was the case – Llandudno was a unique place that was attractive to tourists, characterized by its scenic, natural beauty also because of the view on the sea and its Victorian heritage. These meaningful characteristics were widely perceived to be threatened by a wind farm that would 'industrialize' the area and 'fence in the bay'".

The essence of this section for the conceptualization of value sensitive design, is that it emphasizes that stakeholder interaction in which values get specified is a dynamic process. The emergent and dynamic nature of value specification implies that an *ex ante* assessment of relevant and conflicting values is not possible. Designing for values requires a continuous and flexible approach. This approach is symmetrical in terms of its consideration of the values of the project stakeholders and those of the local communities affected by the project, as well as of its consideration of the interaction between these groups of actors. The values are articulated by expectations of both types of stakeholders about the project and its impacts, the decision-making procedure, and about the other stakeholders. Finally, the approach should be sensitive to specific contextual factors, which may render certain values more salient in context A than in context B. This means that value sensitive design will never be a blueprint, but that it should targeted for a specific context, in which specific cultural, political and economic factors shape the process of value specification.

Value sensitive design

Value sensitive design aims at systematically incorporating human values in the design of new technologies. This method has been primarily introduced and developed in information technology and for designing human computer interaction (Friedman and Kahn Jr, 2000, Friedman and Kahn Jr, 2002, Van den Hoven, 2007), but later it has been elaborated to address the inclusion of moral values in other domains of technological design (Nissenbaum, 2005, Van de Poel, 2009b, Van den Hoven *et al.*, Forthcoming). VSD argues that the design process has value implications, since new technology can shape our practice and hence promote or undermine certain values (Van Den Hoven, 2008).

Friedman and Kahn (2002) present VSD as a tripartite iterative method that integrates conceptual, empirical and technical investigations. Conceptual investigations involve a philosophical questioning of the values, like which values are affected in what way by technological design? Who is affected? And how to engage in trade-offs among values? Empirical investigations are aimed at social-scientific understanding of experiences of people affected by technological design. Technical investigations analyse the technical artefact or system, to assess how they support or undermine certain values and support the development of alternative technical solutions.

There are many challenges and difficulties in following the tripartite methodology of VSD. Manders-Huits (2011) discusses two key issues, namely the lack of empirical analysis and the lack of moral methodology. Firstly, whereas VSD emphasizes the need to consider all stakeholders (i.e. those who use the technology and those who could be affected by the use of technology), it lacks a clear methodology for identifying these stakeholders and for assessing and systematically including stakeholders' values). So, VSD will always be in need of social-scientific empirical methods. Secondly, it is not clear how trade-offs could be dealt with, once we are familiar with the conflicting values. In other words, VSD will always be in need of moral analysis and ethical theory. In the remainder of this section, we will present our approach and discuss how our adjustments to VSD could help overcome some of these methodological problems.

We propose to apply VSD not only in case of the technological design of energy systems. As has been shown in the previous sections, values are also be specified in dynamic social processes and they are embedded in the formal and informal institutions that surround a major technological system. Hence, in the iterative approach of VSD, we will analyse this dynamic and the *design* of the surrounding institutions in such projects. Following Van de Poel's approach for translating values into design requirements, we will distinguish between three different levels in a "value hierarchy" (Van de Poel, forthcoming). At the highest – most abstract - level, there are fundamental *values* someone may hold paramount such as safety, environmental friendliness, economic efficiency and so forth. Contestations do not (often) arise from what constitutes a value. Everybody will endorse abstract values like safety, equity, efficiency, etc.) Rather, controversy arises from how the value is specified into *norms*. Norms are located at the second level of hierarchy and form 'prescription for or restriction on' actions (Van de Poel, forthcoming). Such norms may include *objectives* (like "maximize safety", "safeguard environment" or "minimize costs" without a specific target), *goals* that specify a more tangible target, and *constraints* that set boundary or minimum conditions. The bottom level of a value hierarchy, which is also the most concrete one, indicates the technical and institutional *design requirements* that are derived from the norms. Figure 2 illustrates this hierarchy.

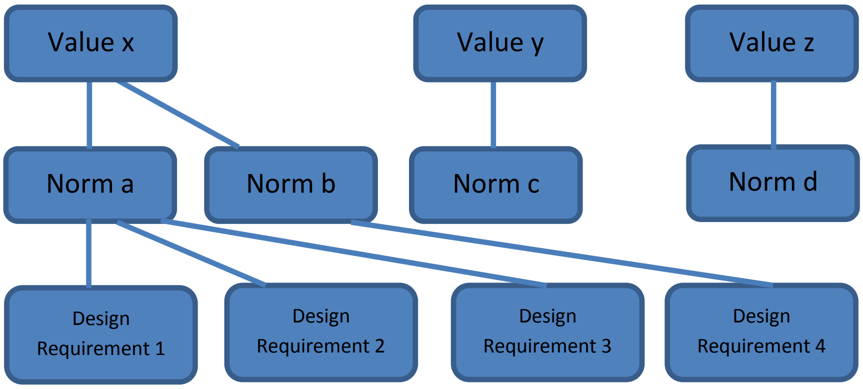

Figure 2: The three levels of value hierarchy: i.e. values, norms and design requirements.

The value hierarchy can be used as an analytical tool and as a design tool, being important steps in VSD. As an analytical tool, it can help to analyse *why*, or *for the sake of what* (Van de Poel, forthcoming), something is being done or preferred by someone. It can help to explicate the values that underlie certain decisions or characteristics of a design (analyse *why*) and it can help to understand controversies when values and/or norms were specified in the design process but were not incorporated in the design (analyse *for the sake of what*). As a design tool, the value hierarchy can be used to come up with a design that is robust in the sense that it can bring together divergent values and norms into a coherent set of *ex ante* design requirements, as regards process and substance. VSD investigations should start with applying this value hierarchy as an *analytical* tool to unpack the emergent societal process of value specification in energy projects. With this analytical tool, the following could be achieved:

- Insight in values, norms and design requirements can be identified in the *technological* and *institutional* design;
- Insight in the way how the interaction between stakeholders and their expectations (about the technology, a specific project, other stakeholders and decision-making procedures) has shaped the process of value specification;
- Insight in the way how values that are held by stakeholders are specified and institutionalized as procedures, norms providing the (dis)incentives for technical innovation.

Our main goal in applying VSD as an analytical tool is to identify and understand the conflicting values and controversies. Once we have identified these, we move on to apply the value hierarchy in the design tool fashion. We will look into the potential for changing technological features or institutional design characteristics, in such way that conflicts can be accommodated. Indeed, controversies and conflicting values may fuel technological innovation, like the Eastern Scheldt Estuary, Moreover, controversies may also suggest substantial changes in the institutional context, including the rules for decision-making .

Discussion and conclusion: Designing technology, institutions, and stakeholder interactions

Energy projects are strongly driven by market incentives. However, for the successful implementation of these projects, market incentives alone are insufficient. Even when externalities and transaction costs are incorporated in the project design, economic evaluation does not pay sufficient attention to the dynamics of stakeholder values, which may cause trouble in case of the implementation of projects that seem rational from an economical perspective. The values of stakeholders are also influenced by the specific process through which an energy project is initiated and licensed, which suggests that for the successful initiation of an energy project, it is important to pay attention to the process through which the project becomes established and the stakeholders' values that are addressed in this process.

Each design process embeds values. However, making these latent values in technologies and the institutional environment explicit provides us with the opportunity to facilitate a process of redesigning technologies and institutions in such a way that conflicting values are accommodated. The theoretical approach presented in this paper aims to open the black-box of values and provide an analytical framework with which value conflicts around energy projects can be managed. The question then is how to use the identification of a range of values in order to (re)design technologies and institutions. We have to identify and outline how technology and institutions can be developed in such a way as to synthesize the variety of (conflicting) stakeholder values. The value hierarchy instructs that we have to find out which values and norms are embedded in technologies and institutions, and which values and norms are specified by the several groups of stakeholders, after which these sets of values and norms have to be translated into design requirements. To do so in a practical case, we will have to address the following questions:

- If there are values and/or norms missing in the current *technological* design, and if so, how these can be specified into design requirements;
- If there are values and/or norms missing in the current *institutional* context, and if so, how these can be specified into design requirements;

- If the processes in which the different groups of stakeholders interact allow the specification of all stakeholder values ;

Until now, the proposed framework proposed in this paper is based on theoretical reflections. Empirical and practical detail, however, will have to shed more light upon a number of important questions that yet remain unanswered. This requires a thorough and context-specific operationalization of the framework, which will be the first step to take. One of the most important questions then, involves the relation between the technological design and the institutional design. Ideally, both institutions and technology could be subject to value-sensitive design. However, it may not always be possible to have a satisfactorily design of both elements, which prompts questions such as: are people willing to accept a technological artefact in their backyard, if their values are taken seriously because of a well-designed institutional context? And under what conditions would they do so? In other words, what determines the elasticity of public acceptance? This question cannot be answered theoretically, which clearly urges the operationalization and empirical testing of our framework in the real world. In the meantime, the framework we propose, promises an integral approach to manage value-laden conflicts in the development of new energy projects.

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